

V.S.B. ENGINEERING COLLEGE, KARUR.

(An Autonomous Institution)

Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai.

NH – 67, Covai Road, Karudayampalayam PO, Karur - 639 111.



CURRICULUM AND SYLLABI REGULATIONS – 2023

**Department of
Chemical Engineering**

I. Vision and Mission of the Institute

Vision

We endeavor to impart futuristic technical education of the highest quality to the student community and to inculcate discipline in them to face the world with self-confidence and thus we prepare them for life as responsible citizens to uphold human values and to be of service at large. We strive to bring of the Institution as an Institution of academic excellence of International standard.

Mission

We transform persons into personalities by the state-of the art infrastructure, time consciousness, quick response and the best academic practices through assessment and advice.

II. Vision and Mission of the Department

Vision

To be a centre of excellence for development and dissemination of knowledge in Chemical Engineering for the Nation and beyond

Mission

•	Impart knowledge to students at all levels through a vibrant, dynamic and state of the art intellectual delivery to ensure the creation of a complete Chemical Engineer with a high sense of social responsibility and professional ethics
•	Synergize the efforts of the students and faculty to evolve innovative engineering practices and teaching methodologies
•	Generate an environment of continuous learning and research

III. Program Educational Objectives(PEOs)

PEO1:	Apply principles of mathematics, science, and engineering to analyze and solve problems encountered in chemical engineering and related areas.
PEO2:	Think critically and creatively, especially about the use of technology to address local and global problems and become a socially responsible engineer by involving with community and professional organizations.
PEO3:	Exhibit professional, ethical codes of conduct, team work and continuous learning for catering the ever changing needs of the society

IV. Program Outcomes(POs)

Graduates of the CHEMICAL ENGINEERING will be able to

PO1:	Engineering knowledge Apply the knowledge of mathematics, science, engineering fundamentals to the solution of complex engineering problems in the major areas of Chemical Engineering.
PO2:	Problem analysis Identify, formulate, review research literature, and analyze complex problems of Chemical Engineering reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:	Design/development of solutions Design solutions for complex Chemical engineering problems and design construction related components and processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4:	Conduct investigations of complex problems Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5:	Modern tool usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6:	The engineer and society Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Chemical engineering practice.
PO7:	Environment and sustainability Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8:	Ethics Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9:	Individual and team work Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10:	Communication Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11:	Project management and finance Demonstrate the acquisition of the body of engineering knowledge and insight and management principles and apply them as member /leader in teams and multidisciplinary environments.
PO12:	Life-long learning Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

V. Program Specific Outcomes(PSOs)

Graduates of the CHEMICAL ENGINEERING will be able to

PSO1:	Applying knowledge in core and allied fields to solve complex Engineering problems.
PSO2:	Able to expose their skills using latest tools to arrive cost effective and appropriate solutions.
PSO3:	Apply the contextual knowledge with professional ethics to manage different projects in multi-disciplinary environment.

VI. PEOs mapped with POs and PSOs

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
PEO 1	2	2	3	2	2	1	1	1	1	1	1	2	3	2	1
PEO 2	3	2	3	3	2	2	2	1	1	2	2	2	3	3	1
PEO 3	3	2	3	2	3	2	2	1	2	1	2	2	3	2	2

1-low 2-medium 3-high '-' – no correlation

VII. Mapping of Course Outcomes(Cos) with Program Outcomes(POs)

		COURSE NAME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9	PO10	PO 11	PO 12	PS O1	PS O2	PS O3
YEAR 1	SEMESTER 1	Professional English - I	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-
		Matrices and Calculus	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
		Engineering Physics	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-
		Engineering Chemistry	3	1	1.6	-	1	1	1	-	-	-	1	1	-	-	-
		Programming in C	2	2.4	2.2	1	2.2	1	1.2	1	2	-	3	2.4	1.8	2.2	-
		தமிழர் மரபு /Heritage of Tamils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Programming in C Laboratory	1.8	2.4	2.6	1.6	1.4	1.6	-	-	2.2	1	2.4	2.4	2.4	2.4	-
		Physics and	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-
		Chemistry Laboratory	3	1	-	-	-	1	1	-	2	-	1	1	-	-	-
		English Laboratory	3	3	3	3	1	3	3	3	3	3	3	3	-	-	-

SEMESTER 2	Professional English II	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
	Computational Methods	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
	Physics of Materials	3	2.25	2	1.66	2	1.6	1.75	1				1			
	Basic Electrical, Electronics and Instrumentation Engineering	2.2	1.6	1.6	2		2	2	1.2		2		3	1		2
	Engineering Graphics	3	1	2		2					3		2	2	2	
	Basics of Chemical Engineering	3	2.25	2	3	2.25	2	1	1	-	-	2.25	2	3	2.25	-
	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Engineering Practice Laboratory	3	2			1	1	1					2	2	1	1
	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
	Communication Laboratory / Foreign Language	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
YEAR 2 SEMESTER 3	Transforms and Partial Differential Equations	3	3	2.4	1.8	1.6	1	0.4	0	0.4	0.2	0.6	1.6	2	1.2	1
	Basic Mechanical Engineering	2.6	2.6	2.8	2	2.3	2.2	1.6	1.5	2.6	2	2.4	2.8	2.4	2	2
	Mechanics of	2.4	2.4	2.8	2.0	2.3	2.3	2.3	2.5	2.6	1.8	2.4	2.8	2.4	2.0	2.0

YEA	SEMESTER 3	Solids															
		Chemical Process Calculations	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
		Fluid Mechanics for Chemical Engineers	2.7	3.0	3.0	3.0	2.0	2.0	1.7	1.0	-	2.0	1.5	2.5	3.0	1.7	2.0
		Chemical Process Industries	2.4	2.4	2.8	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.8	2.0	2.0
		Basic Mechanical Engineering Laboratory	2.6	2.6	2.8	2.0	2.3	2.3	2.3	2.5	2.6	2.0	2.4	2.8	2.4	2.0	2.0
		Technical Analysis Laboratory	1.0	2.6	2.8	2.0	2.3	2.3	2.3	2.5	2.6	2.0	2.4	2.8	2.4	1.8	1.3
		Statistics and Quality Control	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
	SEMESTER 4	Mass Transfer I	3.0	3.0	3.0	2.4	1.4	1.0	1.0	1.0	1.2	1.0	1.4	3.0	2.2	1.5	1.2
		Mechanical Operations	2.6	2.2	2.4	2.2	1.6	1.2	2.0	1.3	1.4	1.8	2.2	1.8	2.0	2.4	1.8
		Chemical Engineering Thermodynamics-I	2.6	2.2	1.8	2.0	1.3	1.3	1.5	1.7	2.0	1.4	1.5	1.3	2.7	2.3	1.7
		Heat Transfer	2.2	2.4	2.8	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.6	1.6	1.4
		Environmental Science and Sustainability	3.0	1.0	1.0	-	1.0	1.0	2.0	-	2.0	-	1.0	1.0	-	-	-
		Fluid Mechanics Laboratory	3.0	3.0	3.0	3.0	2.0	-	2.0	-	-	3.0	2.0	2.2	3.0	3.0	3.0
		Mechanical Operations Laboratory	3.0	2.8	2.0	2.2	1.4	2.0	2.4	1.6	2.4	1.8	1.6	1.8	3.0	2.4	1.4
		Mass Transfer	3	3	2	-	-	1	1	1	-	1	-	3	3	2	2

		II															
		Chemical Engineering Thermodynamics –II	3	3	3	2.8	2.8	-	-	-	-	-	-	3	3	3	-
		Computational Chemical Engineering Laboratory	3	3	3	3	3	-	2	1	1	-	-	-	3	3	-
		Heat Transfer Laboratory	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
		Mass Transfer Laboratory	3	3	-	3	-	-	-	-	2	-	-	2	3	3	-
		Chemical Reaction Engineering-I	3	3	3	2	2	2	2	-	-	-	-	-	3	3	-
	SEMESTER 6	Process Dynamics and Control	3	3	3	3	2	2	3	-	2	2	2	2	3	3	1
		Chemical Reaction Engineering Laboratory	3	3	3	2	2	2	2	-	-	2	2	1	3	3	-
		Process Equipment design and drawing	3	3	-	3	-	-	-	-	2	-	-	2	3	3	-
		Mini Project	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
YEAR 4	SEMESTER 7	Chemical Reaction Engineering-II	3	3	3	3	2	2	2	-	-	-	-	3	3	3	-
		Transport Phenomena	3	3	3	2	1	-	-	-	1	-	-	1	3	3	-
		Process Control Laboratory	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
		Project Work I	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	SEM 8	Project Work II	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1-Low,2-Medium,3-High,”-“no correlation

B.Tech. CHEMICAL ENGINEERING
Regulations 2023
For the students admitted from 2023 onwards
CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR I – VIII SEMESTERS
SEMESTER I

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23IP101	Induction Programme	-	-	-	-	-	-	0
THEORY									
2	23HST101	Professional English – I	HSMC	40/60	3	0	0	3	3
3	23MAT101	Matrices and Calculus	BSC	40/60	3	1	0	4	4
4	23PHT101	Engineering Physics	BSC	40/60	3	0	0	3	3
5	23CYT101	Engineering Chemistry	BSC	40/60	3	0	0	3	3
6	23GET101	Programming in C	ESC	40/60	3	0	0	3	3
7	23GET102	தமிழர் மரபு /Heritage of Tamils	HSMC	40/60	1	0	0	1	1
PRACTICALS									
8	23GEP101	Programming in C Laboratory	ESC	60/40	0	0	4	4	2
9	23PHP101	Physics and Chemistry Laboratory	BSC	60/40	0	0	4	4	2
10	23HSP102	English Laboratory ^s	EEC	100/-	0	0	2	2	1
TOTAL				-	16	1	10	27	22

^s Skill Based Course

SEMESTER II

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23HST201	Professional English – II	HSMC	40/60	2	0	0	2	2
2	23MAT201	Computational Methods	BSC	40/60	3	1	0	4	4
3	23PHT207	Physics of Materials	BSC	40/60	3	0	0	3	3
4	23EET203 R	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40/60	3	0	0	3	3
5	23GET201	Engineering Graphics	ESC	40/60	2	0	4	6	4
6	23CHT201	Basics of Chemical Engineering	PCC	40/60	3	0	0	3	3
7	23GET202	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	40/60	1	0	0	1	1
8	-	NCC Credit Course Level 1 [#]	-	-	2	0	0	2	2 [#]
PRACTICALS									
9	23GEP201	Engineering Practices Laboratory	ESC	60/40	0	0	4	4	2
10	23EEP202	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	60/40	0	0	4	4	2
11	23GEP202	Communication Laboratory /Foreign Language ^{\$}	EEC	60/40	0	0	4	4	2
TOTAL				-	19	1	16	36	26

[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA. [§] Skill Based Course

SEMESTER III

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23MAT301	Transforms and Partial Differential Equations	BSC	40/60	3	1	0	4	4
2	23CHT301	Basic Mechanical Engineering	ESC	40/60	3	0	0	3	3
3	23CHT302	Mechanics of Solids	PCC	40/60	3	0	0	3	3
4	23CHT303	Chemical Process Calculations	PCC	40/60	3	0	0	3	3
5	23CHT304	Fluid Mechanics for Chemical Engineers	PCC	40/60	3	0	0	3	3
6	23CHT305	Chemical Process Industries	PCC	40/60	3	0	0	3	3
PRACTICALS									
7	23CHP301	Basic Mechanical Engineering Laboratory	ESC	60/40	0	0	4	4	2
8	23CHP302	Technical Analysis Laboratory	PCC	60/40	0	0	4	4	2
9	23GEP301	Professional Development	EEC	100/-	0	0	2	2	1
TOTAL				-	18	1	10	29	24

^sSkill Based Course**SEMESTER IV**

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23MAT403	Statistics and Quality control	BSC	40/60	3	1	0	4	4
2	23CHT401	Mass Transfer I	PCC	40/60	3	0	0	3	3
3	23CHT402	Mechanical Operations	PCC	40/60	3	0	0	3	3
4	23CHT403	Chemical Engineering	PCC	40/60	3	0	0	3	3

		Thermodynamics – I							
5	23CHT404	Heat Transfer	PCC	40/60	3	0	0	3	3
6	23GET401	Environmental Science and Engineering	BSC	40/60	2	0	0	2	2
7		NCC Credit Course Level 2 [#]	-	-	3	0	0	3	3 [#]
PRACTICALS									
8	23CHP401	Fluid Mechanics Laboratory	PCC	60/40	0	0	3	3	1.5
9	23CHP402	Mechanical Operations Laboratory	PCC	60/40	0	0	3	3	1.5
TOTAL				-	20	1	6	27	21

[#] NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER V

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23CHT501	Chemical Engineering Thermodynamics – II	PCC	40/60	3	0	0	3	3
2	23CHT502	Mass Transfer II	PCC	40/60	3	0	0	3	3
3		Mandatory Course-I ^{&}	MC	100/-	3	0	0	3	0
4		Professional Elective I	PCC	40/60	3	0	0	3	3
5		Professional Elective II	PEC	40/60	3	0	0	3	3
6		Professional Elective III	PEC	40/60	3	0	0	3	3
PRACTICALS									
7	23CHP501	Computational ChemicalEngineering Laboratory	PCC	60/40	0	0	4	4	2
8	23CHP502	Heat Transfer Laboratory	PCC	60/40	0	0	4	4	2

9	23CHP503	Mass Transfer Laboratory	PCC	60/40	0	0	4	4	2
TOTAL				-	18	0	12	30	21

& Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

SEMESTER VI

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23CHT601	Chemical Reaction Engineering – I	PCC	40/60	3	0	0	3	3
2		Open Elective – I*	OEC	40/60	3	0	0	3	3
3		Professional Elective IV	PEC	40/60	3	0	0	3	3
4		Professional Elective V	PEC	40/60	3	0	0	3	3
5		Professional Elective VI	PEC	40/60	3	0	0	3	3
6	23CHT602	Process Dynamics and Control	PEC	40/60	3	0	0	3	3
7		Mandatory Course-II ^{&}	MC	100/-	3	0	0	3	0
8		NCC Credit Course Level 3 [#]		-	3	0	0	3	3 #
PRACTICALS									
9	23CHP601	Chemical Reaction Engineering Laboratory	PCC	60/40	0	0	3	3	1.5
10	23CHP602	Process Equipment Design and Drawing	PCC	60/40	0	0	3	3	1.5
11	23CHP603	Mini Project	EEC	60/40	0	0	4	4	2
TOTAL				-	24	0	12	36	23

*Open Elective – I shall be chosen from the emerging technologies.

& Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC- II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.

SEMESTER VII

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23CHT701	Chemical Reaction Engineering II	PCC	40/60	3	0	0	3	3
2	23CHT702	Transport Phenomena	PCC	40/60	3	0	0	3	3
3	23GET701	Human values and Ethics	HSMC	40/60	2	0	0	2	2
4		Elective - Management [#]	HSMC	40/60	3	0	0	3	3
5		Open Elective – II**	OEC	40/60	3	0	0	3	3
PRACTICALS									
6	23CHP701	Process Control Laboratory	PCC	60/40	0	0	4	4	2
7	23CHP702	Industrial Training /Internship I [#]	EEC	100/-	-	-	-	-	1
8	23CHP703	Project Work I	EEC	60/40	-	-	8	8	4
TOTAL				-	14	0	12	26	21

^{##}Two weeks industrial training/internship carries one credit. Industrial training/Internship during VI Semester Summer Vacation will be evaluated in VII semester

SEMESTER VIII

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1		Open Elective – III***	OEC	40/60	3	0	0	3	3
2		Open Elective – IV***	OEC	40/60	3	0	0	3	3
PRACTICALS									
1	23CHP801	Project Work II	EEC	60/40	0	0	12	12	6
TOTAL					6	0	12	18	12

ELECTIVE - MANAGEMENT COURSES

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23EMT001	Principles of Management	HSMC	40/60	3	0	0	3	3
2	23EMT002	Total Quality Management	HSMC	40/60	3	0	0	3	3
3	23EMT003	Engineering Economics and Financial Accounting	HSMC	40/60	3	0	0	3	3
4	23EMT004	Human Resource Management	HSMC	40/60	3	0	0	3	3
5	23EMT005	Knowledge Management	HSMC	40/60	3	0	0	3	3
6	23EMT006	Industrial Management	HSMC	40/60	3	0	0	3	3
TOTAL					18	0	0	18	18

MANDATORY COURSES I

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1.	23MCT001	Introduction to Women and Gender Studies	MC	100/-	3	0	0	3	0
2.	23MCT002	Elements of Literature	MC	100/	3	0	0	3	0
3.	23MCT003	Film Appreciation	MC	100/	3	0	0	3	0
4.	23MCT004	Disaster Management	MC	100/	3	0	0	3	0
TOTAL				-	12	0	0	12	0

MANDATORY COURSES II

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23MCT006	Well Being with traditional Practices (Yoga, Ayurveda and Siddha)	MC	100/	3	0	0	3	0
2	23MCT007	History of Science and Technology in India	MC	100/	3	0	0	3	0
3	23MCT008	Political and Economic Thought for a Humane Society	MC	100/	3	0	0	3	0
4	23MCT009	State, Nation Building and Politics in India	MC	100/	3	0	0	3	0
5	23MCT010	Industrial Safety	MC	100/	3	0	0	3	0
TOTAL					15	0	0	15	0

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical I Petroleum Process Technology	Vertical II Energy Engineering	Vertical III Biochemical Engineering	Vertical IV Environmental and Safety Engineering	Vertical V Computational Chemical Engineering	Vertical VI Emerging Technologies
Petroleum Chemistry and Refining Fundamentals	Bioenergy	Biochemistry	Air Pollution Engineering	Computational Techniques	Polymer Technology
Chemical Plant Design	Renewable Energy Resources	Bioprocess Technology	Waste Water Treatment	Optimization of Chemical Processes	Process Automation
Design Safety	Pinch Technology	Fermentation Technology	Solid waste Management	Process Modeling and Simulation	Nano Technology
Refinery Advancements and Environmental Regulations	Hydrogen And Fuel Cell Technology	Downstream Processing Technology	Environmental Impact Assessment	Pinch Analysis and Heat Exchange Network Design	Material Selection
Process Utilities	Power Plant Engineering	Enzyme Technology	Process Safety Management	Chemical Process Flow sheeting	Industry 4.0 Concepts
Petrochemical Technology	Non- Renewable Energy Sources	Bioreactor Design	Risk andHAZOP Analysis	Computational Fluid Dynamics	Mineral Processing Technology

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation. Students are permitted to choose all Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI. The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to Regulations 2021 Clause 4.10.

PROFESSIONAL ELECTIVE COURSES: VERTICALS**VERTICAL 1: PETROLEUM PROCESS TECHNOLOGY**

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal /External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE001	Petroleum Chemistry and Refining Fundamentals	PEC	40/60	3	0	0	3	3
2	23CHE002	Chemical Plant Design	PEC	40/60	3	0	0	3	3
3	23CHE003	Design Safety	PEC	40/60	3	0	0	3	3
4	23CHE004	Refinery Advancements and Environmental Regulations	PEC	40/60	3	0	0	3	3
5	23CHE005	Process Plant Utilities	PEC	40/60	3	0	0	3	3
6	23CHE006	Petrochemical Technology	PEC	40/60	3	0	0	3	3

VERTICAL 2: ENERGY ENGINEERING

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE007	Bioenergy	PEC	40/60	3	0	0	3	3
2	23CHE008	Renewable Energy Resources	PEC	40/60	3	0	0	3	3
3	23CHE009	Pinch Technology	PEC	40/60	3	0	0	3	3
4	23CHE010	Hydrogen And Fuel Cell Technology	PEC	40/60	3	0	0	3	3
5	23CHE011	Power Plant Engineering	PEC	40/60	3	0	0	3	3
6	23CHE012	Non-Renewable Energy Sources	PEC	40/60	3	0	0	3	3

VERTICAL 3: BIOCHEMICAL ENGINEERING

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE013	Biochemistry	PEC	40/60	2	0	2	4	3
2	23CHE014	Bioprocess Technology	PEC	40/60	2	0	2	4	3
3	23CHE015	Fermentation Technology	PEC	40/60	2	0	2	4	3
4	23CHE016	Downstream Processing Techniques	PEC	40/60	2	0	2	4	3
5	23CHE017	Enzyme Technology	PEC	40/60	3	0	0	3	3
6	23CHE018	Bioreactor Design	PEC	40/60	3	0	0	3	3

VERTICAL 4: ENVIRONMENTAL AND SAFETY ENGINEERING

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE019	Air Pollution Engineering	PEC	40/60	3	0	0	3	3
2	23CHE020	Waste Water Treatment	PEC	40/60	3	0	0	3	3
3	23CHE021	Solid waste Management	PEC	40/60	3	0	0	3	3
4	23CHE022	Environmental Impact Assessment	PEC	40/60	3	0	0	3	3
5	23CHE023	Process Safety Management	PEC	40/60	3	0	0	3	3
6	23CHE024	Risk and HAZOP Analysis	PEC	40/60	3	0	0	3	3

VERTICAL 5: COMPUTATIONAL CHEMICAL ENGINEERING

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE025	Computational Techniques	PEC	40/60	3	0	0	3	3
2	23CHE026	Optimization of Chemical Processes	PEC	40/60	3	0	0	3	3
3	23CHE027	Process Modeling and Simulation	PEC	40/60	3	0	0	3	3
4	23CHE028	Pinch Analysis and Heat Exchange Network Design	PEC	40/60	3	0	0	3	3
5	23CHE029	Chemical Process Flowsheeting	PEC	40/60	3	0	0	3	3
6	23CHE030	Computational Fluid Dynamics	PEC	40/60	3	0	0	3	3

VERTICAL 6: EMERGING TECHNOLOGIES

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CHE031	Polymer Technology	PEC	40/60	3	0	0	3	3
2	23CHE032	Process Automation	PEC	40/60	3	0	0	3	3
3	23CHE033	Nanotechnology	PEC	40/60	3	0	0	3	3
4	23CHE034	Material Selection	PEC	40/60	3	0	0	3	3
5	23CHE035	Industry 4.0 Concepts	PEC	40/60	3	0	0	3	3
6	23CHE036	Mineral Processing Technology	PEC	40/60	3	0	0	3	3

OPEN ELECTIVES

Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories.

OPEN ELECTIVE I AND II (EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

S. No	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1	23CSO001	Artificial Intelligence and Machine Learning Fundamentals	OEC	50/50	2	0	2	4	3
2	23CSO002	IoT Concepts and Applications	OEC	50/50	2	0	2	4	3
3	23CSO003	Data Science Fundamentals	OEC	50/50	2	0	2	4	3
4	23CSO004	Augmented and Virtual Reality	OEC	50/50	2	0	2	4	3

OPEN ELECTIVES – III

S. No.	COURSE CODE	COURSE TITLE	CATEGORY	Internal/ External	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
					L	T	P		
1.	23HSO001	English for Competitive Examinations	OEC	40/60	3	0	0	3	3
2.	23MGO001	NGOs and Sustainable Development	OEC	40/60	3	0	0	3	3
3.	23MGO002	Democracy and Good Governance	OEC	40/60	3	0	0	3	3
4.	23EEO001	Renewable Energy Technologies	OEC	40/60	3	0	0	3	3
5.	23MEO001	Applied Design Thinking	OEC	40/60	2	0	0	4	3
6.	23MEO002	Reverse Engineering	OEC	40/60	3	0	0	3	3
7.	23MEO003	Sustainable Manufacturing	OEC	40/60	3	0	0	3	3

8.	23EEO002	Electric and Hybrid Vehicle	OEC	40/60	3	0	0	3	3
9.	23ECO002	Space Engineering	OEC	40/60	3	0	0	3	3
10.	23MGO004	Industrial Management	OEC	40/60	3	0	0	3	3
11.	23MGO003	Quality Engineering	OEC	40/60	3	0	0	3	3
12.	23CHO001	Fire Safety Engineering	OEC	40/60	3	0	0	3	3
13.	23CEO001	Introduction to non- destructive testing	OEC	40/60	3	0	0	3	3
14.	23MEO004	Mechatronics	OEC	40/60	3	0	0	3	3
15.	23MEO005	Foundation of Robotics	OEC	40/60	3	0	0	3	3
16.	23MEO006	Fundamentals of Aeronautical engineering	OEC	40/60	3	0	0	3	3
17.	23CEO002	Remote Sensing Concepts	OEC	40/60	3	0	0	3	3
18.	23CEO003	Urban Agriculture	OEC	40/60	3	0	0	3	3
19.	23CEO004	Drinking Water Supply and Treatment	OEC	40/60	3	0	0	3	3
20.	23EEO003	Electric Vehicle technology	OEC	40/60	3	0	0	3	3
21.	23EEO004	Introduction to PLC Programming	OEC	40/60	3	0	0	3	3
23.	23CHO002	Nano Technology	OEC	40/60	3	0	0	3	3
23.	23MEO007	Functional Materials	OEC	40/60	3	0	0	3	3
24.	23BMO001	Biomedical Instrumentation	OEC	40/60	3	0	0	3	3
25.	23BTO001	Traditional Indian Foods	OEC	40/60	3	0	0	3	3
26.	23BTO002	Introduction to food processing	OEC	40/60	3	0	0	3	3
27.	23BTO003	IPR for Pharma Industry	OEC	40/60	3	0	0	3	3
28.	23CHO003	Basics of Textile Finishing	OEC	40/60	3	0	0	3	3
29.	23CHO004	Industrial Engineering for Garment Industry	OEC	40/60	3	0	0	3	3
30.	23CHO005	Basics of TextileManufacture	OEC	40/60	3	0	0	3	3

31.	23CHO006	Introduction to Petroleum Refining and Petrochemicals	OEC	40/60	3	0	0	3	3
32.	23EEO005	Energy Conservation and Management	OEC	40/60	3	0	0	3	3
33.	23CHO007	Basics of Plastics Processing	OEC	40/60	3	0	0	3	3
34.	23ECO003	Signals and Systems	OEC	40/60	3	0	0	3	3
35.	23ECO004	Fundamentals of Electronic Devices and Circuits	OEC	40/60	3	0	0	3	3
36.	23MEO008	Foundation Skills in integrated product Development	OEC	40/60	3	0	0	3	3
37.	23BMO002	Assistive Technology	OEC	40/60	3	0	0	3	3
38.	23MAO001	Operations Research	OEC	40/60	3	0	0	3	3
39.	23MAO002	Algebra and Number Theory	OEC	40/60	3	0	0	3	3
40.	23MAO003	Linear Algebra	OEC	40/60	3	0	0	3	3

OPEN ELECTIVES – IV

S. No.	COURS E CODE	COURSE TITLE	CATE GORY	Int./Ext.	PERIODS PER WEEK			TOTAL CONTA CT PERIODS	CREDITS
					L	T	P		
1.	23HSO002	Project Report Writing	OEC	40/60	3	0	0	3	3
2.	23MAO004	Advanced Numerical Methods	OEC	40/60	3	0	0	3	3
3.	23MAO005	Random Processes	OEC	40/60	3	0	0	3	3
4.	23MAO006	Queuing and Reliability Modelling	OEC	40/60	3	0	0	3	3
5.	23MGO004	Production and Operations Management for Entrepreneurs	OEC	40/60	3	0	0	3	3
6.	23MGO005	Multivariate Data Analysis	OEC	40/60	3	0	0	3	3
7.	23MEO009	Additive Manufacturing	OEC	40/60	3	0	0	3	3

8.	23MEO010	New ProductDevelopment	OEC	40/60	3	0	0	3	3
9.	23MEO011	Industrial Design & Rapid Prototyping Techniques	OEC	50/50	2	0	2	4	3
10.	23MEO012	Micro and PrecisionEngineering	OEC	40/60	3	0	0	3	3
11.	23MEO013	Cost Management of Engineering Projects	OEC	40/60	3	0	0	3	3
12.	23EEO011	Batteries and Management system	OEC	40/60	3	0	0	3	3
13.	23EEO006	Sensors and Actuators	OEC	40/60	3	0	0	3	3
14.	23ECO005	Space Vehicles	OEC	40/60	3	0	0	3	3
15.	23MGO006	Management Science	OEC	40/60	3	0	0	3	3
16.	23MEO014	Production Planning and Control	OEC	40/60	3	0	0	3	3
17.	23MGO007	Operations Management	OEC	40/60	3	0	0	3	3
18.	23BMO003	Industrial Hygiene	OEC	40/60	3	0	0	3	3
19.	23CHO008	Chemical Process Safety	OEC	40/60	3	0	0	3	3
20.	23EEO007	Electrical, Electronic and Magnetic materials	OEC	40/60	3	0	0	3	3
21.	23CHO009	Nanomaterials and applications	OEC	40/60	3	0	0	3	3
23.	23CEO010	Hydraulics and Pneumatics	OEC	40/60	3	0	0	3	3
23.	23EEO008	Sensors	OEC	40/60	3	0	0	3	3
24.	23MEO005	Foundation of Robotics	OEC	40/60	3	0	0	3	3
25.	23ECO006	Concepts in Mobile Robotics	OEC	40/60	3	0	0	3	3
26.	23MEO015	Marine Propulsion	OEC	40/60	3	0	0	3	3
27.	23MEO016	Marine Merchant Vehicles	OEC	40/60	3	0	0	3	3
28.	23MEO017	Elements of MarineEngineering	OEC	40/60	3	0	0	3	3
29.	23ECO007	Drone Technologies	OEC	40/60	3	0	0	3	3
30.	23CEO005	Geographical Information System	OEC	40/60	3	0	0	3	3

31.	23CEO006	Agriculture Entrepreneurship Development	OEC	40/60	3	0	0	3	3
32.	23CEO009	Biodiversity Conservation	OEC	40/60	3	0	0	3	3
33.	23EEO009	Introduction to controlsystems	OEC	40/60	3	0	0	3	3
34.	23MEO021	Introduction to Industrial Automation Systems	OEC	40/60	3	0	0	3	3
35.	23EEO010	Energy Technology	OEC	40/60	3	0	0	3	3
36.	23BTO004	Fundamentals of Food Engineering	OEC	40/60	3	0	0	3	3
37.	23BTO005	Food safety and Quality Regulations	OEC	40/60	3	0	0	3	3
38.	23BTO006	Nutraceuticals	OEC	40/60	3	0	0	3	3
39.	23CHO010	Basics of Dyeing and Printing	OEC	40/60	3	0	0	3	3
40.	23CHO011	Fibre Science	OEC	40/60	3	0	0	3	3
41.	23CHO012	Garment Manufacturing Technology	OEC	40/60	3	0	0	3	3
42.	23CEO008	Industrial safety	OEC	40/60	3	0	0	3	3
43.	23CHO013	Unit Operations in Petro Chemical Industries	OEC	40/60	3	0	0	3	3
44.	23MEO018	Plastic Materials for Engineers	OEC	40/60	3	0	0	3	3
45.	23MEO019	Properties and Testing of Plastics	OEC	40/60	3	0	0	3	3
46.	23ECO008	VLSI Design	OEC	40/60	3	0	0	3	3
47.	23ECO009	Wearable devices	OEC	40/60	3	0	0	3	3
48.	23BMO004	Medical Informatics	OEC	40/60	3	0	0	3	3

SUMMARY

Name of the Programme										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII/VII I	VIII/VI I	
1	HSMC	4	3					5		12
2	BSC	12	7	4	6					29
3	ESC	5	11							16
4	PCC		3	19	15	15	6	8		66
5	PEC					6	12			18
6	OEC						3	3	6	12
7	EEC	1	2	1			2	5	6	17
8	Non-Credit (Mandatory)					√	√			
Total		22	26	24	21	21	23	21	12	170

VERTICALS FOR MINOR DEGREE**(In addition to all the verticals of other programmes)**

Vertical I				
Fintech and Block chain	Vertical II	Vertical III	Vertical IV	Vertical V
Fintech and Block Chain	Entrepreneurship	Public Administration	Business Data Analytics	Environment and Sustainability
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Data Mining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

Vertical I : FINTECH AND BLOCK CHAIN

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1.	23CMG001	Financial Management	PEC	40/60	3	0	0	3	3
2.	23CMG002	Fundamentals of Investment	PEC	40/60	3	0	0	3	3
3.	23CMG003	Banking, Financial Services and Insurance	PEC	40/60	3	0	0	3	3
4.	23CMG004	Introduction to Blockchain and its Applications	PEC	40/60	3	0	0	3	3
5.	23CMG005	Fintech Personal Finance and Payments	PEC	40/60	3	0	0	3	3
6.	23CMG006	Introduction to Fintech	PEC	40/60	3	0	0	3	3
TOTAL				-	18	0	0	18	18

Vertical II : ENTREPRENERUSHIP

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1.	23CMG007	Foundations of Entrepreneurship	PEC	40/60	3	0	0	3	3
2.	23CMG008	Team Building and Leadership	PEC	40/60	3	0	0	3	3

		Management for Business							
3.	23CMG009	Creativity and Innovation in Entrepreneurship	PEC	40/60	3	0	0	3	3
4.	23CMG010	Principles of Marketing Management for Business	PEC	40/60	3	0	0	3	3
5.	23CMG011	Human Resource Management for Entrepreneurs	PEC	40/60	3	0	0	3	3
6.	23CMG012	Financing New Business Ventures	PEC	40/60	3	0	0	3	3
TOTAL				18	18	0	0	18	18

Vertical III : PUBLIC ADMINISTRATION

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1.	23CMG013	Principles of Public Administration	PEC	40/60	3	0	0	3	3
2.	23CMG014	Constitution of India	PEC	40/60	3	0	0	3	3
3.	23CMG015	Public Personnel Administration	PEC	40/60	3	0	0	3	3
4.	23CMG016	Administrative Theories	PEC	40/60	3	0	0	3	3
5.	23CMG017	Indian Administrative	PEC	40/60	3	0	0	3	3

		System							
6.	23CMG018	Public Policy Administration	PEC	40/60	3	0	0	3	3
TOTAL				18	0	0	18	18	18

Vertical IV : BUSINESS DATA ANALYTICS

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1.	23CMG019	Statistics for Management	PEC	40/60	3	0	0	3	3
2.	23CMG020	Datamining for Business Intelligence	PEC	40/60	3	0	0	3	3
3.	23CMG021	Human Resource Analytics	PEC	40/60	3	0	0	3	3
4.	23CMG022	Marketing and Social Media Web Analytics	PEC	40/60	3	0	0	3	3
5.	23CMG023	Operation and Supply Chain Analytics	PEC	40/60	3	0	0	3	3
6.	23CMG024	Financial Analytics	PEC	40/60	3	0	0	3	3
		TOTAL		18	0	0	18	18	18

Vertical V : Environment and Sustainability

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1.	23CES001	Sustainable Infrastructure Development	PEC	40/60	3	0	0	3	3
2.	23CES002	Sustainable Agriculture and Environmental Management	PEC	40/60	3	0	0	3	3
3.	23CES003	Sustainable Bio Materials	PEC	40/60	3	0	0	3	3
4.	23CES004	Materials for Energy Sustainability	PEC	40/60	3	0	0	3	3
5.	23CES005	Green Technology	PEC	40/60	3	0	0	3	3
6.	23CES006	Environmental Quality Monitoring and Analysis	PEC	40/60	3	0	0	3	3
7.	23CES007	Integrated Energy Planning for Sustainable Development	PEC	40/60	3	0	0	3	3
8.	23CES008	Energy Efficiency for Sustainable Development	PEC	40/60	3	0	0	3	3
		TOTAL		18	0	0	18	18	18

SYLLUBUS

23IP101	INDUCTION PROGRAMME	Category: -			
		L	T	P	C
		-	-	-	0
This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.					
The induction programme has been introduced by AICTE with the following objective:					
1.“Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.”					
2. “One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. “					
3. Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.					
	Physical Activity				
This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.					
	Creative Arts				
Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.					
	Universal Human Values				
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.					

Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

References:

Guide to Induction program from AICTE

SEMESTER I

23HST101	PROFESSIONAL ENGLISH-I (Common to All BE/B.Tech students except CSBS)	Category: HSMC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: - To improve the communicative competence of learners - To learn to use basic grammatic structures in suitable contexts - To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text. - To help learners use language effectively in professional contexts - To develop learners’ ability to read and write complex texts, summaries, articles, blogs,definitions, essays and user manuals.					
Unit I	Introduction to fundamentals of communication				9
Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails, Letter of introducing oneself, Grammar - Present Tense (simple and progressive); Question types: Wh / Yes or No questions Question Tags, Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technicalcontexts).					
Unit II	Narration And Summation				9
Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing, Short Report on an event (field trip), Grammar –Past tense (simple); Subject-Verb Agreement, Prepositions, Vocabulary - Word forms (prefixes & suffixes) Synonyms and Antonyms, Phrasal verbs.					
Unit III	Description of a Product/Process				9
Reading – Reading advertisements, gadget reviews; user manuals. Writing definitions; instructions; and Product /Process description, Grammar - Imperatives; Adjectives, Degrees of comparison, Present & Past Perfect Tenses, Compound Nouns, Homonyms; and Homophones, Discourse markers (connectives & sequence words)					
Unit IV	Classification And Recommendations				9
Reading – Newspaper articles, Journal reports –and Non Verbal Communication (tables, pie charts etc.). Writing–Note-making/Note-taking(*Study skills to be taught, not tested, Writing recommendations; Transferring information from Non-verbal (chart, graph, etc, to verbal mode), Articles, Pronouns,					

Possessive & Relative pronouns, Vocabulary – Collocations, Fixed / Semi fixed expressions.

Unit V	Expression	9
Reading – Reading editorials, Opinion Blogs, Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation, Negation (Statements & Questions); Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions, Content vs Function words		
Total periods:45		

Text Books:

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

References:

1. Technical Communication – Principles and Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book on Technical English By Lakshmi Narayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education, ISBN : 0070264244
4. Effective Communication Skill, Kulbhusan Kumar, R S Salaria, Khanna Publishing House
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

Course Outcomes:	Blooms Taxonomy
CO1: Use appropriate words in a professional context.	Remember (K1)
CO2: Gain understanding of basic grammatical structures and use them in right context.	Understand(K2)
CO3: Read and infer the denotative and connotative meanings of technical texts.	Apply(K3)
CO4: Write definitions, descriptions, narrations and essays on various topics.	Apply(K3)
CO5: Read and comprehend different types of reading materials.	Apply(K3)

CO-PO, PSO Mappings

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
CO2	1	1	1	1	1	3	3	3	1	3	-	3	-	-	-
CO3	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
CO4	2	3	2	3	2	3	3	3	2	3	3	3	-	-	-
CO5	2	3	3	3	-	3	3	3	2	3	-	3	-	-	-
CO Avg.	1.6	2.2	1.8	2.2	1.5	3	3	3	1.6	3	3	3	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - no correlation

23MAT101	MATRICES AND CALCULUS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites Basic Mathematical Knowledge					
Course Objectives: - To develop the use of matrix algebra techniques that is needed by engineers for practical applications. - To familiarize the students with differential calculus. - To familiarize the student with functions of several variables. This is needed in many branches of engineering. - To make the students understand various techniques of integration. - To understand various techniques of multiple integrals.					
Unit I	MATRICES				9+3
Characteristic equation - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton Theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms- Applications of Eigen value and Eigen vector in Engineering (for classroom discussion, assignments and term paper work).					
Unit II	DIFFERENTIAL CALCULUS				9+3
Derivatives – Differentiation rules (Sum, Product, Quotient, Chain rules) – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variables- Role of derivatives in Engineering Problems (for classroom discussion, assignments and term paper work).					
Unit III	FUNCTIONS OF SEVERAL VARIABLES				9+3
Partial differentiation – Total derivative - Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables –Maxima and minima of functions of two variables and Lagrange’s method of undetermined multipliers-Engineering Problems using Partial derivatives (for classroom discussion, assignments and term paper work).					
Unit IV	INTEGRAL CALCULUS				9+3
The Definite and Indefinite integral – Integration techniques - Substitution methods-Integration by parts –Reduction formula ($\sin^n x, \cos^n x$) - Integration of rational functions (Partial fraction method) -Improper Integrals. Role of Integrations in Engineering Problems (for classroom discussion, assignments and term paper work.).					
Unit V	MULTIPLE INTEGRALS				9+3
Double integrals– Double integrals in polar coordinates – Change of order of integration– Area enclosed by plane curves- Triple integrals – Volume of solids – Change of variable in double and triple integrals. Double integral models in Engineering (for classroom discussion, assignments and term paper work).					
Total periods: 60					

Text Books:

1. Kreyszig E, "Advanced Engineering Mathematics" John Wiley and 10th Edition, New Delhi, 2016.
2. Grewal B. S, "Higher Engineering Mathematics, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning 8th Edition, New Delhi, 2015.

References:

1. Jain R. K and Iyengar S.R.K, "Advanced Engineering Mathematics", Narasa Publications, New Delhi, 5th Edition, 2016.
2. Narayanan S, and Manicavachagam Pillai T. K, "Calculus: Volume I and II", S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
3. Ramana B. V, "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd., New Delhi, 2016.
4. Daniel T. Fink Beiger, "Introduction to matrices and Linear transformations", Dover publications, 3rd Edition, January 2011.

Course Outcomes:**Blooms Taxonomy****CO 1:** Use the matrix algebra methods for solving practical problems.

Apply(K3)

CO2: Apply differential calculus tools in solving various application problems.

Apply(K3)

CO3: Able to use differential calculus ideas on several variable functions.

Understand(K2)

CO4: Apply different methods of integration in solving practical problems.

Apply(K3)

CO5: Apply various techniques in multiple integrals.

Apply(K3)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO AVG	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - no correlation

23PHT101	ENGINEERING PHYSICS (Common to AIDS, BME, Biotech, CSE(AIML), CIVIL, CHEMICAL, CSE, CCE, CSBS, ECE, EEE, IT, MECH)	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites Basic Science Knowledge					
Course Objectives: - To make the students effectively to achieve an understanding of mechanics. - To enable the students to gain knowledge of electromagnetic waves and its applications. - To introduce the basics of oscillations, optics and lasers. - Equipping the students to be successfully understand the importance of quantum physics. - To motivate the students towards the applications of quantum mechanics.					
Unit I	MECHANICS				9
Multiparticle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kineticenergy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.					
Unit II	ELECTROMAGNETIC WAVES				9
The Maxwell’s equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.					
Unit III	OSCILLATIONS, OPTICS AND LASERS				9
Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference – Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein’s coefficients - population inversion - Nd-YAG laser, CO ₂ laser, semiconductor laser –Basic applications of lasers in industry.					
Unit IV	BASIC QUANTUM MECHANICS				9
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D, 2D and 3D Boxes- Normalization, probabilities andthe correspondence principle.					

Unit V	APPLIED QUANTUM MECHANICS												9		
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch’s theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.															
Total periods: 45															
Text Books:															
1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. Mc Graw Hill Education (Indian Edition), 2017.															
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ. Press, 2013.															
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, Mc Graw-Hill (Indian Edition), 2017.															
References:															
1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.															
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004															
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications,(Indian Edition), 2019.															
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.															
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand the importance of mechanics.													Understand(K2)		
CO2: Express their knowledge in electromagnetic waves													Understand(K2)		
CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.													Understand(K2)		
CO4: Understand the importance of quantum physics.													Remember(K1)		
CO5: Comprehend and apply quantum mechanical principles towards the formation of energy bands.													Apply(K3)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	2	2	1	-	-	-	-	-	-	-	-	-
CO4	3	3	1	1	2	1	-	-	-	-	-	1	-	-	-
CO5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	
CO AVG.	3	3	1.6	1.2	1.8	1	-	-	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - no correlation

23CYT101	ENGINEERING CHEMISTRY (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: - To understand water quality parameters, treatment process and corrosion. - To understand adsorption and phase rule - To evaluate engineering materials and the nature of polymers - To Apply recent advanced energy sources and batteries. - To observe various chemical composition in fuels and apply shock waves.					
Unit I	Universal Solvent (Water) and Corrosion				9
Water quality parameters of-color, odour, turbidity, pH, hardness, TDS, COD and BOD, Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion. Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process. Corrosion- causes- factors- types chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control anodic and cathodic methods and corrosion inhibitors.					
Unit II	Surface Chemistry and Phase Rule				9
Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms. Langmuir’s adsorption isotherm –Catalysis: Catalyst – types of catalysis – criteria – autocatalysis acid base catalysis – enzyme catalysis– Michaelis – Menten equation. Phase rule: Introduction, definition of terms with examples. One component system – water system; Reduced phase rule;– Thermal analysis; Two component system: lead-silver system – Pattinson process.					
Unit III	Polymers and Alloys				9
Introduction- Definition- Properties of alloys- Significance and Functions and Ferrous alloys. Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze. Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.					
Unit IV	Batteries and Energy Sources				9
Batteries: Types of batteries, Primary battery – dry cell, Secondary battery – lead acid battery and lithium-ion battery; Electric vehicles. Advanced Energy Sources-Recent developments in solar cell materials. Fuel cells: H2-O2 fuel cell, microbial fuel cell; Super capacitors: Storage principle, types and examples					

Unit V	Analytical Chemistry and Shock Wave												9		
Proximate and ultimate analysis of coal. Accuracy, precision, sensitivity, detection limits, significant figures, rounding off. Types of errors, determinate and indeterminate errors. Petroleum process. Shock Wave - Description of a shock wave and its applications. Methods of creating shock waves in the laboratory using a shock tube, description of hand operated Reddy shock tube and its characteristics.															
Total periods:45															
Text Books:															
1. P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, DhanpatRai, Publishing Company (P) Ltd, New Delhi, 2018.															
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.															
3. S.S. Dara, “A text book of Engineering Chemistry”, S. Chand Publishing, 12th Edition, 2018.															
4. Skoog, D.A.; West, D.M.; Holler, F.J.; Crouch, S.R. (2014),Fundamentals of Analytical Chemistry, Cengage Learning.															
References:															
1. O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited, 2nd Edition, 2017															
2. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.															
3. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019.															
4. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.															
5. Shock waves made simple- Chintoo S Kumar, K Takayama and KPJ Reddy: Willey India Pvt. Ltd. New Delhi 2014.															
Course Outcomes:													Blooms Taxonomy		
CO 1: To know well about water quality parameters and corrosive nature of metals													Remember (K1)		
CO2: Understand adsorption, its types and phases, phase rule													Understand (K2)		
CO3: To use alloys and polymers in day to day life													Apply(K3)		
CO4: To Understand the advantages of batteries, super capacitors and solar cell fabrication													Understand (K2)		
CO5: To Analyse chemical composition of coal and understand petroleum process and uses of shock waves in real life.													Analyze (K4)		
CO - PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	1	-	-	-	1	1	-	-	-
CO2	3	1	-	-	-	1	1	-	-	-	-	1	-	-	-
CO3	3	1	-	-	1	1	1	-	-	-	1	1	-	-	-
CO4	3	1	-	-	1	1	1	-	-	-	1	1	-	-	-
CO5	3	1	-	-	1	1	1	-	-	-	1	1	-	-	-
CO Avg.	3	1	-	-	1	1	1	-	-	-	1	1	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23GET101	PROGRAMMING IN C	Category: ESC			
		L	T	P	C
		3	0	0	3
Prerequisites Nil					
Course Objectives: - To understand the constructs of Language. - To develop C Programs using basic programming constructs - To develop C programs using arrays and strings - To develop modular applications in C using functions - To develop applications in C using pointers and structures - To do input/output and file handling in C					
Unit I	BASICS OF C PROGRAMMING				9
Introduction to programming paradigms–Applications of C Language-Structure of C program - C programming: Data Types - Constants – Enumeration Constants - Keywords – Operators:Precedence and Associativity - Expressions - Input/Output statements, Assignment statements –Decision making statements - Switch statement - Looping statements – Preprocessor directives –Compilation process					
Unit II	ARRAYS AND STRINGS				9
Introduction to Arrays: Declaration, Initialization – One dimensional array –Two dimensional arrays - String operations: length, compare, concatenate, copy – Selection sort, linear and binarysearch.					
Unit III	FUNCTIONS AND POINTERS				9
Modular programming - Function prototype, function definition, function call, Built-in functions(stringfunctions,mathfunctions)–Recursion,Binary Search using recursive functions–Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers –Parameter passing:Pass by value,Pass by reference.					
Unit IV	STRUCTURES AND UNION				9
Structure-Nested structures–Pointer and Structures–Array of structures–Self referential structures– Dynamic memory allocation-Singly linked list–typedef–Union-Storage classes and Visibility.					
Unit V	FILE PROCESSING				9
Files–Types of file processing:Sequential access,Random access–Sequential access file- Random access file- Command line arguments.					
Total periods: 45					
Text Books:					
1. ReemaThareja,“ProgramminginC”,Oxford UniversityPress,Second Edition,2016.					
2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition,PearsonEducation,2015.					

References:

1. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Letus C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
4. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st edition, Pearson Education, 2013.

Course Outcomes:													Blooms Taxonomy		
CO 1: Demonstrate knowledge on C Programming constructs													Apply (K3)		
CO2: Develop simple applications in C using basic constructs													Understand (K2)		
CO3: Design and implement applications using arrays and strings													Analyze (K4)		
CO4: Develop and implement modular applications in C using functions.													Understand (K2)		
CO5: Develop applications in C using structures and pointers.													Understand (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	2	1	1	1	2	-	3	2	1	2	-
CO2	2	2	2	1	2	1	1	1	2	-	3	3	2	2	-
CO3	2	3	2	1	2	1	1	1	2	-	3	2	2	2	-
CO4	3	2	2	1	3	1	1	1	2	-	3	3	2	2	-
CO5	2	3	3	1	2	1	2	1	2	-	3	2	2	3	-
CO Avg.	2	2.4	2.2	1	2.2	1	1.2	1	2	-	3	2.4	1.8	2.2	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23GET102	தமிழர் மரபு (Common to all)	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites					
•					
COURSE OBJECTIVES:					
- To understand water quality parameters, treatment process and corrosion. - To analyses absorption, adsorption and phases. - To evaluate engineering materials and study of batteries. - To understand the nature of polymers and recent advanced energy sources. - To observe various chemical composition analyses and shock waves.					
அலகு I	மொழி மற்றும் இலக்கியம்:				9
இந்திய தமிழ் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.					
அலகு II	மரபு-பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை-சிற்பக் கலை:				9
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.					

அலகு III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:	9
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.		
அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்:	9
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:	9
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப்புத்தகங்களின் அச்ச வரலாறு.		
Total periods:45		
Text Cum Reference Books		
1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வேளியீடு: தமிழ்நாடு பொதுநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)..		
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).		
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)		
4. பொருளை- ஆற்றங்கரை நாகரிகம்.(தொல்லியல் துறை வெளியீடு)		
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)		

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

23GET102	HERITAGE OF TAMILS (Common to All Programmes)	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites NIL					
Unit I	LANGUAGE AND LITERATURE				3
Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.					
Unit II	HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE				3
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.					
Unit III	FOLK AND MARTIAL ARTS				3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.					
Unit IV	THINAI CONCEPT OF TAMILS				3
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and					

Import during Sangam Age - Overseas Conquest of Cholas.		
Unit V	CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE	3
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.		
Total periods: 15		
Text Books:		
1.Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)		
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.		
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).		
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)		
5. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)		
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
References:		
1. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.		

23GEP101	PROGRAMMING IN C LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites Nil					
Course Objectives: - To familiarize with C programming constructs. - To develop programs in C using basic constructs. - To develop programs in C using arrays. - To develop applications inC using strings,pointers,functions. - To develop applications in C using structures. To develop applications in C using file processing					
LIST OF EXPERIMENTS					
1	I/O statements,operators,expressions				
2	Decision-making constructs:if-else,goto,switch-case,break-continue				
3	Loops:for,while,do-while				
4	Arrays:1Dand2D,Multi-dimensional arrays,traversal				
5	Strings:operations				
6	Functions:call,return,passing parameters by(value,reference),passing arrays to function				
7	Recursion				
8	Pointers: Pointers to functions,Arrays,Strings,Pointers to Pointers,Array of Pointers				
9	Structures: Nested Structures,Pointers to Structures,Arrays of Structures and Unions.				
10	Files:reading and writing,File pointers,file operations,random access, process or directives.				
Total periods:60					
Text Books:					
1.ReemaThareja,“Programming in C”,Oxford University Press,Second Edition,2016					
2.Kernighan,B.Wand Ritchie,D.M,“The C Programming language”,Second Edition,Pearson Education,2015.					
References:					
1.Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education,2018.					
2.Yashwant Kanetkar, Letus C,17 th Edition, BPB Publications,2020.					
3.ByronS.Gottfried,"Schaum's Outline of Theory and Problems of Programming with C",McGraw-HillEducation,1996.					
4.PradipDey, ManasGhosh, “Computer Fundamentals and Programming in C”,Second Edition, Oxford University Press, 2013.					

5. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013

Course Outcomes:	Blooms Taxonomy
CO1: Demonstrate knowledge on C programming constructs.	Apply (K3)
CO2: Develop programs in C using basic constructs.	Understand (K2)
CO3: Develop programs in C using arrays.	Understand (K2)
CO4: Develop applications in C using strings, pointers, functions.	Understand (K2)
CO5: Develop applications in C using structures.	Understand (K2)

CO – PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	1	1	1	-	-	2	1	2	2	2	2	-
CO2	2	3	3	2	1	1	-	-	2	1	2	2	2	3	-
CO3	2	2	2	1	1	2	-	-	2	-	2	2	2	2	-
CO4	2	2	2	2	1	2	-	-	3	-	3	3	3	2	-
CO5	2	2	3	2	3	2	-	-	2	-	3	3	3	3	-
CO Avg.	1.8	2.4	2.6	1.6	1.4	1.6			2.2	1	2.4	2.4	2.4	2.4	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23BSP101	Category: BSC			
	L	T	P	C
	0	0	2	1

Prerequisites

- Nil

Course Objectives:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS

1	Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.

2	Simple harmonic oscillations of cantilever.
3	Non-uniform bending - Determination of Young's modulus.
4	Uniform bending – Determination of Young's modulus.
5	Laser- Determination of the wavelength of the laser using grating.
6	a) Optical fibre -Determination of Numerical Aperture and acceptance angle. b) Compact disc- Determination of width of the groove using laser.
7	Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids.

Total periods: 30 PERIODS

Text Books:

1. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, "Vogel's Textbook of Quantitative Chemical Analysis", Pearson Education, 2009.

Course Outcomes:**Blooms Taxonomy**

CO1: Understand the functioning of various physics laboratory equipment.	Understanding (K2)
CO2: Use graphical models to analyze laboratory data.	Understanding (K2)
CO3: Use mathematical models as a medium for quantitative reasoning and describing physical reality.	Remembering (K1)
CO4: Access, process and analyze scientific information.	Analyzing (K4)
CO5: Solve problems individually and collaboratively.	Applying (K3)

CO – PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	1	1	-	-	-	-	-	-	-	-	-	-
CO5	3	2	3	1	1	-	-	-	-	-	-	-	-	-	-
CO Avg.	3	2.4	2.6	1	1	-	-	-	-	-	-	-	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23BSP101	CHEMISTRY LABORATORY (Common to All Branches)												Category: BSC			
													L	T	P	C
													0	0	2	1
Prerequisites																
• NIL																
Course Objectives:																
• To estimate the amount of alkalinity and hardness by volumetric and analysis																
• To evaluate the skills of water quality of DO and chloride by volumetric analysis																
• To understand strength of mixture of acids by using instrumental analysis																
• To familiarize with conductometry in the determination of precipitation titration																
• To acquire techniques to determine Fe content by potentiometer.																
LIST OF EXPERIMENTS																
1	Determination of total, temporary & permanent hardness of water by EDTA method															
2	Determination of chloride content of water sample by Argentometric method															
3	Determination of types and amount of alkalinity in water sample															
4	Determination of DO content of water sample by Winkler’s method															
5	Determination of strength of acids in a mixture of acids using conductivity meter.															
6	Conductometric titration of barium chloride against sodium (precipitation titration).															
7	Estimation of iron content of the given solution using potentiometer.															
Total periods:																
Text Books:																
1. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, “Vogel’s Textbook of Quantitative Chemical Analysis”, Pearson Education, 2009.																
2. V. K. Ahluwalia, Sunitha Dhingra and Adarsh Gulati, “College Practical Chemistry”, Universities Press (India) Pvt Ltd., 2018.																
Course Outcomes:														Blooms Taxonomy		
CO1: To analyse the quantity of hardness and Chloride in water sample														Analyze (K4)		
CO2: To analyze the quantity of alkalinity and DO in water sample														Analyze (K4)		
CO3: Using conductivity meter the strength and amount of acids are analyzed.														Analyze (K4)		
CO4: To Analyze quantitatively BaCl ₂ present in the given solution by conductivity meter.														Analyze (K4)		
CO5: To determine the amount of Fe content potentiometrically.														Analyze (K4)		
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	1	-	-	-	1	1	-	2	-	1	1	-	-	-	
CO2	3	1	-	-	-	1	1	-	2	-	1	1	-	-	-	

CO3	3	-	-	-	-	1	1	-	2	-	-	1	-	-	-
CO4	3	-	-	-	-	1	1	-	2	-	-	1	-	-	-
CO5	3	-	-	-	-	1	1	-	2	-	-	1	-	-	-
CO Avg.	3	1	-	-	-	1	1	-	2	-	1	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23HSP102	ENGLISH LABORATORY (Common to All Branches)	Category: EEC			
		L	T	P	C
		0	0	2	1

Prerequisites: NIL

Course Objectives:

- To improve the communicative competence of learners
- To help learners use language effectively in academic /work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1	Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation;
2	Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies
3	Making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions (filling out a bank application for example).
4	Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities.
5	Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations*
6	Describing experiences and feelings- engaging in small talk- describing requirements and abilities.
7	Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products.
8	Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product- explaining uses and purposes
9	Presenting a product- describing shapes and sizes and weights- talking about quantities(large & small)-talking about precautions.

10	Listening – Listening to TED Talks; Listening to lectures - and educational videos.
11	Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress-
12	Talking about positions and directions of movement-talking about travel preparations- talking about transportation-
13	Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.
14	Speaking –making predictions- talking about a given topic-giving opinions
15	Understanding a website-describing processes

Total periods: 30**Text Books:**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

References:

1. Raman. Meenakshi, Sharma. Sangeeta (2019).Professional English.Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, MeeraBannerji- Macmillan India Ltd. 1990, Delhi.

Course Outcomes:	Blooms Taxonomy
CO1: To listen and comprehend complex academic texts .	Remember (K1)
CO2: To speak fluently and accurately in formal and informal communicative contexts	Apply (K3)
CO3: To express their opinions effectively in both oral and written medium of communication	Understand (K2)
CO4: Write critical reports to convey data and information with clarity and precision	Apply (K3)
CO5: Give appropriate instructions and recommendations for safe execution of tasks	Apply (K3)

CO – PO& PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-
CO2	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-
CO3	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-
CO4	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-
CO5	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-
CO Avg.	1	-	-	-	1	-	2	2	2	3	2	3	-	-	-

1 - Low, 2 - Medium, 3 -High , ‘-‘ No correlation2

SEMESTER II

23HST201	PROFESSIONAL ENGLISH – II (Common to All BE/B.Tech(Except CSBS))	Category: HSMC			
		L	T	P	C
		2	0	0	2
Prerequisites Professional English- I					
Course Objectives: - To engage learners in meaningful language activities to improve their reading and writing skills - To learn various reading strategies and apply in comprehending documents in professional context. - To help learners understand the purpose, audience, contexts of different types of writing - To develop analytical thinking skills for problem solving in communicative context - To demonstrate an understanding of job applications and interviews for internship and placements					
Unit I	UNIT I - MAKING COMPARISONS				6
Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases					
Unit II	UNIT II - EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING				6
Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds					
Unit III	UNIT III - PROBLEM SOLVING				6
Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences					
Unit IV	UNIT IV -REPORTING OF EVENTS AND RESEARCH				6
Reading –Newspaper articles; Writing – Recommendations, Transcoding, Accident Report, Survey Report Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions					
Unit V	UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY				6
Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.					
Total periods:30					
Text Books:					
1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.					
2. English for Science & Technology Cambridge University Press 2021.					
3. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.					

References:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

Course Outcomes:**Blooms Taxonomy****CO1:** To compare and contrast products and ideas in technical texts.

Remember (K1)

CO2: To identify and report cause and effects in events, industrial processes through technical texts

Understand (K2)

CO3: To analyse problems in order to arrive at feasible solutions and communicate them in the written format.

Apply (K3)

CO4: To present their ideas and opinions in a planned and logical manner

Apply (K3)

CO5: To draft effective resumes in the context of job search.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
CO2	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
CO3	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
CO4	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
CO5	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-
CO Avg.	1	-	-	-	-	-	1	2	1	3	2	3	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23MAT201	COMPUTATIONAL METHODS (Common to all Branches B.E / B.TECH except B.E EEE)	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites - Basic Mathematical Knowledge - Matrices and Calculus					
Course Objectives: - To introduce the basic concepts of solving algebraic and transcendental equations. - To introduce the various numerical techniques for interpolation, differentiation and integration, this plays an important role in engineering and technology disciplines. - To acquaint the knowledge of various techniques and methods of solving ordinary differential equations. - To understand the knowledge of various techniques and methods of solving various types of partial differential equations. - To acquaint the knowledge of numerical methods by MATLAB.					
UNIT I	NUMERICAL SOLUTION OF EQUATIONS AND MATRIX PROBLEMS				9+3
Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi’s method for symmetric matrices.					
UNIT II	INTERPOLATION, APPROXIMATION AND INTEGRATION				9+3
Interpolation with unequal intervals - Lagrange's interpolation – Newton’s divided difference interpolation – Newton’s forward and backward difference formulae - Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson’s 1/3 rule – Romberg’s Method.					
UNIT III	NUMERICAL APPROACH FOR IVP IN ORDINARY DIFFERENTIAL EQUATIONS				9+3
Single step methods - Taylor’s series method - Euler’s method - Modified Euler’s method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne’s and Adams - Bash forth predictor corrector methods for solving first order equations.					
UNIT IV	NUMERICAL APPROACH FOR BVP IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS				9+3
Finite difference methods for solving second order two - point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace’s and Poisson’s equations on rectangular domain – One dimensional heat equation (Crank Nicholson, Bender Schemidt’s methods) and One dimensional wave equation.					

UNIT V		MAT LAB INTRODUCTION											9+3		
Introduction – Basic features – MATLAB Session – Getting started – Mathematical functions – Basic plotting – Matrix generation-Solutions of algebraic and transcendental equations using MATLAB-Gauss elimination and Gauss Jordan method for system of linear equations by MATLAB.															
Total periods:60															
Text Books:															
1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.															
2. Grewal, B.S., “Numerical Methods in Engineering & Science (with Programs in C,C++ & MATLAB)” Khanna Publishers, 10th Edition, New Delhi, 2015.															
3. William J. Palm III., “Introduction to MATLAB® for Engineers” , Published by McGraw Hill,2005.															
References:															
1. Burden, R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.															
2. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.															
3. William Bober., “Numerical and analytical methods with MATLAB® for Engineers and Scientists” , Published by CRC press, November 2013.															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand the basic concepts and techniques of solving algebraic and transcendental equations.													Understanding (K2)		
CO2: Appreciate the numerical techniques of interpolation, differentiation and integration for engineering problems.													Applying (K3)		
CO3: Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.													Understanding (K2)		
CO4: Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.													Applying (K3)		
CO5: Understand the basic concepts of MATLAB for Computational Methods.													Understanding (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
CO2	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
CO3	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
CO4	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
CO5	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-
CO AVG.	3	2	2	2	2	1	-	-	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23PHT207	PHYSICS OF MATERIALS (For Chemical Engineering)	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites Basic Science Knowledge					
Course Objectives: - To make the students to understand the basics of phase diagrams and various materialspreparation techniques - To equip the students to have a knowledge on different types of electron theory, basics ofquantum mechanics and about superconductors - To introduce the physics of semiconducting materials and applications of semiconductors indevice fabrication. - To familiarize the students with the theory and applications of magnetic and dielectric materials - To provide the students a sound platform towards learning about advanced materials and theirapplications.					
UNIT I	PREPARATION OF MATERIALS				9
Phases - phase rule – binary systems – tie line – lever rule – phase diagram – invariant reactions - nucleation – homogeneous and heterogeneous nucleation – free energy of formation of a critical nucleus – Thin films – preparation: PVD, CVD method – Nanomaterials Preparation: wet chemical, solvothermal, sol-gel method.					
UNIT II	ELECTRICAL PROPERTIES OF MATERIALS				9
Classical free electron theory - expression for electrical conductivity – thermal conductivity, - Wiedemann-Franz law - Quantum free electron theory – tunneling - degenerate states – Fermi-Dirac statistics – density of energy states – electron in periodic potential – electron effective mass – conceptof hole. Superconducting phenomena, properties of superconductors – Meissner effect and isotope effect. Type I and Type II superconductors, High T _c superconductors – Magnetic levitation and SQUIDS.					
UNIT III	SEMICONDUCTING PROPERTIES OF MATERIALS				9
Elemental Semiconductors - Compound semiconductors - Origin of band gap in solids (qualitative) - carrier concentration in metals - carrier concentration in an intrinsic semiconductor (derivation) – Fermi level – variation of Fermi level with temperature – electrical conductivity – band gap determination – carrier concentration in n-type and p-type semiconductors (derivation) – variation of Fermi level with temperature and impurity concentration – Hall effect – determination of Hall coefficient – LED - Solar cells.					
UNIT IV	DIELECTRIC AND MAGNETIC MATERIALS				9
Dielectric, Para electric and ferroelectric materials - Electronic, Ionic, Orientational and space charge polarization – Internal field and deduction of Clausius- Mosotti equation – dielectric loss – different types of dielectric breakdown – classification of insulating materials and their applications - Ferroelectric materials - Introduction to magnetic materials - Domain theory of ferromagnetism, Hysteresis, Soft and Hard magnetic materials – Anti-ferromagnetic					

materials – Ferrites, Giant Magneto Resistance materials.

UNIT V**NEW MATERIALS AND APPLICATIONS****9**

Ceramics – types and applications – Composites: classification, role of matrix and reinforcement – processing of fibre reinforced plastics and fibre reinforced metals – Metallic glasses – Shape memory alloys – Copper, Nickel and Titanium based alloys – graphene and its properties – Relaxor ferroelectrics - Biomaterials – hydroxyapatite – PMMA – Silicone - Sensors: Chemical Sensors - Biosensors – Polymer semiconductors – Photoconducting polymers.

Total periods: 45 PERIODS**Text Books:**

1. W. D. Callitser and D. G. Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. V. Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M. F. Ashby, P. J. Ferreira and D. L. Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.

REFERENCE BOOKS:

1. J. F. Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
2. D. R. Askeland and W. J. Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. Jean P. Mercier, G. Zambelli and W. Kurz, Introduction to Materials Science, Elsevier, 2002.
5. Yaser Dahman, Nanotechnology and Functional Materials for Engineers, Elsevier, 2017.

Course Outcomes:**Blooms Taxonomy**

CO1: Acquire knowledge of phase diagram, and thin film and nanomaterial preparation techniques.

Understanding (K2)

CO2: Familiarize with conducting materials, basic quantum mechanics, and properties and applications of superconductors.

Remembering (K1)

CO3: Gain knowledge on semiconducting materials based on energy level diagrams, its types, temperature effect. Also, fabrication methods for semiconductor devices will be understood.

Understanding (K2)

CO4: Realize with theories and applications of dielectric and ferromagnetic material.

Understanding (2)

CO 5: Familiarize with ceramics, composites, metallic glasses, shape memory alloys, biomaterials and their important applications.

Applying (K3)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	1	2	1	-	-	-	1	-	-	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	2	1	-	2	1	-	-	-	-	1	-	-	-
CO4	3	2	-	1	2	2	2	-	-	-	-	1	-	-	-

CO5	3	-	2	-	2	2	2	-	-	-	-	1	-	-	-
CO Avg.	3	2.2	2	1.6	2	1.6	1.7	1	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23EET203	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING (Common to BIOTECH, CIVIL, CHEMICAL)						Category: ESC			
							L	T	P	C
							3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To introduce the basics of electric circuits and analysis
- To impart knowledge in domestic wiring
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To introduce the functional elements and working of sensors and transducers.

Unit I	ELECTRICAL CIRCUITS	9

DC Circuits:Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only), Three phase supply – star and delta connection – power in three-phase systems.

Unit II	MAGNETIC CIRCUITS AND ELECTRICAL INSTALLATIONS	9

Magnetic circuits-definitions-MMF, flux, reluctance, magnetic field intensity, flux density, fringing, self and mutual inductances-simple problems.

Domestic wiring , types of wires and cables, earthing ,protective devices- switch fuse unit- Miniature circuit breaker- moulded case circuit breaker- earth leakage circuit breaker, safety precautions and First Aid.

Unit III	ELECTRICAL MACHINES	9

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.

Unit IV	ANALOG ELECTRONICS	9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters, harmonics

Unit V	SENSORS AND TRANSDUCERS												9		
Sensors, solenoids, pneumatic controls with electrical actuator, mechatronics, types of valves and its applications, electro-pneumatic systems, proximity sensors, limit switches, piezoelectric, hall effect, photo sensors, Strain gauge, LVDT, differential pressure transducer, optical and digital transducers, Smart sensors, Thermal Imagers.															
Total periods:45															
Text Books:															
1. D P Kothari and I.J Nagarath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education (India) Private Limited, Second Edition, 2020															
2. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.															
3. S.K. Bhattacharya, Basic Electrical Engineering, Pearson Education, 2019															
4. James A Svoboda, Richard C. Dorf, Dorf’s Introduction to Electric Circuits, Wiley, 2018															
References:															
1. John Bird, “Electrical Circuit theory and technology”, Routledge; 2017.															
2. Thomas L. Floyd, ‘Electronic Devices’, 10th Edition, Pearson Education, 2018.															
3. Albert Malvino, David Bates, ‘Electronic Principles, McGraw Hill Education; 7th edition, 2017															
4. Muhammad H. Rashid, “Spice for Circuits and electronics”, 4th Edition Cengage India, 2019.															
5. H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010															
Course Outcomes:													Blooms Taxonomy		
CO1: Compute the electric circuit parameters for simple problems													Apply (K3)		
CO2: Explain the concepts of domestics wiring and protective devices													Understanding (K2)		
CO3: Explain the working principle and applications of electrical machines													Understanding (K2)		
CO4: Analyze the characteristics of analog electronic devices													Analyze (k4)		
CO5: Explain the types and operating principles of sensors and transducers													Understanding (K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	2	-	-	-	2	-	-	-	3	1	-	2
CO2	3	2	2	2	-	2	2	1	-	-	-	3	1	-	2
CO3	3	2	1	-	-	-	-	1	-	-	-	3	1	-	2
CO4	2	2	2	-	-	-	-	1	-	2	-	3	1	-	2
CO5	2	1	2	-	-	-	-	1	-	2	-	3	1	-	2
CO Avg.	2.2	1.6	1.6	2		2	2	1.2		2		3	1		2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23GET201	ENGINEERING GRAPHICS	Category: ESC			
		L	T	P	C
		2	0	4	4
Prerequisites • Basic knowledge of geometry at higher secondary level • Ability to visualize simple 2D and 3D shapes • Basic skills in freehand sketchingSS					
Course Objectives: • To draw engineering curves such as ellipse, parabola, hyperbola, cycloid, and involutes. • To draw freehand sketches of simple objects and multiple views from pictorial representations. • To construct orthographic projections of points, lines, planes, and solids, including inclined and sectioned solids. • To draw the development of lateral surfaces of simple and sectioned solids like prisms, pyramids, cylinders, and cones. • To draw isometric and perspective projections of simple solids and combinations of solids.					
Unit I	PLANE CURVES				6
Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.					
Unit II	PROJECTION OF POINTS, LINES AND PLANE SURFACE				6
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.					
Unit III	PROJECTION OF SOLIDS				6
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)					
Unit IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES				6
Sectioning of above solids in simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones. Practicing three dimensional modeling of simple objects by CAD Software (Not for examination)					

Unit V	ISOMETRIC AND PERSPECTIVE PROJECTIONS												6		
Principles of isometric projection — isometric scale — isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method. Practicing three dimensional modeling of isometric projection of simple objects by CAD Software (Not for examination)															
Total periods: 60															
Text Books:															
1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.															
2. Natarajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.															
3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015															
References:															
1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edition, 2019.															
2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.															
3. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.															
4. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India, 2nd Edition, 2009.															
5. Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited, 2008.															
Course Outcomes:													Blooms Taxonomy		
CO1:Use BIS conventions and specifications for engineering drawing.													Applying(K3)		
CO2:Construct the conic curves, involutes and cycloid.													Applying(K3)		
CO3:Solve practical problems involving projection of lines.													Analyze(K4)		
CO4:Draw the orthographic, isometric and perspective projections of simple solids.													Applying(K3)		
CO5:Draw the development of simple solids.													Applying(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	1	2	-	-	-	-	-	-	-	2	1	-
CO2	2	1	-	-	2	-	-	-	-	-	-	-	2	-	-
CO3	3	2	1	-	2	-	-	-	-	-	-	-	3	1	-
CO4	3	1	-	1	3	-	-	-	-	-	-	-	3	2	-
CO5	2	-	-	-	2	-	-	-	-	-	-	-	2	1	-
CO Avg.	2.4	1.3	1	1	2.2	-	-	-	-	-	-	-	2.4	1.25	-
1 - Low, 2 - Medium, 3 - High , ‘ ‘ No correlation															

23CHT201	BASICS OF CHEMICAL ENGINEERING	Category: PCC			
		L	T	P	C
		3	0	0	3
• Prerequisites: Engineering Chemistry					
Course Objectives: To understand about the basics of Unit Operations of Chemical Engineering and its application, and Career Opportunities of Chemical Engineering					
Unit I	Introduction Fluid Mechanics				9
Chemical Engineering in day to life with examples, Origin and growth of Chemical Engineers in Chemical Process Industries, Unit Operations and Unit Processes concepts, Scaling up or down, Units and Dimensions, Application of Mathematics in Chemical Engineering, Recent Developments in Chemical Process Industries, Nature of fluid, Viscosity, Flow field, Conservation of mass and energy. Frictional losses, pumping of fluids. Dimensional Analysis and Correlations					
Unit II	Material and Energy Balance				9
Basic concepts of Material and Energy balances, Energy and Mass transport, and Kinetics of Chemical Reactions. Introduction to Heat and Mass Transfer. Process Flow Sheet and Symbols					
Unit III	Mechanical Operations Heat Transfer				9
Characterization of Solid particles, Screen Analysis, Properties of masses of Particles, Mixing of solids, Size Reduction, Crushing laws and Work Index, Equipment for Size reduction, Screening, Screening Equipment, Screen capacity and efficiency. Basic Law of Conduction, Typical Heat Exchange equipment, Double Pipe Heat exchangers, Shell and tube Heat Exchangers, Scraped surface exchangers.					
Unit IV	Mass Transfer				9
Gas Absorption, Principles of Absorption, Humidification operations, Humidity Chart, Wet Bulb Temperatures, Distillation – Flash Distillation, Continuous Distillation with Reflux, Plate Efficiencies, Batch distillation					
Unit V	Career Opportunities of Chemical Engineering				9
Career Development Leading to Specialization, Chemical Engineering Job Titles/Options, Chemical and Process Engineers, Commissioning Engineer, Process Control/Automation Engineer, Process Safety Engineer, Research & Development Engineer Pharmaceutical Engineer/Pharmaceutical Process Engineer, Pipeline Engineer Chemical Manufacturing Engineer, Environment Engineer					
Total periods:45					
Text Books:					
1. Ghosal, S.K., Sanyal, S.K., Datta, S., “Introduction to Chemical Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi (1997).					
2. McCabe, W.L., Smith, J. C. and Harriot, P. “Unit operations in Chemical Engineering”, McGrawHill, 7th Edition, 2001					

References:

1. Badger W.L. and Banchero J.T., "Introduction to Chemical Engineering", 6th Edition, TataMcGraw Hill, 1997

Course Outcomes: Upon successful completion of the course, student should be able to													Blooms Taxonomy		
CO1: Correlate day to day like with the principles of chemical Engineering													Remember (K1)		
CO2: Assess the mass and energy involved in any chemical plant													Remember (K1)		
CO3: Have an insight into areas where Chemical Engineering plays major role													Understand (K2)		
CO4: Carry out modelling and simulation using software tools													Understand (K2)		
CO5: Understand about the career Opportunities of Chemical Engineering													Understand (K2)		
CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	3	2	2	1	1	-	-	2	2	3	2	-
CO2	3	3	2	3	3	2	1	1	-	-	3	2	3	3	-
CO3	3	2	2	3	2	2	1	-	-	-	2	2	3	2	-
CO4	3	2	-	3	2	-	-	-	-	-	2	-	3	2	-
CO5	3	-	2	3	-	2	1	-	-	-	-	2	3	-	-
CO Avg.	3	2.2	2	3	2.2	2	1	1	-	-	2.2	2	3	2.25	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23GET202	தமிழரும் தொழில்நுட்பமும் (Common to All Branches)	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites Nil					
COURSE OBJECTIVES: - To understand water quality parameters, treatment process and corrosion. - To analyses absorption, adsorption and phases. - To evaluate engineering materials and study of batteries. - To understand the nature of polymers and recent advanced energy sources. - To observe various chemical composition analyses and shock waves.					
அலகு I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்				9
சங்க காலத்தில் நெசவுத் தொழில் – பானை தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் –					

பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	9
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ சாரோசெனிக் கட்டிடக் கலை		
அலகு III	உற்பத்தித் தொழில் நுட்பம்:	9
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணொடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள் .		
அலகு IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	9
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குழுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.		
அலகு V	அறிவியல் தமிழ் மற்றும் கணித்தமிழ்	9
அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவை திட்டம்.		

		Total periods:45
Text Cum Reference Books		
1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வேளியீடு:		
2. தமிழ்நாடு பொதுநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).		
3. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).		
4. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)		
5. பொருநை– ஆற்றங்கரை நாகரிகம்.(தொல்லியல் துறை வெளியீடு)		
6. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)		
7. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.		
8. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).		
9. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)		
10. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
11. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)		
12. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
13. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.		

23GET202	TAMILS AND TECHNOLOGY (Common to all Programmes)	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites					
• NIL					
Unit I	WEAVING AND CERAMIC TECHNOLOGY				3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.					
Unit II	DESIGN AND CONSTRUCTION TECHNOLOGY				3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

Unit III	MANUFACTURING TECHNOLOGY	3
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold Coins as source of history - Minting of Coins – Beads making - industries Stone beads - Glass beads - Terracotta beads - Shell beads/ bone beads - Archeological evidences - Gem stone types described in Silappathikaram.		
Unit IV	AGRICULTURE AND IRRIGATION TECHNOLOGY	3
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
Unit V	SCIENTIFIC TAMIL & TAMIL COMPUTING	3
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
Total periods: 15		
Text Books:		
1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print) .		
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).		
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).		
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)		
5. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)		
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)		
References:		
1. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.		

23GEP201	ENGINEERING PRACTICES LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites • Basic knowledge of workshop tools and safety procedures. • Elementary understanding of electrical, plumbing, and mechanical concepts.					
Course Objectives: • To draw plumbing line plans and lay various pipe connections using fittings commonly used in household plumbing. • To perform woodworking operations such as sawing, planning, and making joints like T-joint, mortise and tenon joint, and dovetail joint. • To wire electrical circuits including basic switchboard wiring, staircase wiring, and fluorescent lamp wiring, and assemble household electrical appliances like fans, lamps, and emergency lights. • To perform basic welding, machining (turning, drilling, tapping), sheet metal work, and mechanical assembly of simple household equipment. • To assemble, solder, and test simple electronic circuits and components on printed circuit boards (PCB).					
CIVIL ENGINEERING PRACTICES (CIVIL & ELECTRICAL)					
PART I:					
LIST OF EXPERIMENTS					
PLUMBING WORK:					
a)	Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.				
b)	Preparing plumbing line sketches.				
c)	Laying pipe connection to the suction side of a pump.				
d)	Laying pipe connection to the delivery side of a pump.				
e)	Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.				
WOOD WORK:					
a)	Sawing,				
b)	Planing and				
c)	Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.				
Wood Work Study:					
a)	Studying joints in door panels and wooden furniture.				
b)	Studying common industrial trusses using models.				

PART II :**ELECTRICAL ENGINEERING PRACTICES**

a)	Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket
b)	Staircase wiring
c)	Fluorescent Lamp wiring with introduction to CFL and LED types.
d)	Energy meter wiring and related calculations/ calibration
e)	Study of Iron Box wiring and assembly
f)	Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac)
g)	Study of emergency lamp wiring/Water heater

Total periods: 60**Text Books:**

1.Engineering Practices Laboratory Manual, Anna University, 2023 Edition.

2.Kalpajian S., **Manufacturing Engineering & Technology**, 7th Edition, Pearson, 2014.3.R.K. Rajput, **A Textbook of Engineering Workshop**, Laxmi Publications, 2015.**Reference Books:**

1. Hajra Choudhury S.K., Workshop Technology, Vol. I & II, Media Promoters & Publishers Pvt. Ltd., 2008.

2. P.Kannaiah & K.Lakshminarayana, Workshop Practice, Scitech Publications, 2012.

3. Bawa H.S., Workshop Technology, Tata McGraw Hill, 2003.

4. Raghuvanshi B.S., Electrical and Electronics Engineering Practice Lab Manual, Wiley India, 2016.

Course Outcomes:**Blooms Taxonomy****CO1:** Perform plumbing work, including pipe layout, connections, and fittings.

Applying(K3)

CO2: Demonstrate woodworking skills including sawing, planning, and making joints.

Applying(K3)

CO3: Carry out electrical wiring tasks for common household circuits.

Applying(K3)

CO4;Perform basic welding, machining, sheet metal work, and mechanical assembly.

Applying(K3)

CO5: Assemble, solder, and test simple electronic circuits.

Applying(K3)

CO – PO& PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-
CO2	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-
CO3	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-
CO4	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-
CO5	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-
CO Avg.	2	-	3	-	-	2	-	-	1	-	-	-	2	-	-

1 - Low, 2 - Medium, 3 -High , ‘ ‘ No correlation

23EEP202	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites Nil					
Course Objectives: - To train the students in conducting load tests electrical machines - To gain practical experience in experimentally obtaining the characteristics of electronic devices and rectifiers - To train the students to measure three phase power and displacement					
LIST OF EXPERIMENTS					
1	Verification of ohms and Kirchhoff’s Laws.				
2	Three Phase Power Measurement				
3	Load test on DC Shunt Motor.				
4	Load test on Self Excited DC Generator				
5	Load test on Single phase Transformer				
6	Load Test on Induction Motor				
7	Characteristics of PN and Zener Diodes				
8	Characteristics of BJT, SCR and MOSFET				
9	Design and analysis of Half wave and Full Wave rectifiers				
10	Measurement of displacement of LVDT				
Total periods:60					
Text Books:					
1. D P Kothari and I.J Nagarath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education (India) Private Limited, Second Edition, 2020					
References:					
1. A.K. Sawhney, PuneetSawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.					
Course Outcomes:					Blooms Taxonomy
CO1: Use experimental methods to verify the Ohm’s law and Kirchhoff’s Law and to measure three phase power					Apply (K3)
CO2: Analyse experimentally the load characteristics of electrical machines					Analyze (k4)
CO3: Analyse the characteristics of basic electronic devices					Analyze (k4)
CO4: Design Half wave and Full Wave rectifiers					Apply (K3)
CO5: Use LVDT to measure displacement					Understanding (K2)

CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
CO2	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
CO3	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
CO4	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
CO5	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
CO Avg.	3	3	2	1	-	-	-	1	3	-	-	-	2	2	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23GEP202	COMMUNICATION LABORATORY (Common to All Branches)	Category: EEC			
		L	T	P	C
		0	0	4	2
Prerequisites • Nil					
Course Objectives: • To identify varied group discussion skills and apply them to take part in effective discussions in a professional context. • To analyze concepts and problems and make effective presentations explaining them clearly and precisely. • To be able to communicate effectively through formal and informal writing. • To be able to use appropriate language structures to write emails, reports and essays • To give instructions and recommendations that are clear and relevant to the context					
LIST OF EXPERIMENTS					
1	Speaking-Role Play Exercises Based on Workplace Contexts				
2	Talking about competition- discussing progress toward goals-talking about experiences-				
3	Talking about events in life- discussing past events-Writing: writing emails (formal& semi-formal).				
4	Speaking: discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems				
5	Making arrangements-describing arrangements-discussing plans and decisions-				
6	Discussing purposes and reasons- understanding common technology terms-Writing: - writing different types of emails.				
7	Speaking: discussing predictions-describing the climate-discussing forecasts and scenarios- talking about purchasing-discussing advantages and disadvantages				
8	Making comparisons- discussing likes and dislikes- discussing feelings about experiences-				
9	Discussing imaginary scenarios Writing: short essays and reports-formal/semi-formal letters.				

10	Speaking: discussing the natural environment-describing systems-describing position and movement-
11	Explaining rules-(example-discussing rental arrangements)- understanding technical instructions-
12	Writing: Writing instructions-writing a short article.
13	Speaking: describing things relatively-describing clothing
14	Discussing safety issues (making recommendations) talking about electrical devices
15	Describing controlling actions- Writing: job application (Cover letter + Curriculum vitae)-writing recommendations.

Total periods: 60**Text Books:**

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. VeenaSelvam, Dr. SujathaPriyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Jeevani, Department of English, Anna University.

References:

1. Raman. Meenakshi, Sharma. Sangeeta (2019).Professional English.Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, NewDelhi
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, MeeraBannerji- Macmillan India Ltd. 1990, Delhi.

Course Outcomes:	Blooms Taxonomy
CO1: Speak effectively in group discussions held in a formal/semi formal contexts.	Remember (K1)
CO2: Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions	Apply (K3)
CO3: Write emails, letters and effective job applications	Understand (K2)
CO4: Write critical reports to convey data and information with clarity and precision	Apply (K3)
CO5: Give appropriate instructions and recommendations for safe execution of tasks	Apply (K3)

CO – PO& PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
CO2	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
CO3	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
CO4	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
CO5	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-
CO Avg.	1	0	0	0	0	0	2	2	2	3	2	3	-	-	-

1 - Low, 2 - Medium, 3 -High, ‘-’ No correlation2

SEMESTER III

23MAT301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (B.E. CIVIL, MECH, BIOMED, ECE, EEE & B.TECH. BIOTECH, CHEM)	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites • Basic Mathematical Knowledge • Matrices and Calculus					
Course Objectives: ➤ To introduce the basic concepts of PDE for solving standard partial differential equations. ➤ To introduce Fourier series analysis this is central to many applications in engineering apart from its use in solving boundary value problems. ➤ To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations. ➤ To acquaint the student with Fourier transform techniques used in wide variety of situations. ➤ To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.					
Unit I	PARTIAL DIFFERENTIAL EQUATIONS				9+3
Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First orders partial differential equations reducible to standard types- Lagrange’s linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.					
Unit II	FOURIER SERIES				9+3
Dirichlet’s conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval’s identity – Harmonic analysis.					
Unit III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS				9+3
Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).					
Unit IV	FOURIER TRANSFORMS				9+3
Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval’s identity.					
Unit V	Z - TRANSFORMS AND DIFFERENCE EQUATIONS				9+3
Z-transforms - Elementary properties – Convergence of Z-transforms - – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.					

Total periods:60**Text Books:**

1. Grewal B.S., "Higher Engineering Mathematics" 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.

References:

1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, New Delhi, 2016.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.
5. Wylie. R.C. and Barrett . L.C., "Advanced Engineering Mathematics "Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

Course Outcomes:**Blooms Taxonomy**

CO 1: Understand how to solve the given standard partial differential equations.	Understanding (K2)
CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.	Applying (K3)
CO3: Apply the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Applying (K3)
CO4: Conclude the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.	Applying (K3)
CO5: Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	Understanding (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-
CO2	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-
CO3	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-
CO4	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-
CO5	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-
CO Avg.	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23CHT301	BASIC MECHANICAL ENGINEERING	Category: ESC			
		L	T	P	C
		3	0	0	3
• Prerequisites: Nil					
Course Objectives: To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines					
Unit I	LAWS OF THERMODYNAMICS				9
Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics — Kelvin - Planck statement and Clausius statement-problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Third law of Thermodynamics - Statement.					
Unit II	HEATING AND EXPANSION OF GASES				9
Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.					
Unit III	AIR STANDARD CYCLES				9
Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle- Derivations and problems					
Unit IV	I.C. ENGINES, STEAM AND ITS PROPERTIES AND TEAM				9
Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption. Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle. Steam turbines — Impulse and Reaction types - Principles of operation					
Unit V	SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALNCING				9
Definition of Kinematic Links, Pairs and Kinematic Chains; Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes					
Total periods: : 45					
Text Books:					
1.Nag, P.K., “Engineering Thermodynamics “, IInd Edition, Tata McGraw Hill Publishing Co.,Ltd., 1995					
2.Rajput, R .K, “Thermal Engineering”, Laxmi publications (P) Ltd, 2001.					
3.Khurmi R.S., and Gupta J.K, “Theory of Machines”, Eurasia Publishing House (P) Ltd., 2004					
References:					
1.Bhaskaran, K.A., and Venkatesh, A., “Engineering Thermodynamics “,Tata McGraw Hill,1973.					

2.Khurmi R.S., and Gupta J.K, “Thermal Engineering”, S.Chand & Company (P) Ltd.,2001.

3.Kothandaraman and Dhommkudwar,”: A course in Thermal Engineering (SI Units)”, Dhanpati and Sons, Delhi (2001)

4.Pandya A. and Shah, “ Theory of Machines “, Charatakar Publishers, 1975.

5.Smith, “Chemical Thermodynamics “, Reinhold Publishing Co., 1977.

Course Outcomes: On completion

Blooms Taxonomy

CO 1:Understand the basic concepts and Laws of thermodynamics and its applications.

Remember (K1)

CO2:Understand the various processes with its derivation and gaining knowledge of various processes in Chemical Industries

Understand (K2)

CO3:Understand the various thermodynamic cycles with its derivation

Analyze (K4)

CO4:Understand the thermal engineering equipments like IC engine etc with its performance, and rankine cycle

Understand (K2)

CO5:Understand the drives used to transmit power from one shaft to another belt drive, chain drive, gear drive etc and flywheel.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	1	3	2	2	3	3	2	-
CO2	2	2	3	2	2	2	2	1	3	2	3	3	3	2	2
CO3	2	2	2	-	-	2	-	1	3	2	2	3	2	2	2
CO4	3	3	3	2	-	-	-	-	2	2	2	2	2	-	2
CO5	3	3	3	2	3	3	2	3	2	2	3	3	2	2	2
CO Avg.	2.6	2.6	2.8	2	2.3	2.2	1.6	1.5	2.6	2	2.4	2.8	2.4	2	2

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHT302	MECHANICS OF SOLIDS	Category: PCC			
		L	T	P	C
		3	0	0	3

- Prerequisites: Nil

Course Objectives:

To impart knowledge on designing the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing

Unit I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Rigid bodies and deformable solids – forces on solids and supports – equilibrium and stability – strength and stiffness – tension, compression and shear stresses – Hooke’s law and simple problems – compound bars –

thermal stresses – elastic constants and poisson's ratio.

Unit II	TRANSVERSE LOADING ON BEAMS	9

Beams –support conditions–types of Beams –transverse loading on beams–shear force and bending moment in beams–analysis of cantilevers, simply – supported beams and over hanging beams – relationships between loading, S.F. and B.M. in beams and their applications– S.F.& B.M. diagrams

Unit III	DEFLECTIONS OF BEAMS	9

Double integration method – Macaulay's method –Area – moment theorems for computation of slopes and deflections in beams.

Unit IV	STRESSES IN BEAMS	9

Theory of simple bending – assumptions and derivation of bending equation ($M/I = F/Y = E/R$)– analysis of stresses in beams–load carrying capacity of beams–proportioning beam sections – leaf springs – flitched beams – shear stress distribution in beams – determination of shear stress in flanged beams.

Unit V	TORSION AND COLUMNS	9

Torsion of circular shafts – derivation of torsion equation ($T/J = \tau/R = C\theta/L$) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts–stepped shafts – shafts fixed at both ends– stresses in helical springs–deflection of springs–spring constant. Axially loaded short columns– columns of unsymmetrical sections– Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

Total periods:60

Text Books:

1. Junarkar, S. B., Mechanics of Structure Vol.1, 21st Edition, Character Publishing House, Anand, Indian, (1995).
2. William A. Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series.
3. McGraw Hill International Editions, Third Edition, 1994.
4. Bansal, R.K, Strength of Materials, Laxmi Publications(P) Ltd., Fourth Edition 2010

References:

1. 1. Elangovan A. ,Thinma Visai Iyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995

Course Outcomes: Upon completion of the course, the students would be able to	Blooms Taxonomy
CO1: Understand the basic concepts of stress, strain and deformation of solids	Understand (K2)
CO2: Understand the concept of transverse loading on statistically deterministic beams and its	Understand (K2)
CO3: Understand the concept of slope and deflection in beams through Double Integration,	Apply (K3)
CO4: Understand the stress distribution concept like bending and shear stresses in beams and leaf springs	Understand (K2)
CO5: Understand the stress and deformation in shafts, analysis of columns by Euler's theory and effect of eccentricity	Analyze (K4)

CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	3	2	2	2	3	2	3	1	2	3	3	2	-
CO2	2	2	3	2	2	2	2	3	3	2	3	3	3	2	2
CO3	2	2	2	-	-	2	-	2	3	2	2	3	2	2	2
CO4	3	3	3	2	-	-	-	-	2	2	2	2	2	-	2
CO5	3	3	3	2	3	3	2	3	2	2	3	3	2	2	2
CO Avg.	2.4	2.4	2.8	2.0	2.3	2.3	2.3	2.5	2.6	1.8	2.4	2.8	2.4	2.0	2.0
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHT303	CHEMICAL PROCESS CALCULATIONS	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Nil					
Course Objectives: To enable the students to acquire knowledge on laws of chemistry and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.					
Unit I					9
Base and derived Units - Composition of Mixture and solutions - calculations of pressure, volume and temperature using ideal gas law. Use of partial pressure and pure component volume in gas calculations, applications of real gas relationship in gas calculation					
Unit II					9
Stoichiometric principles, Application of material balance to unit operations like distillation, evaporation, crystallisation, drying etc., - Material balance with chemical reaction - Limiting and excess reactants - recycle - bypass and purging - Unsteady state material balances					
Unit III					9
Calculation of absolute humidity, molal humidity, relative humidity and percentage humidity - Use of humidity in condensation and drying - Humidity chart, dew point					
Unit IV					9
Heat capacity of solids, liquids, gases and solutions, use of mean heat capacity in heat calculations, problems involving sensible heat and latent heats, evaluation of enthalpy. Standard heat of reaction, heats of formation, combustion, solution, mixing etc., calculation of standard heat of reaction - Effect of pressure and temperature on heat of reaction -Energy balance for systems with and without chemical reaction - Unsteady state energy balances					

Unit V													9		
Determination of Composition by Orsat analysis of products of combustion of solid, liquid and gas fuels - Calculation of excess air from orsat technique, problems on sulphur and sulphur burning compounds - Application of Process simulators in energy and material balance problems.															
Total periods:45															
Text Books:															
1.Bhatt, B.L., Vora, S.M., “Stoichiometry “, 4 th Edition, Tata McGraw-Hill (2004)															
2.Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, EEEighth Edition, Prentice Hall Inc., 2012															
3.Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes”,5 th															
References:															
1. Hougen O A, Watson K M and Ragatz R A, “Chemical process principles” Part I, CBSpublishers ,Second edition,2004.															
Course Outcomes:												Blooms Taxonomy			
CO1:Understand the concepts of dimensional consistency and effective application of unitsand dimensions.												Understand (K2)			
CO2:Analyze a problem statement and balance the material flowing through single and various operations												Understand (K2)			
CO3:Understand the gas behavior and its properties												Understand (K2)			
CO4:Understand general energy balance, simplify and apply to open and closed systems												Apply (K3)			
CO5:Write material and energy balance for unsteady state how material and energy balances are formulated for equation- and modular based flow sheeting codes												Apply (K3)			
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO2	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO3	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO4	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO Avg.	2	3	2	3	3	2	1	1	1	1	1	1	2	3	1
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHT304	FLUID MECHANICS FOR CHEMICAL ENGINEERS	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Nil					
Course Objectives: To enable the students to acquire a sound knowledge on fluid properties, fluid statics, dynamic characteristics of fluid flow for through pipes and porous medium, flow measurement and fluid machineries					
Unit I					9
Methods of analysis and description - fluid as a continuum – Velocity and stress field - Newtonian and non-Newtonian fluids – Classification of fluid motion					
Unit II					9
Fluid statics – basic equation - equilibrium of fluid element – pressure variation in a static fluid - application to manometer – Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier- Stokes equation.					
Unit III					9
The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi- theorem - non-dimensional action of the basic equations - similitude - relationship between dimensional analysis and similitude - use of dimensional analysis for scale up studies					
Unit IV					9
Reynolds number regimes, internal flow - flow through pipes – pressure drop under laminar and turbulent flow conditions – major and minor losses; Line sizing; External flows - boundary layer concepts, boundary layer thickness under laminar and turbulent flow conditions- Flow over a sphere – friction and pressure drag - flow through fixed and fluidized beds					
Unit V					9
Flow measurement - Constant and variable head meters; Velocity measurement techniques; Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans					
Total periods: 45					
Text Books:					
1.Noel de Nevers, “Fluid Mechanics for Chemical Engineers “, Third Edition, McGraw-Hill,(2017).					
2.McCabe W.L, Smith, J C and Harriot. P “Unit operations in Chemical Engineering”, McGrawHill, VII Edition, 2017					
3.Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 9 th Edition“, John Wiley, 2021					
References:					
1, F.M., “Fluid Mechanics “, IV Edition, McGraw-Hill Inc., 1999.					
2.White James O Wilkes and Stacy G Bike, “Fluid Mechanics for Chemical Engineers’ Prentice Hall PTR					

(International series in Chemical Engineering) (1999)

Course Outcomes:													Blooms Taxonomy		
CO1: Understand the fundamental properties of fluids, stress-strain relationship in fluids, and its characteristics under static conditions and establish force balance in static systems.													Understand (K2)		
CO2: Apply Bernoulli principle, Navier - Stokes equation and compute pressure variation in static fluid.													Apply (K3)		
CO3: Use of dimensional analysis to derive relationships among process or system variables. Further they would develop dimensionless groups that help in scale-up studies.													Understand (K2)		
CO4: Understand the different types of flow conditions in fixed bed and fluidized beds.													Remember (K1)		
CO5: Describe function of flow metering devices, apply Bernoulli equation to determine the performance of flow-metering devices and also analyze the performance aspects of fluid machinery such as pumps, compressors and valves.													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	1	2	-	3	1	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	-	3	3	3	2	-	2	-	-	3	1	2	-	-	2
CO4	3	-	3	3	2	-	2	-	-	-	-	3	3	-	-
CO5	2	3	-	3	-	2	1	1	-	-	-	-	-	2	2
CO Avg.	2.7	3.0	3.0	3.0	2.0	2.0	1.7	1.0	-	2.0	1.5	2.5	3.0	1.7	2.0
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHT305	CHEMICAL PROCESS INDUSTRIES	Category: PCC			
		L	T	P	C
		3	0	0	3

Prerequisites: Nil**Course Objectives:**

- To impart knowledge on various aspects of production engineering and make the student understand the practical methods of production in a chemical factory

Unit I	SULFUR, SULFURIC ACID AND CEMENT	9
Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.		

Unit II	FERTILIZER INDUSTRY												9		
Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries, Phosphoric acid, Single Super Phosphate, DAP, MAP and NPK – Potassium chloride, Potassium Sulphate – Liquid Fertilizers – Bio Fertilizers.															
Unit III	PULP, PAPER, SUGAR AND STARCH INDUSTRIES												9		
Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products,Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugarindustry – Starch – Methods of production, Starch derivations															
Unit IV	PETROLEUM AND PETRO CHEMICAL INDUSTRIES												9		
Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Butadiene – Chemicals from Aromatics - Benzene, Toluene and Xylene															
Unit V	FUEL AND INDUSTRIAL GASES												9		
Fuel Gases – Natural gas, Liquefied natural gas, Synthesis Gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen – Argon.															
Total periods: 45															
Text Books:															
1.Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.															
2.Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley,Secondedition 2013															
References:															
1. Austin, G.T., Shreve’s “Chemical Process Industries”, 5 th ed., McGraw-Hill, 2017.															
2. Srikumar Koyikkal, “Chemical Process Technology and Simulation”, PHI Learning Ltd															
Course Outcomes:													Blooms Taxonomy		
CO1 : Understand the various unit operations and processes with their symbols													Remember (K1)		
CO2 : Understand the various chemical reactions involved in the process													Understand (K2)		
CO3 : Students will know to draw the process Flow sheet and understand the major engineeringproblems encountered in the processes.													Understand (K2)		
CO4 : To learn manufacturing processes of organic and Inorganic Chemicals and its applications.													Apply (K3)		
CO5 : Students will understand the role of chemical Engineering in the process plants													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	1	1	-	-	-	-	-	1	2	3	2
CO2	2	2	3	3	2	1	-	1	1	1	1	-	2	2	2
CO3	3	2	2	2	2	1	-	1	1	1	-	1	1	1	1

CO4	2	3	3	2	3	1	1	-	-	-	-	2	2	2	2
CO5	2	3	3	2	3	1	1	-	1	-	1	1	2	2	3
CO Avg.	2.4	2.4	2.8	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.8	2.0	2.0

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHP301	BASIC MECHANICAL ENGINEERING LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2

Prerequisites: Nil

Course Objectives:

The course is aimed to

- Impart practical knowledge in operating IC engines and conduct experiments.
- To make the students understand the test procedures in testing material for engineering applications

LIST OF EXPERIMENTS

1	Port timing diagram
2	Valve timing diagram
3	Study of 2,4 stroke I C Engines
4	Load test on 4-stroke petrol engine
5	Performance test on 4-stroke single cylinder diesel engine
6	Performance test on 4-stroke twin cylinder diesel engine
7	Heat balance test on diesel engines
8	Tension test
9	Compression test
10	Deflection test
11	Hardness test (Rockwell and Brinell)
12	Spring test
13	Torsion test
14	Impact test

Total periods: 45

Course Outcomes:	Blooms Taxonomy
CO1: Determine Brake power, Indicated power and frictional power of single cylinder diesel engines	Understand (K2)
CO2: Determine Brake power, Indicated power and frictional power of twin cylinder diesel engines	Understand (K2)

CO3: Determine Brake power, Indicated power and frictional power of single cylinder petrol engines													Apply (K3)		
CO4: Evaluate the heat distribution from engine and preparing heat balance chart													Apply (K3)		
CO5: Estimate the engine performance with mechanical loading, PTD and VTD of two and four stroke engines													Apply (K3)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	3	2	3	2	2	3	3	2	-
CO2	2	2	3	2	2	2	2	3	3	2	3	3	3	2	2
CO3	2	2	2	-	-	2	-	2	3	2	2	3	2	2	2
CO4	3	3	3	2	-	-	-	-	2	2	2	2	2	-	2
CO5	3	3	3	2	3	3	2	3	2	2	3	3	2	2	2
CO Avg.	2.6	2.6	2.8	2.0	2.3	2.3	2.3	2.5	2.6	2.0	2.4	2.8	2.4	2.0	2.0
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHP302	TECHNICAL ANALYSIS LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2
Prerequisites Chemistry Laboratory					
Course Objectives: To learn basic principles involved in estimation and characterization of industrially important materials					
LIST OF EXPERIMENTS					
1	Soap Analysis				
a.	Estimation of total fatty acid				
b.	Estimation of percentage alkali content				
2	Oil Analysis				
a.	Estimation of free acid				
b.	Determination of Saponification value				
c.	Determination of iodine value				
3	Cement Analysis				
a.	Estimation of Silica content				
b.	Estimation of mixed oxide content				
c.	Estimation of calcium oxide content				
d.	Estimation of calcium oxide by rapid method				

4	Coal Analysis														
a.	Estimation of Sulphur present in coal														
b.	Ultimate analysis of coal														
c.	Proximate analysis of coal														
5	Analysis of Bleaching Powder														
a.	Estimation of available chlorine														
6	Analysis of Glycerol Estimation of purity of glycerol														
7	Analysis of fuels														
a.	Flash point														
b.	Fire point														
c.	Cloud point														
d.	Pour point														
e.	Aniline point.														
Total periods:30															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand the estimation and analysis of Soap.													Analyze (K4)		
CO2: Understand the estimation and analysis of Cement Analysis													Analyze (K4)		
CO3: Understand the estimation and analysis of Coal Analysis													Analyze (K4)		
CO4: Understand the estimation and analysis of Analysis of Glycerol													Analyze (K4)		
CO5: Understand the estimation and analysis of Analysis of fuels													Analyze (K4)		
Course Outcomes:															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	3	2	2	2	3	2	3	2	2	3	3	2	-
CO2	1	2	3	2	2	2	2	3	3	2	3	3	3	2	1
CO3	1	2	2	-	-	2	-	2	3	2	2	3	2	2	1
CO4	1	3	3	2	-	-	-	-	2	2	2	2	2	-	1
CO5	1	3	3	2	3	3	2	3	2	2	3	3	2	1	2
CO Avg.	1.0	2.6	2.8	2.0	2.3	2.3	2.3	2.5	2.6	2.0	2.4	2.8	2.4	1.8	1.3
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

SEMESTER IV

23MAT403	STATISTICS AND QUALITY CONTROL Second year EVEN semester (B.Tech. Chemical Engineering)	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites - Basic Mathematical Knowledge - Matrices and Calculus					
Course Objectives: - This course aims at providing the required skill to apply the statistical tools in engineering problems. - To introduce the basic concepts of probability and random variables. - To introduce the basic concepts of two dimensional random variables. - To acquaint the knowledge of testing of hypothesis for small and large samples this plays an important role in real life problems. - To introduce the basic concepts of classifications of design of experiments this plays very important roles in the field of agriculture and statistical quality control.					
UNIT I	PROBABILITY AND RANDOM VARIABLES				9 + 3
Random Variable - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Uniform, Exponential and Normal distributions - Functions of a random variable.					
UNIT II	TWO – DIMENSIONAL RANDOM VARIABLES				9 + 3
Joint distributions –Marginal and conditional distributions (Discrete and Continuous random variables) – Covariance – Correlation (Discrete and Continuous random variables) and linear regression – Transformation of random variables					
UNIT III	TESTING OF HYPOTHESIS				9 + 3
Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.					
UNIT IV	DESIGN OF EXPERIMENTS				9 + 3
One way and two way classifications - Completely randomized design – Randomized block design -Latin square design - 2^2 factorial design.					
UNIT V	STATISTICAL QUALITY CONTROL				9 + 3
Control charts for measurements ($\bar{X}$ and R charts) – Control charts for attributes (p, c, and np charts) – Tolerance limits – Acceptance sampling.					
Total periods:60					

Text Books:

1. Johnson. R.A., Miller. I.R and Freund . J.E, " Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2016.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata Mc Graw Hill, 4th Edition, 2007.
3. John E. Freund, "Mathematical Statistics", Prentice Hall, 5th Edition, 1992.

References:

1. Gupta. S.C. and Kapoor. V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5 thEdition, Elsevier, 2014.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2010.

Course Outcomes:**Blooms Taxonomy**

CO1: Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life Phenomenon.

Understanding (K2)

CO2: Understand the basic concepts of one and two dimensional random variables And apply in engineering applications.

Applying (K3)

CO3: Apply the concept of testing of hypothesis for small and large samples in real Life problems.

Applying (K3)

CO4: Apply the basic concepts of classifications of design of experiments in the Field of agriculture and statistical quality control.

Applying (K3)

CO5: Have the notion of sampling distributions and statistical techniques used in Engineering and management problems.

Understanding (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-

CO5	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-
CO Avg.	3	2	1	1	-	-	-	-	-	-	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23CHT401	MASS TRANSFER I	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Basics of Chemical Engineering					
Course Objectives: Learn and determine mass transfer rates under laminar and turbulent conditions and apply these concepts in the design of humidification columns, dryers and crystallisers					
Unit I	MOLECULAR DIFFUSION				9
Introduction to mass transfer operations. Molecular diffusion in gases, liquids and solids. Diffusivity measurement and prediction; multi-component diffusion					
Unit II	CONVECTIVE TRANSFER AND INTERPHASE MASS TRANSFER				9
Eddy diffusion, concept of mass transfer coefficients, theories of mass transfer, different transport analogies, application of correlations for mass transfer coefficients, inter phase mass transfer, relationship between individual and overall mass transfer coefficients. NTU and NTP concepts, Stage-wise and differential contractors					
Unit III	HUMIDIFICATION OPERATIONS				9
Humidification — Equilibrium, humidity chart, adiabatic and wet bulb temperatures; humidification operations; theory and design of cooling towers, dehumidifiers and humidifiers using enthalpy transfer unit concept					
Unit IV	DRYING				9
Drying — Equilibrium. Classification of dryers, batch drying — Mechanism and time of cross through circulation drying, theoretical estimation of drying rate and time. Continuous dryers — material and energy balance. Advance drying techniques such as freeze drying, microwave drying					
Unit V	CRYSTALLIZATION				9
Crystal geometry. Equilibrium, yield and purity of products, theory of super saturation, nucleation and crystal growth, classification of crystallizers, design of batch crystallizers and continuous crystallizers					
Total periods:45					
Text Books:					
1. Treybal, R. E., “Mass Transfer Operations”, 3rd Edition, McGraw-Hill,2017.					
2. Geankoplis, C.J., “Transport Processes and Unit Operations”, 4 th Edition, PrenticeHall Inc., NewJersey, 2003.					
3. Narayanan K.V. and Lakshmikutty, B “Mass Transfer — Theory and Applications”, 1 st Edition, CBS					

Publishers & Distributors Pvt Ltd, New Delhi, 2014

References:

1. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edition., McGraw-Hill, 2005.
2. Coulson, J.M. and Richardson, J.F., "Chemical Engineering" Vol. I and II, 5th Edition, AsianBooks Pvt. Ltd., India, 2002.
3. Seader J.D. and Henley E.J., "Separation Process Principles", 4th Ed., John Wiley, 2016

Course Outcomes:**Blooms Taxonomy****CO 1:** Understand the fundamentals, types and mechanism of mass transfer operations

Understand (K2)

CO2: Understand the theories of mass transfer and the concept of inter-phase mass transfer

Understand (K2)

CO3: Understand the basics of humidification process and its application

Apply (K3)

CO4: Understand the concept and mechanism of drying operations

Understand (K2)

CO5: Understand the concept of crystallization process and identification of suitable crystallizer And formulate to solve material balances for unit operations such as humidification, drying and crystallization operations

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	-	-	-	1	1	1	3	3	2	1
CO2	3	3	3	3	2	-	-	-	2	1	1	3	3	2	1
CO3	3	3	3	2	1	-	-	-	1	1	1	3	2	-	2
CO4	3	3	3	3	2	1	1	1	1	1	2	3	2	1	1
CO5	3	3	3	2	1	1	-	1	1	1	2	3	1	1	1
CO Avg.	3.0	3.0	3.0	2.4	1.4	1.0	1.0	1.0	1.2	1.0	1.4	3.0	2.2	1.5	1.2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CHT402	MECHANICAL OPERATIONS	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Nil					
Course Objectives: To impart knowledge in the field of particle size reduction and also construction and working of equipment's used for mechanical operations.					
Unit I	PARTICLE CHARACTERIZATION AND MEASUREMENT				9
General characteristics of solids, different techniques of size analysis- Static - Image analysis and Dynamic analysis - Light scattering techniques, shape factor, surface area determination, estimation of particle size. Advanced particle size analysis techniques. Screening methods and equipment, screen efficiency, ideal and actual screens.					
Unit II	PARTICLE SIZE REDUCTION AND SIZE ENLARGEMENT				9
Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; Advanced size reduction techniques - Nano particle fabrication - Top-down approach - Bottom-up approach. Size enlargement - Importance of size enlargement, principle of granulation, briquetting, palletization, and flocculation. Fundamentals of particle generation					
Unit III	PARTICLE SEPARATION (GAS-SOLID AND LIQUID-SOLID SYSTEM)				9
Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging					
Unit IV	FILTRATION AND FILTRATION EQUIPMENTS				9
Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids					
Unit V	MIXING AND PARTICLE HANDLING				9
Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, Powder hazards, conveyer selection, different types of conveyers and their performance characteristics					
Total periods: 45					
Text Books:					
1.McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7 th Edn., McGraw-Hill, 2005.					
2.Badger W.L. and Banchero J.T., “Introduction to Chemical Engineering”, Tata McGraw Hill,1997.					
3.Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of UnitOperations”, 2 nd					

Edn., John Wiley & Sons, 1994.

4.Hiroaki Masuda , KoHigashitani and Hideto Yoshida, Powder Technology Handbook, 3rd Edition**References:**1.Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. II, 4th Edn., Asian Books Pvt.Ltd., India, 1998.

2.Christie J. Geankoplis, Transport processes and unit operations.

3.Sunggyu Lee, Kimberly H. Henthorn, Particle Technology and Applications.

4.Martin Rhodes, Introduction to Particle Technology, Second Edition

Course Outcomes:**Blooms Taxonomy****CO1:** Understand and determine various properties of particulates

Understand (K2)

CO2: Gain Preliminary understanding on Size Reduction and Size Enlargement

Understand (K2)

CO3: Understand various separation and purification techniques employed in solid particles

Apply (K3)

CO4: Enhance their knowledge on Filtration Process

Understand (K2)

CO5: Understand Handling, Storage and Transportation of Solids and Obtain knowledge on various unit operations and their applications

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	1	1	-	3	3	3	2	3	3	1
CO2	3	2	2	2	2	1	1	-	1	2	2	2	2	3	1
CO3	3	2	2	3	3	1	3	2	1	2	3	2	2	3	3
CO4	2	2	2	1	1	1	2	1	1	1	1	1	2	2	1
CO5	2	2	3	2	1	2	3	1	1	1	2	2	1	1	3
CO Avg.	2.6	2.2	2.4	2.2	1.6	1.2	2.0	1.3	1.4	1.8	2.2	1.8	2.0	2.4	1.8

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHT403	CHEMICAL ENGINEERING THERMODYNAMICS - I	Category: PCC			
		L	T	P	C
		3	0	0	3

Prerequisites: Nil**Course Objectives:**

- Learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

Unit I**9**

Terminologies of thermodynamics, the variables and quantities of thermodynamics, characteristics of systems and processes, energy classifications, point and path functions, energy in transition work and heat. Zeroth law; temperature scales

Unit II		9
The first law of thermodynamics, statements of first law for the flow and non-flow processes. PVT behaviour of fluids; Mathematical representation of PVT behaviour; generalized compressibility factor correlation; generalized equations of state		
Unit III		9
Joule's experiment, energy balance for closed systems, mass and energy balance for open systems, Statements of the second law of thermodynamics, heat engine and refrigerator, Carnot cycle and Carnot theorems, thermodynamic temperature scale, entropy and its calculation, second law of thermodynamics for a control volume, Third law of thermodynamics, entropy from a microscopic point of view.		
Unit IV		9
Thermodynamic properties – internal energy, enthalpy, Helmholtz free energy, Gibbs free energy; thermodynamic property relations – Maxwell relations – partial derivatives and Jacobian method; residual properties; thermodynamic property tables and diagrams		
Unit V		9
Thermodynamic aspects of compression, expansion processes and duct flow of compressible fluids, steam power plant.		
Total periods:45		
Text Books:		
1.Smith J.M., VanNess,H.C., &Abbot M.C,," Introduction to Chemical Engineering Thermodynamics",McGraw Hill VII Edition 2009		
2.Kyle B.G.,,"Chemical and Process Thermodynamics", Pearson International third Edition.		
3.Rao Y.V.C.,,"Chemical Engineering Thermodynamics"Universities Press, 2005		
4.Koretsky.,Engineering and Chemical thermodynamics,Wiley,2011		
References:		
1.Sandler,S.I.,,"Chemical and Engineering Thermodynamics",IV Edition,Wiley,2006.		
2.Narayanan K.V"A Text Book of Chemical Engineering Thermodynamics"Prentice Hall of IndiaPvt.Ltd,2 nd edition,2013.		
3.Kevin Douglas, Fundamentals of Chemical Engineering Thermodynamics, Timothy Anderson,2015		
Course Outcomes:		Blooms Taxonomy
CO 1: Understand the fundamental concepts of thermodynamics and its related functions		Understand (K2)
CO2: Relate PVT behaviour of fluids and understand the real gas behaviour		Apply (K3)
CO3: Apply second law and analyse the feasibility of system/devices		Apply (K3)
CO4: Analyse the thermodynamic property relations and their application to fluid flow		Analyze (K4)
CO5: Develop the significance of thermodynamic potentials and their use in the analysis of processes and formulate thermodynamic formulations and the working of compressors		Apply (K3)

and expanders															
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	-	2	-	-	2	1	-	3	-	-
CO2	3	2	-	2	1	-	-	-	1	1	-	1	-	-	-
CO3	3	3	3	2	-	2	2	1	3	2	1	1	3	2	2
CO4	2	2	2	2	2	1	1	2	3	1	2	2	2	3	2
CO5	2	2	1	-	-	1	1	2	1	1	2	-	-	2	1
CO Avg.	2.6	2.2	1.8	2.0	1.3	1.3	1.5	1.7	2.0	1.4	1.5	1.3	2.7	2.3	1.7
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHT404	HEAT TRANSFER	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Course Objectives: The course is aimed to teach the fundamental concepts of heat transfer viz., conduction, convection, radiation, boiling and condensation and its application to the students					
Unit I					9
Importance of heat transfer in Chemical Engineering operations - Modes of heat transfer ; One dimensional steady state heat conduction through plane and composite walls, hollow cylinder and spheres - Thermal conductivity measurement-effect of temperature on thermal conductivity; Heat transfer in extended surfaces; Transient heat conduction					
Unit II					11
Concepts of heat transfer by convection - Natural and forced convection, Hydrodynamic and thermal Boundary layers; analogies between transfer of momentum and heat - Reynold’s analogy, Prandtl and Colburn analogy. Dimensional analysis in heat transfer, heat transfer coefficient for flow through a pipe, flow past flat plate.					
Unit III					9
Heat Exchangers — classification and design, overall and individual film coefficients, mean temperature difference, LMTD correction factor for multiple pass exchanger, NTU and efficiency of Heat exchangers					
Unit IV					8
Heat transfer to fluids with phase change - heat transfer from condensing vapours, drop wise and film wise condensation, Nusselt equation for vertical and horizontal tubes, condensation of superheated vapours, Heat transfer to boiling liquids - mechanism of boiling, nucleate boiling and film boiling					

Unit V														8		
Evaporation- single and multiple effect operation, material and Energy balance in evaporators, boiling point elevation, Duhring’s rule. Radiation heat transfer - Black body radiation, Emissivity, Stefan - Boltzman law, Plank’s law, radiation between surfaces.																
Total periods:45																
Text Books:																
1.Holman, J. P., ‘Heat Transfer ’, 10th Edn., McGraw Hill,2010.																
2.Ozisik, M. N., Heat Transfer: A Basic Approach, McGraw-Hill, 1984																
3.Kern, D.Q., “Process Heat Transfer “, McGraw-Hill, 1999.																
4.B.K. Dutta, Heat transfer principles and applications, PHI Learning PVT Ltd, 2016																
References:																
1.McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”,6thEdn., McGraw-Hill, 2001.																
2.Coulson, J.M. and Richardson, J.F., “Chemical Engineering “ Vol. I, 4th Edn., Asian BooksPvt. Ltd., India, 1998																
Course Outcomes:													Blooms Taxonomy			
CO1: Familiarize the students with the fundamental concepts of Heat Transfer. provide the student with knowledge about heat transfer by conduction in solids for steady state.													Understand (K2)			
CO2: Understand convective heat transfer and use of heat transfer coefficients for laminar and turbulent flows													Understand (K2)			
CO3: Students will be able to calculate and use overall heat transfer coefficients in designing heat exchangers													Apply (K3)			
CO4 : The course provides the student with knowledge about heat transfer with phase change(boiling and condensation) and evaporation													Understand (K2)			
CO5: Students will understand radiative heat transfer including blackbody radiation and Kirchoff’slaw, and will be able to solve radiative problems apply knowledge of heat transfer to solve thermal engineering problems													Apply (K3)			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	2	3	3	2	1	1	-	-	-	-	-	1	2	2	2	
CO2	2	2	3	3	2	1	-	1	1	1	1	-	1	2	2	
CO3	3	2	2	2	2	1	1	1	1	1	-	1	1	1	1	
CO4	2	2	3	2	3	1	1	-	-	-	-	2	2	1	1	
CO5	2	3	3	2	3	1	1	-	1	-	1	1	2	2	1	
CO Avg.	2.2	2.4	2.8	2.2	2.2	1.0	1.0	1.0	1.0	1.0	1.0	1.3	1.6	1.6	1.4	
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation																

23GET401	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to all programmes)	Category: BSC			
		L	T	P	C
		2	0	0	2
Prerequisites Engineering Chemistry					
Course Objectives: ❖ To study the nature of environment and biodiversity. ❖ To impart knowledge on the causes, effects and control/preventive measures of environmental pollution. ❖ To facilitate the understanding of renewable energy resources. ❖ To understand the social aspects of environment. ❖ To study the information related to environment and society.					
Unit I	ENVIRONMENT AND BIODIVERSITY				9
Definition, scope and importance of environment – need for public awareness. Eco-system and energy flow– ecological succession. Ecosystems: Forest ecosystem and grassland ecosystem. Types of biodiversity: genetic, species and ecosystem diversity. Values of biodiversity, hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife and man- wildlife conflicts. Conservation of biodiversity: In-situ and ex-situ.					
Unit II	ENVIRONMENTAL POLLUTION				6
Causes, effects, prevention and treatment technologies for Air, Water, Soil. Solid waste management and R principle. Solid, hazardous and E-waste management, Industrial safety measures.					
Unit III	RENEWABLE ENERGY RESOURCES				6
Deforestation. New Energy Sources: Need of new energy resources. Different energy resources: Tidal, Solar, Wind, Nuclear and Biomass energy resources. Applications of Hydrogen energy, Ocean energy resources and Tidal energy conversion.					
Unit IV	SOCIAL ISSUES OF ENVIRONMENT				9
From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people. Environmental ethics: Issues and possible solutions – Climate change, Global warming, Acid rain, Ozone layer depletion, Central and state pollution control boards. Waste product and consumerism.					
Unit V	ENVIRONMENT AND HUMAN POPULATIONS				6
Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education, Professional ethics – HIV / AIDS – women and child welfare – Role of information technology in environment and human health.					
Total periods:36					

Text Books:

1. Benny Joseph, 'Environmental Science and Engineering', 3rd edition, Tata McGraw-Hill, New Delhi, 2017
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004
3. Anubha Kaushik and C.P. Kaushiks, 'Perspectives in Environmental Studies, 6th edition, New Age International Publishers, 2018.
4. A.K. De, 'Environmental Chemistry, New Age International Publishers, New Delhi, 2016.

References:

1. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia, Jaico Publishing House, Mumbai, 2001.
2. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure, 'Oxford University Press, 3rd edition, 2015.
3. Erach Bharucha, 'Textbook of Environmental Studies for Undergraduate Courses, Orient Black swan Private limited, 2013.

Course Outcomes:**Blooms Taxonomy**

CO1: Familiar the functions of ecosystems, environment and biodiversity.	Remember (K1)
CO2: Know well about the effects of environmental pollutions	Remember (K1)
CO3: Inculcate the basic knowledge of renewable energy resources	Remember (K1)
CO4: Differentiate various social problems.	Understand (K2)
CO5: Describe the importance/impacts of population growth.	Understand (K2)

CO - PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	-	-	-	1	2	-	-	-	1	1	-	-	-
CO2	3	1	1	-	-	1	2	-	2	-	1	1	-	-	-
CO3	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
CO4	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
CO5	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-
CO Avg.	3.0	1.0	1.0	-	1.0	1.0	2.0	-	2.0	-	1.0	1.0	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23CHP401	FLUID MECHANICS LABORATORY												Category: PCC			
													L	T	P	C
													0	0	3	1.5
Prerequisites: Nil																
Course Objectives: To enable the students to learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.																
LIST OF EXPERIMENTS																
1	Viscosity measurement of non-Newtonian fluids															
2	Calibration of constant and variable head meters															
3	Calibration of weirs and notches															
4	Open drum orifice and draining time															
5	Flow through straight pipe															
6	Flow through annular pipe															
7	Flow through helical coil and spiral coil															
8	Losses in pipe fittings and valves															
9	Characteristic curves of pumps (Centrifugal / Gear / Reciprocating)															
10	Pressure drop studies in packed column															
11	Hydrodynamics of fluidized bed															
12	Drag coefficient of solid particle															
Total periods:45																
Course Outcomes:														Blooms Taxonomy		
CO 1:Identify and characterize of flow patterns and regimes														Apply (K3)		
CO 2:Calibrate flow measurement devices														Understand (K2)		
CO 3:Correlate the difference between fixed and fluidized bed columns and its application.														Apply (K3)		
CO 4:Select pumps for the transportation of fluids based on process conditions/requirements and fluid properties														Understand (K2)		
CO 5:Compare the results of theoretical analytical models to the actual behavior of real fluid flows and draw sustainable conclusions														Apply (K3)		
CO – PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	-	-	-	-	-	-	-	-	-	2	3	3	-	
CO2	-	3	3	3	-	-	-	-	-	-	-	2	3	3	-	
CO3	-	3	3	3	-	-	-	-	-	-	-	2	3	3	3	
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3	3	
CO5	3	3	3	3	2	-	2	-	-	3	2	3	3	3	3	
CO Avg.	3.0	3.0	3.0	3.0	2.0	-	2.0	-	-	3.0	2.0	2.2	3.0	3.0	3.0	
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation																

23CHP402	MECHANICAL OPERATIONS LABORATORY												Category: PCC			
													L	T	P	C
													0	0	3	1.5
Prerequisites: Nil																
Course Objectives: The course is aimed to Develop sound practical knowledge on different types of mechanical operations equipments																
LIST OF EXPERIMENTS																
1	Sieve analysis															
2	Batch filtration studies using a Leaf filter															
3	Batch filtration studies using a Plate and Frame Filter press															
4	Characteristics of batch Sedimentation															
5	Reduction ratio in Jaw Crusher															
6	Reduction ratio in Ball mill															
7	Separation characteristics of Cyclone separator															
8	Reduction ratio of Roll Crusher															
9	Separation characteristics of Elutriator															
10	Reduction ratio of Drop weight crusher															
11	Size separation using Sub-Sieving															
													Total periods: 45			
Course Outcomes:													Blooms Taxonomy			
CO1:Determine the size analysis in solid- solid separation systems													Apply (K3)			
CO2: Capability to select different solid - fluid separation equipments.													Understand (K2)			
CO3:Evaluate the size reduction and various crushing parameters													Understand (K2)			
CO4: Estimate the separation characteristics													Apply (K3)			
CO5:Understand the technical methods related to unit operations in process plant													Understand (K2)			
CO – PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	2	2	1	3	3	1	3	2	1	2	3	2	1	
CO2	3	3	2	3	1	2	3	2	2	1	2	1	3	3	2	
CO3	3	3	2	2	1	2	2	1	2	1	1	1	3	2	1	
CO4	3	2	2	1	1	1	1	1	2	2	2	2	3	2	1	
CO5	3	3	2	3	3	2	3	3	3	3	2	3	3	3	2	
CO Avg.	3.0	2.8	2.0	2.2	1.4	2.0	2.4	1.6	2.4	1.8	1.6	1.8	3.0	2.4	1.4	
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation																

SEMESTER V

23CHT501	CHEMICAL ENGINEERING THERMODYNAMICS II	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Course Objectives: The course is aimed to Understand the phase Behavior of fluids under different PVT conditions and apply them for practical purposes. The course will render a comprehensive understanding of theory and application of solution thermodynamics.					
Unit I	SOLUTION THERMODYNAMICS				6
Partial molar properties, ideal and non-ideal solutions, standard states definition and choice, Gibbs- Duhem equation, excess properties of mixtures, pure species and liquids.					
Unit II	PHASE EQUILIBRIA				12
Phase Rule, Phase equilibrium in ideal solution, excess Gibbs free energy models, Henry’s law, fugacity, Phase diagrams for homogeneous systems and for systems with a miscibility gap, effect of temperature and pressure on azeotrope composition, liquid-liquid equilibrium, ternary liquid-liquid equilibrium.					
Unit III	CORRELATION AND PREDICTION OF PHASE EQUILIBRIA				12
Vapor-Liquid Equilibrium at low, moderate and high pressures; bubble and dew point calculation, thermodynamic consistency test of VLE data					
Unit IV	CHEMICAL REACTION EQUILIBRIA				9
Chemical Reaction Equilibrium of single and multiple reactions, Standard Gibbs free change, equilibrium constant-effect of temperature; homogeneous gas and liquid phase reactions					
Unit V	REFRIGERATION				6
Principles of refrigeration, methods of producing refrigeration, liquefaction process, coefficient of performance, Evaluation and performance of vapor compression and gas refrigeration cycles.					
Total periods:45					
Text Books:					
1.Smith J.M., Van Ness, H.C., &Abbot M.C,” Introduction to Chemical Engineering thermodynamics”, McGraw Hill VII Edition 2009					
2.Kyle B.G.,” Chemical and Process Thermodynamics”, Pearson International third Edition2015.					
3.Rao Y.V.C.,” Chemical Engineering Thermodynamics” Universities Press,2005					
References:					
1.Sandler,S.I.,”Chemical and Engineering Thermodynamics”,IV Edition,Wiley,2006.					
2.Narayanan K.V”A Text Book of Chemical Engineering Thermodynamics ”Prentice Hall of IndiaPvt.Ltd,2nd					

edition,2013

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the systematic development of new class of properties to describe real mixtures													Understand (K2)		
CO2: Develop the idea of chemical potential to derive the idea of phase equilibria													Apply (K3)		
CO3: Understand the relationship connecting T, P and composition originating from the concept of chemical potential and fugacity coefficient													Understand (K2)		
CO4: Understand the principle of chemical reaction thermodynamics for the prediction of equilibrium conversion.													Apply (K3)		
CO5: Analyze the ideal and actual vapor-compression refrigeration cycle and Evaluate the performance of Liquefaction processes													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO2	3	3	3	3	2	-	-	-	-	-	-	3	3	3	-
CO3	3	3	3	2	3	-	-	-	-	-	-	3	3	3	-
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3	-
CO Avg.	3	3	3	2.8	2.8	-	-	-	-	-	-	3	3	3	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHT502	MASS TRANSFER II												Category: PCC			
													L	T	P	C
													3	0	0	3

Prerequisites; Nil

Course Objectives:

The course is aimed to

- Impart knowledge on how certain substances undergo the change in composition, change in phases and exhibit their properties according to the changed environment. Also, to design absorber and stripper, distillation column, extraction and leaching equipment and adsorber.

Unit I	ABSORPTION	9
Equilibrium and operating line concept in absorption calculations; types of contactors, design of packed and plate type absorbers; Operating characteristics of stage wise and differential contactors, concepts of NTU, HTU and overall volumetric mass transfer coefficients; multicomponent absorption; mechanism and model of absorption with chemical reaction; thermal effects in absorption process		

Unit II	DISTILLATION	9
Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by McCabe-Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation.		
Unit III	LIQUID-LIQUID EXTRACTION	9
Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction.		
Unit IV	LEACHING	9
Solid-liquid equilibria- leaching equipment for batch and continuous operations, calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (Shank's system), equipments for leaching operation, multi stage continuous cross current and countercurrent leaching, stage calculations, stage efficiency		
Unit V	ADSORPTION, ION EXCHANGE AND MEMBRANE SEPARATION PROCESSES	9
Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.		
Total periods:45		
Text Books:		
1.Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill,2017.		
2.Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.		
3.Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1998.		
4.B. K. Dutta., "Mass Transfer and separation processes, Prentice Hall, 2006		
References:		
1.McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7 th Edition, McGraw-Hill, 2017.		
2.Seader J.D. and Henley E.J., "Separation Process Principles", 2nd Ed., John Wiley, 2006.		
3.King, C.J., "Separation Processes", 2 nd Edn., Tata McGraw-Hill 1980		
Course Outcomes:		Blooms Taxonomy
CO1: Understand concept and determine the theoretical stages, number of transfer units		Understand (K2)

and height requirements for a gas absorption process.															
CO2: Identify the suitable distillation techniques, determine the number of trays for stage wise contact and determine the height of the packed tower													Apply (K3)		
CO3: Apply the ternary equilibrium diagram concepts to determine the number of stages required for separation of liquid-liquid extraction process													Apply (K3)		
CO4: Describe core principles of leaching, setting up mass balances, use graphical methods to estimate the number of ideal stages in leaching operation													Apply (K3)		
CO5: Understand the concept of adsorption techniques, various isotherms and ion exchange Process and Formulate to solve mass and energy balances for unit operations such as absorption, distillation, extraction, leaching, adsorption and other separation processes													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	1	1	1	-	1	-	3	3	2	2
CO2	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2
CO3	3	3	3	-	-	1	1	1	-	1	-	3	3	2	2
CO4	3	3	1	-	-	1	1	1	-	1	-	3	3	2	2
CO5	3	2	1	-	-	1	1	1	-	1	-	3	3	2	2
CO Avg.	3	2.6	2			1	1	1		1		3	3	2	2
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHP501	COMPUTATIONAL CHEMICAL ENGINEERING LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2
Prerequisites:Nil					
Course Objectives: The course is aimed to Solve chemical engineering problems form core courses using Excel/MATLAB/Polymath /problem solving software tool and chemical process simulation software tool					
LIST OF EXPERIMENTS					
1	Friction factor, pressure drop, minimum fluidization velocity calculations				
2	Settling velocity, drag coefficient, Reynolds number estimations				
3	Equation of state, activity coefficient, VLE data, equilibrium conversion calculations				
4	Empirical equation in fluid flow, heat and mass transfer operations				
5	Solving a simple flow sheet by simultaneous approach				

6	One, two and three dimensional heat conduction equations
7	Differential equation for reactors in series, non isothermal reactors, dispersion models, gravity tank
8	Partial differential equation involved in heat transfer, mass transfer, reaction engineering
9	First order and second order system in control system
10	Simulation of heat exchangers, Distillation, Absorber, Extraction column, reactors.
11	Simulation of process plant/simple flow sheet
	Specific examples:
	1. Solving chemical Engineering Numerical problems (fluid flow, mechanical operations, heat transfer, mass transfer, thermodynamics and reaction Engineering problems) using Goal seek, solver, Regression function of Microsoft office Excel. 2. Solve simultaneous equation in chemical engineering by Matrix method using Microsoft office Excel. 3. Solve differential equation in chemical engineering by Runge Kutta method using Microsoft office Excel 4. Solving simultaneous equations, linear and non linear equations and differential equations in Chemical Engineering using problem solving software tool/Polymath 5. Solving Simultaneous equations, Differential equations and Partial differential Equations in Chemical Engineering using MATLAB. 6. Apply MATLAB Simulink tool to simulate Chemical process control systems with suitable examples. 7. Predictions thermodynamics properties using PROCESS SIMULATION SOFTWARE TOOL 8. Steady state simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL 9. Steady state simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL 10. Steady state simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL 11. Steady state simulation of an Absorption column using PROCESS SIMULATION SOFTWARE TOOL 12. Dynamic simulation of Heat Exchanger using PROCESS SIMULATION SOFTWARE TOOL 13. Dynamic simulation of different types of Reactor using PROCESS SIMULATION SOFTWARE TOOL 14. Dynamic simulation of Distillation Column using PROCESS SIMULATION SOFTWARE TOOL
* Any 10 Experiments can be performed	
Total periods:45	
Text Books:	
1. Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006.	
2. Michael B. Cutlip, Mordechai Shacham Problem Solving in Chemical and Biochemical Engineering with, Excel,	

and MATLAB, 2nd Edition, Prentice Hall, 2008

References:

1. Pradeep Ahuja Introduction to Numerical Methods in Chemical Engineering PHI New delhi, 2010

2. Amiya K. Jana, Process Simulation and Control using Aspen, PHI New delhi, 2012

3. H.S. Fogler, Elements of Chemical Reaction Engineering, Third Edition, Prentice Hall of India, 1999

Course Outcomes:**Blooms Taxonomy****CO1:** Solving chemical engineering problems using different tools available in the excel software

Apply (K3)

CO2: Solving simultaneous equation and differential equation using polymath

Apply (K3)

CO3: Solving simultaneous equation and differential equation using Matlab

Apply (K3)

CO4: Simulation of simple chemical process with controller using simulink tool

Analyze (K4)

CO5: Estimation of fluid property and understand the unit operation simulation using process simulation tool

Analyze (K4)

CO – PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	1	-	-	-	3	3	-
CO2	3	3	3	3	3	-	-	-	1	-	-	-	3	3	-
CO3	3	3	3	3	3	-	1	-	1	-	-	-	3	3	-
CO4	3	3	3	3	3	-	1	1	1	-	-	-	3	3	-
CO5	3	2	3	3	3	-	1	1	1	-	-	-	3	3	-
CO Avg.	3	2.8	3	3	3	-	1	1	1	-	-	-	3	3	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23CHP502	HEAT TRANSFER LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

Prerequisites: Nil**Course Objectives:**

The course is aimed to

- Develop sound practical knowledge for students on different types of heat transfer equipments

LIST OF EXPERIMENTS

1	Measurement of Thermal Conductivity of metal rod
2	Performance studies on Cooling Tower
3	Batch drying kinetics using Tray Dryer
4	Heat transfer in Open Pan Evaporator
5	Heat Transfer through Packed Bed

6	Heat Transfer in a Double Pipe Heat Exchanger
7	Heat Transfer in a Bare and Finned Tube Heat Exchanger
8	Heat Transfer in a Vertical and Horizontal Condenser
9	Heat Transfer in Helical Coils
10	Heat Transfer in Agitated Vessels
11	Heat transfer studies in Stefan - Boltzmann apparatus

Total periods: 45

Course Outcomes:													Blooms Taxonomy		
CO1: Apply the concepts of heat transfer and fluid dynamics to the operation of heat transferequipments													Understand (K2)		
CO2: Estimate the heat transfer rate and heat transfer co-efficient													Apply (K3)		
CO3: To perform heat transfer operation and to compare observed with predicted performance													Apply (K3)		
CO4: Evaluate the performance/calculate the parameters in heat transfer equipments													Analyze (K4)		
CO5: Collect and analyse the heat transfer data practically and Conduct experiments to solvecomplex engineering problems effectively as an individual as well as team work													Analyze (K4)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO2	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO3	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO4	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO5	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO Avg.	3	3	3	2.4	2	1	1	1	2	3	2	2	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHP503	MASS TRANSFER LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites: Nil					
Course Objectives: The course is aimed to ☐ Develop sound practical knowledge for students on different types of mass transferequipment’s					
LIST OF EXPERIMENTS					
1	Separation of binary mixture using Simple distillation				
2	Separation of binary mixture using Steam distillation				

3	Separation of binary mixture using Packed column distillation
4	Liquid-liquid extraction
5	Adsorption studies
6	Cross current leaching studies
7	Surface evaporation
8	Solid Liquid mass transfer studies
9	Water purification using ion exchange columns
10	Mass transfer characteristics of Rotating disc contactor
11	Estimation of mass/heat transfer coefficient for cooling tower
12	Demonstration of Gas – Liquid absorption

Total periods: 45

Course Outcomes:													Blooms Taxonomy		
CO1: Determine the diffusivity practically and compare the results with the empirical correlations													Understand (K2)		
CO2: Estimate the mass transfer rate and mass transfer co-efficient													Apply (K3)		
CO3: Evaluate the performance/calculate the parameters in different distillation processes													Apply (K3)		
CO4: Evaluate the performance/calculate the parameters in leaching and extraction operations													Analyze (K4)		
CO5: Estimate the drying characteristics													Analyze (K4)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	1	1	1	-	2	1	1	2	3	3	-
CO2	3	3	2	2	2	2	1	1	2	2	2	2	3	3	-
CO3	3	3	2	2	3	1	1	1	2	1	1	2	3	3	-
CO4	3	3	3	2	3	2	1	-	2	1	2	2	3	3	-
CO5	3	3	2	3	1	1	1	-	2	-	-	2	3	3	-
CO Avg.	3	3	2.2	2.4	2	1.4	1	1	2	1.2	1.5	2	3	3	-

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

SEMESTER VI

23CHT601	CHEMICAL REACTION ENGINEERING I	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Nil					
Course Objectives: The course is aimed to □ Learn reaction kinetics, types of reactors, design of reactors, understand the isothermal, non- isothermal operation of reactors and gain knowledge about non ideal reactors.					
Unit I					9
Rate equation, elementary, non-elementary reactions, theories of reaction rate and Prediction; Design equation for constant and variable volume batch reactors, analysis of experimental kinetics data, integral and differential analysis. Half-life calculation. Temperature dependent rate expression					
Unit II					9
Ideal reactor classification. Design of continuous reactors - stirred tank and tubular flow reactor, recycle reactors, combination of reactors, and size comparison of reactors					
Unit III					9
Design of reactors for multiple reactions - consecutive, parallel and mixed reactions - factors affecting choice, optimum yield and conversion, selectivity, reactivity and yield					
Unit IV					9
Non-isothermal homogeneous reactor systems, adiabatic reactors, rates of heat exchanges for different reactors, design for constant rate input and constant heat transfer coefficient, operation of batch and continuous reactors, optimum temperature progression					
Unit V					9
The residence time distribution for chemical reactors, residence time functions and relationship between them in reactor; Models for non-ideal reactors, conversion in non-ideal reactors					
Total periods:45					
Text Books:					
1.O. Levenspiel, Chemical Reaction Engineering , Third Edition, John Wiley 2006					
2.H.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008					
3.Lanny D. Schmidh The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004					
References:					
1.L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013					
2.G.Fronment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3 rd edition,2010					

3.J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the kinetics of homogenous reaction.													Understand (K2)		
CO2: Develop performance equation and determine the conversion for different reactors													Apply (K3)		
CO3: Understand the reactor arrangement in series and parallel configuration.													Apply (K3)		
CO4: Understand the design of reactor for multiple reactions.													Understand (K2)		
CO5: Understand the non-isotherm operation of the reactor and gain knowledge on the residence time distribution function and analyze the non-ideality in the reactor													Understand (K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	-	-	1	1	1	1	3	3	-
CO2	3	3	3	2	2	-	-	-	2	1	2	2	3	3	-
CO3	3	3	3	2	-	1	1	-	1	1	1	1	3	3	-
CO4	3	3	3	2	2	1	1	-	1	-	2	2	3	3	-
CO5	3	2	3	2	2	1	1	-	-	-	1	1	3	3	-
CO Avg.	3	2.8	3	2	2	1	1	-	1.2	1	1.4	1.4	3	3	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHT602	PROCESS DYNAMICS AND CONTROL	Category: BSC			
		L	T	P	C
		3	0	0	3

Prerequisites: Nil

Course Objectives:

The course is aimed to

- Determine possible control objectives, input variables (manipulated variables and disturbances), model the dynamic behavior of a process, design PID controllers, frequency response and analyze stability of closed loop and open loop systems.

Unit I	9
Introduction to Chemical Process Control, Mathematical description of chemical processes, Formulating Process Models, Laplace Transforms, Properties of Laplace Transforms, Solution of ODE using Laplace Transforms, Standard input forcing functions, State – Space representation, transform domain models, Impulse response models, Inter relationship between process model forms	

Unit II		9
Open-loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag, FOPDT Model, Skogestad's rule for FOPDT and SOPDT, Lead- Lag systems		
Unit III		9
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, control valves, transient response of closed-loop control systems and their stability, Root locus diagram		
Unit IV		9
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings, Nyquist Stability Criterion		
Unit V		9
Introduction to advanced control systems, cascade control, feed forward control, Controllers for Inverse response Smith predictor controller, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.		
Total periods:45		
Text Books:		
1.Stephanopoulos, G. (2015). Chemical process control, 3 rd Ed New Jersey: Prentice hall.		
2.Ogunnaike, B. A., & Ray, W. H. (1997). Process dynamics, modeling, and control (Vol. 1). New York: Oxford University Press.		
3.Coughanowr, D. R., & Leblanc, S. E. (2017). Introductory concepts. Process Systems Analysis and Control, 3rd Ed, 1-6.		
References:		
1.Seborg, D. E., Mellichamp, D. A., Edgar, T. F., & Doyle IV, F. J. (2016). Process dynamics and control. John Wiley & Sons.		
2.Bequette, B. W. (2003). Process control: modeling, design, and simulation. Prentice Hall Professional.		
3.Riggs, J. B., & Karim, M. N. (2007). Chemical and Bio-process Control: James B. Riggs, M. Nazmul Karim. Prentice Hall.		
4.Luyben, W. L., Tyr��s, B. D., &Luyben, M. L. (1998). Plantwide process control (Vol. 43). New York: McGraw-Hill.		
Course Outcomes:		Blooms Taxonomy
CO 1: Understand the need to develop mathematical description of a chemical process as a Prerequisite to process design and to control the process.		Understand (K2)
CO2: Develop transient models for chemical processes using material and/or energy balance equations by incorporating constitutive relationships and seek their solution using Laplace Transforms		Apply (K3)

CO3: Represent a physical system using FOPDT model and estimate parameters in FOPDT model													Understand (K2)		
CO4: Convert a process and instrumentation diagram to a control block diagram													Apply (K3)		
CO5: Understand Frequency response of control systems and tune the PID controllers and appreciate the performance augmentation of PID controllers by using advanced control strategies such as Cascade, Feed forward, Dead time compensation													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	3	3	-	2	2	2	2	3	3	2
CO2	3	3	3	2	2	3	3	-	-	-	2	2	3	3	-
CO3	3	3	3	2	2	-	-	-	-	-	2	2	3	3	-
CO4	3	3	3	2	2	-	-	-	-	-	2	2	3	3	-
CO5	3	3	3	2	2	2	-	-	-	-	2	2	3	3	-
CO Avg.	3	3	3	2	2	2.6	3		2	2	2	2	3	3	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHP601	CHEMICAL REACTION ENGINEERING LABORATORY	Category: PCC			
		L	T	P	C
		0	0	3	1.5

Prerequisites: Nil

Course Objectives:

The course is aimed to

Develop sound practical knowledge for students on different types of reactors

LIST OF EXPERIMENTS

1	Kinetic studies in a Batch reactor
2	Kinetic studies in a Plug flow reactor
3	Kinetic studies in a CSTR
4	Kinetic studies in a Packed bed reactor
5	Kinetic studies in a PFR followed by a CSTR
6	RTD studies in a PFR
7	RTD studies in a Packed bed reactor
8	RTD studies in a CSTR
9	Study of temperature dependence of rate constant using CSTR.
10	Kinetic studies in Sono chemical reactor
11	Studies on Cascade CSTR

12	Kinetics of photochemical reaction														
13	Demonstration of heterogeneous catalytic reaction														
14	Kinetic study in semi batch reactor														
Total periods: 45															
Course Outcomes:													Blooms Taxonomy		
CO1: Determine the rate constant experimentally in a batch reactor													Understand (K2)		
CO2: Determine the conversion of a reaction in different reactors (batch, CSTR, PFR)													Apply (K3)		
CO3: Study of temperature dependence of rate constant													Apply (K3)		
CO4: Determine the non-ideal behaviour and residence time distribution in PFR and CSTR.													Analyze (K4)		
CO5: Determine the conversion of reactor arranged in series and the rate constant using sono and photo chemical reactors													Analyze (K4)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO2	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO3	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO4	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO5	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO Avg.	3	3	3	3	2	1	1	1	2	3	2	3	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHP602	PROCESS EQUIPMENT DESIGN AND DRAWING	Category: PCC			
		L	T	P	C
		0	0	3	1.5
Prerequisites:Nil					
Course Objectives: Students learn to do in detail process and mechanical design and engineering drawing of different chemical engineering equipments					
LIST OF EXPERIMENTS					
1	UNIT I: Heat Exchangers, Condensers, Evaporators				
2	UNIT II: Cooling Tower, Dryers				
3	UNIT III: Absorption column, Distillation Column, Extraction Column, Adsorption column				
4	UNIT IV: Packed bed Reactors, Pressure Vessel, Storage Vessel				
5	UNIT V: Design of Plant Layout, Pipe Lines and Pipe Layouts, Schematics and Presentation Materials of				

	Construction and Selection of process equipments														
Total periods: 45															
Course Outcomes:													Blooms Taxonomy		
CO1: Design double pipe and shell and tube heat exchangers according to standards such as BIS, TEMA													Analyze (K4)		
CO2: Design Cooling towers and evaporators and design evaporators and crystallizer													Analyze (K4)		
CO3: Process and Equipment Design of separation equipments such as absorbers, distillation column, extractors													Analyze (K4)		
CO4: Calculate the design specifications of packed bed reactor and storage vessels, bins and silos													Analyze (K4)		
CO5: Determine sizes, materials, and capital and operating costs of equipment commonly used in the chemical processing industries and the essential elements of a chemical engineering process (equipment sizes, material & energy balances, economics, environmental, safety)													Analyze (K4)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO2	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO3	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO4	3	3	3	2	2	1	1	1	2	3	2	2	3	3	-
CO5	3	3	3	3	2	1	1	1	2	3	2	2	3	3	-
CO Avg.	3	3	3	3	2	1	1	1	2	3	2	3	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHP603	MINI PROJECT												Category: EEC			
													L	T	P	C
													0	0	4	2
Prerequisites 23HST101-PROFESSIONAL ENGLISH-I 23HST201-PROFESSIONAL ENGLISH -II																
Course Objectives: - To develop their own innovative prototype of ideas. - To train the students in preparing mini project reports and examination. The students in a group of 5 to 6 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.																
Total periods: 60																
Course Outcomes:													Blooms Taxonomy			
On Completion of the mini project work students will be in a position to take up their final year project work and find solution by formulating proper methodology.													Analyze(K4)			
CO-PO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Co Avg.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation																

SEMESTER VII

23CHT701	CHEMICAL REACTION ENGINEERING II	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Chemical Reaction Engineering I					
Course Objectives: The course is aimed to □ Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.					
Unit I					9
Gas solid non catalytic reaction. Reaction kinetics, Shrinking Core Model and Progressive conversion model, Controlling resistances (diffusion through gas film, ash layer and chemical reaction controlling), rate controlling steps; time for Complete Conversion for Single and Mixed Sizes, design of fluid –particle reactors					
Unit II					9
Catalysis and adsorption: physical properties of catalyst, surface area, void volume, solid density, volume determination, catalyst classification and preparation, catalyst promoters, catalyst inhibitors, catalyst poisons. Adsorption Isotherms Freundlich and Langumir isotherms					
Unit III					9
Gas solid catalytic reaction: steps in catalytic reaction, Single site, dual site mechanisms, Langmuir Hinshelwood, EleyRideal, Rate controlling steps. Experimental methods for determining rate, differential, integral reactor and reactor deign					
Unit IV					9
Diffusion within Catalyst Particle, Mass and Heat Transfer Within Catalyst Pellets, Effectiveness Factor, Thiele Modulus, Effectiveness factor for non isothermal condition					
Unit V					9
Fluid Fluid reaction. Kinetics and design of Fluid- Fluid Reactions. Rate equation, Kinetic regimes for absorption combined with chemical reaction. Various cases of mass transfer with chemical reaction ,Factors to select the contactor, Tower Reactor Design.					
Total periods:45					
Text Books:					
1. J.M.Smith Chemical Engineering Kinetics, Third Edition, Mc Graw Hill New York 1981.					
2. O. Levenspiel, Chemical Reaction Engineering , Third Edition, John WileyH.S. Fogler, Elements of Chemical Reaction Engineering, Fourth Edition, Prentice Hall of India,2008					
References:					
1. Lanny D. Schmidt The Engineering of Chemical Reactions, Second Edition, Oxford University Press, 2004.					

2. L.K Doraiswamy, DenizUner, Chemical Reaction Engineering Beyond the fundamentals, CRC Press , 2013
3. G.F. Froment, K.B.Bischoff Chemical Reactor Analysis and Design , John Wiley and Sons, 3rd edition, 2010

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the gas solid non catalytic reaction and different models for non catalytic reaction.													Understand (K2)		
CO2: Understand catalyst, catalyst preparation, property estimation and isotherm study													Apply (K3)		
CO3: Understand the gas solid catalytic reaction and their mechanism													Understand (K2)		
CO4: Design of catalytic reactor for gas solid reaction													Apply (K3)		
CO5: Understand the concepts of effectiveness factor, Thiele modulus and the concept of Mass Transfer and Mass transfer with reaction for fluid reaction and tower design													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	-	-	2	-	-	-	-	3	3	3	-
CO2	3	1	3	2	2	-	-	-	-	-	-	3	3	3	-
CO3	3	3	3	2	-	1	1	-	-	-	-	3	3	3	-
CO4	3	3	3	2	2	2	1	-	-	-	-	3	3	3	-
CO5	3	2	3	2	-	1	1	-	-	-	-	3	3	3	-
CO Avg.	3	3	3	3	2	2	2	-	-	-	-	3	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHT702	TRANSPORT PHENOMENA	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites: Fluid Mechanics					
Course Objectives: The course is aimed to □ Describe mass, momentum and energy transport at molecular, microscopic and macroscopic level to determine velocity, temperature and concentration profiles.					
Unit I	MOMENTUM TRANSPORT				9
Viscosity, temperature and pressure effect on viscosity of gases and liquids, Newton’s law, mechanism of momentum transport, shell momentum balance method, Shear stress and velocity distributions in falling film, circular tube, annulus, slit					
Unit II	ENERGY TRANSPORT				9
Thermal conductivity, temperature and pressure effect on thermal conductivity of gases and liquids, Fourier’s law, mechanism of energy transport, shell energy balance method, Energy flux and temperature distribution in solids					

and laminar flow with electrical, nuclear, viscous, chemical heat source, heat conduction through composite walls, cylinders, spheres, fins, slits.

Unit III	MASS TRANSPORT	9
Diffusivity, temperature and pressure effect on diffusivity, Fick's law, mechanism of mass transport, shell mass balance method, Mass flux and concentration distribution in solids and in laminar flow: stagnant gas film, heterogeneous and homogeneous chemical reaction systems, falling film, porous catalyst		
Unit IV	EQUATIONS OF CHANGE AND THEIR APPLICATIONS	9
Momentum: Equations of continuity, motion and mechanical energy (Isothermal), Energy: Equation of energy (non-isothermal). Mass: Equations of change (multi-component), equations of continuity for each species, equation of energy (multi-component). Solutions of momentum, heat and mass transfer problems discussed under shell balance by applications of equation of change, dimensional analysis of equations of change		
Unit V	TRANSPORT IN TURBULENT FLOWS AND ANALOGIES	9
Comparison of laminar and turbulent flows, time-smoothed equations of change, empirical expressions. Comparison of laminar and turbulent hydrodynamics, thermal and concentration boundary layer and their thicknesses. Development and applications of analogies between momentum, heat and mass transfer.		
Total periods:45		
Text Books:		
1. Bird, R. B., Stewart, W. E. and Lighfoot, E. W., "Transport Phenomena", 2nd Edn., John Wiley, 2006.		
2. Brodkey, R. S., and Hershey, H. C., "Transport Phenomena", McGraw-Hill, 1987		
References:		
1. Welty, J. R., Wilson, R. W., and Wicks, C. W., "Fundamentals of Momentum Heat and Mass Transfer", 5 th Edition. John Wiley, New York, 2008.		
2. Slattery, J. S., "Advanced Transport Phenomena", Cambridge University Press, London, 1999		
3. C. J. Geankopolis, "Transport Processes in Chemical Operations", 3rd Edn., Prentice Hall of India, New Delhi, 1993		
Course Outcomes:		Blooms Taxonomy
CO 1: Understand the mechanisms of momentum, heat and mass transfer each at molecular, micro and macro levels.		Understand (K2)
CO2: Develop mathematical models to determine transfer fluxes and velocity, temperature and concentration distribution for flow channels, heat sources and systems involving diffusion and reactions		Apply (K3)
CO3: Determine the interrelationship between the molecular, microscopic and macroscopic descriptions of transport processes and compare the various coordinate systems to formulate equations of change.		Understand (K2)
CO4: Apply the equation of change for different coordinate systems and solve of momentum, mass and heat transport problems		Apply (K3)

CO5: Apply the concepts of dimensional analysis and scale factors for equation of change for different coordinate systems and analyze the analogy between the transports and understand the turbulence and boundary layer concept in heat and mass transport													Analyze (K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	1	3	3	-
CO2	3	3	3	2	2	-	-	-	1	-	-	1	3	3	-
CO3	3	3	3	1	1	-	-	-	1	-	-	1	3	3	-
CO4	3	3	3	2	1	-	-	-	1	-	-	1	3	3	-
CO5	3	3	3	2	1	-	-	-	1	-	-	1	3	3	-
CO Avg.	3	3	3	2	1	-	-	-	1	-	-	1	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23GET701	HUMAN VALUES AND ETHICS	Category: PCC			
		L	T	P	C
		2	0	0	2
Prerequisites:Nil					
Course Objectives: The course is aimed to Learn gas solid non catalytic, gas solid catalytic and fluid- fluid reaction and apply the knowledge for the reactor design.					
Unit I	DEMOCRATIC VALUES				9
Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance — World Democracies: French Revolution, American Independence, Indian Freedom Movement. Reading Text: Excerpts from John Stuart Mills’ <i>On Liberty</i>					
Unit II	SECULAR VALUES				9
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices. Reading Text: Excerpt from <i>Secularism in India: Concept and Practice</i> by Ram Puniyani					
Unit III	SCIENTIFIC VALUES				9
Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, Validating facts using evidence based approach — Skepticism and Empiricism — Rationalism and Scientific Temper. Reading Text: Excerpt from <i>The Scientific Temper</i> by Antony Michaelis R					

Unit IV	SOCIAL ETHICS												9		
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices. Reading Text: Excerpt from <i>21 Lessons for the 21st Century</i> by Yuval Noah Harari															
Unit V	SCIENTIFIC ETHICS												9		
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions — Role and Responsibility of Scientist in the modern society. Reading Text: Excerpt from <i>American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer</i> by Kai Bird and Martin J. Sherwin															
Total periods:45															
References:															
1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.															
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016															
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017															
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press															
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022															
Course Outcomes:													Blooms Taxonomy		
CO 1: Identify the importance of democratic, secular and scientific values in harmonious functioning of social life.													Understand (K2)		
CO2: Practice democratic and scientific values in both their personal and professional life													Apply (K3)		
CO3: Find rational solutions to social problems													Understand (K2)		
CO4: Behave in an ethical manner in society													Apply (K3)		
CO5: Practice critical thinking and the pursuit of truth													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	3	3	3	2	2	2	2	2	1	-
CO2	2	1	2	1	2	3	3	2	3	-	2	2	2	1	-
CO3	2	1	1	1	2	-	-	3	3	-	2	2	1	1	-
CO4	2	1	2	2	2	-	-	2	2	-	2	2	1	1	-
CO5	2	2	3	2	2	2	-	3	1	-	2	2	2	2	-
CO Avg.	2	1.4	2	1.6	2	2.6	3	2.6	2.2	2	2	2	1.6	1.2	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHP701	PROCESS CONTROL LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2
Prerequisites: Process Dynamics and Control					
Course Objectives: To determine experimentally the methods of controlling the processes including measurements using process simulation techniques					
LIST OF EXPERIMENTS					
1	Response of first order system				
2	Response of second order system				
3	Response of Non-Interacting level system				
4	Response of Interacting level system				
5	Open loop study on a thermal system				
6	Closed loop study on a level system				
7	Closed loop study on a flow system				
8	Closed loop study on a thermal system				
9	Tuning of a level system				
10	Tuning of a pressure system				
11	Tuning of a thermal system				
12	Flow co-efficient of control valves				
13	Characteristics of different types of control valves				
14	Closed loop study on a pressure system				
15	Tuning of pressure system				
16	Closed loop response of cascade control system				
17	Optimum Controller Tuning using Ziegler Nichols method				
*Minimum 10 experiments shall be offered				Total periods: 45	
Course Outcomes:					Blooms Taxonomy
CO1: Able to determine the response of a first order and second order system for various input					Analyze (K4)
CO2: Able to determine the response of a interacting and non- interacting system for various input					Analyze (K4)
CO3: Understand the difference between an open loop and closed loop system					Analyze (K4)
CO4: Understand the concept of three classical controller P, PI, PID controller					Analyze (K4)
CO5: Understand the concept of stability and tuning of a system					Analyze (K4)
CO – PO & PSO Mapping					

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO2	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO3	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO4	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO5	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1
CO Avg.	3	3	2	3	3	2	1	1	1	1	1	1	2	3	1

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHP703	PROJECT WORK I				Category: PCC			
					L	T	P	C
					0	0	8	4

Prerequisites: Process Dynamics and Control

Course Objectives:

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.

Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations

Total periods: 120

Course Outcomes:	Blooms Taxonomy
CO1: Formulate and analyze problem / create a new product/ process	Understand (K2)
CO2: Design and conduct experiments to find solution	Analyze (K4)
CO3: : Analyze the results and provide solution for the identified problem	Analyze (K4)
CO4: To prepare project report	Analyze (K4)
CO5: To make presentation	Analyze (K4)

CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO2	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO3	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO4	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO5	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
CO Avg.	3	3	2	3	3	2	1	1	3	3	3	3	3	3	3
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

SEMESTER VIII

23CHP801	PROJECT WORK II	Category: PCC			
		L	T	P	C
		0	0	12	6

Prerequisites: Process Dynamics and Control

Course Objectives:

To train the students in

- Identifying problem and developing the structured methodology to solve the identified problem in the industry or research problem at research Institution or college.
- Conducting experiments, analyze and discuss the test results, and make conclusions.
- Preparing project reports and presentation

The students shall individually / or as group work on a specific topic approved by the Department. The student can select any topic which is relevant to his/her specialization of the programme. The student should continue the work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work, results and discussion, conclusion and references should be prepared as per the format prescribed by the University and submitted to the Head of the department. The students will be evaluated based on the report and viva-voce examination by a panel of examiners as per the Regulations

Total periods: 180

Course Outcomes:	Blooms Taxonomy
CO1: Formulate and analyze problem / create a new product/ process	Understand (K2)
CO2: Design and conduct experiments to find solution	Analyze (K4)
CO3: : Analyze the results and provide solution for the identified problem	Analyze (K4)

CO4: To prepare project report													Analyze (K4)		
CO5: To make presentation													Analyze (K4)		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO Avg.	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

ELECTIVE – MANAGEMENT COURSES

23EMT001	PRINCIPLES OF MANAGEMENT	Category: HSMC			
		L	T	P	C
		3	0	0	3
Prerequisites A basic understanding of business, economics, or organizational functions is helpful for learning core management concepts.					
Course Objectives: • Sketch the Evolution of Management. • Extract the functions and principles of management. • Learn the application of the principles in an organization. • Study the various HR related activities. • Analyze the position of self and company goals towards business.					
Unit I	INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS				9
Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.					
Unit II	PLANNING				9
Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.					

Unit III	ORGANISING												9		
Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.															
Unit IV	DIRECTING												9		
Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.															
Unit V	CONTROLLING												9		
System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.															
Total periods : 45															
Text Books:															
1.Harold Koontz and Heinz Weihrich “Essentials of management” Tata McGraw Hill,1998.															
2. Stephen P. Robbins and Mary Coulter, “ Management”, Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.															
References:															
1. Robert Kreitner and MamataMohapatra, “Management”, Biztantra, 2008.															
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, “Fundamentals of Management” Pearson Education, 7th Edition, 2011.															
3. Tripathy PC and Reddy PN, “Principles of Management”, Tata Mcgraw Hill, 1999.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.													Understand (K2)		
CO2: Have same basic knowledge on international aspect of management.													Understand (K2)		
CO3: Ability to understand management concept of organizing.													Understand (K2)		
CO4: Ability to understand management concept of directing.													Understand (K2)		
CO5: Ability to understand management concept of controlling.													Understand (K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		-	-	-	1	-	-	-	-	-	-	2	1	1
CO2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
CO3	1		-	2	-	-	1	-	2	-	1	1	-	-	2
CO4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
CO5	1		-	-	1	1	-	-	-	3	-	1	1	-	1
CO Avg.	1.6	1	1	1.5	1.5	1	1	1	2	3	1	1	1.5	1	1.25

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23EMT002	TOTAL QUALITY MANAGEMENT	Category: HSMC			
		L	T	P	C
		3	0	0	3

Prerequisites

A basic understanding of management principles and organizational processes is required to grasp quality management concepts.

Course Objectives:

- Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.
- Explain the TQM Principles for application.
- Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.
- Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.
- Illustrate and apply QMS and EMS in any organization.

Unit I	INTRODUCTION	9
Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.		
Unit II	TQM PRINCIPLES	9
Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, 183 Supplier selection, Supplier Rating and Relationship development.		
Unit III	TQM TOOLS & TECHNIQUES I	9
The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.		
Unit IV	TQM TOOLS & TECHNIQUES II	9
Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.		

Unit V	QUALITY MANAGEMENT SYSTEM												9		
Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.															
Total periods : 45															
Text Books:															
1. Dale H.Besterfield, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.															
References:															
1. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.															
2.Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.															
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.															
4.Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Ability to apply TQM concepts in a selected enterprise.													Apply (K3)		
CO2: Ability to apply TQM principles in a selected enterprise.													Apply (K3)		
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.													Understand (K2)		
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.													Understand (K2)		
CO5: Ability to apply QMS and EMS in any organization.													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	-	-	-	-	3	2	-	3
CO2	-	-	-	-	-	3		-	-	-	-	3	-	2	-
CO3	-	-		-	3	-	-		3	-	-	-	-	2	3
CO4	-	2	-	-	3	2	3	2	-		-	3	3	2	-
CO5	-		3	-	-	3	3	2	-	-	-	-	-	-	-
CO Avg.	-	2	3	-	3	2.7	3	2	3	-	-	3	2.5	2	3
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23EMT003	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING	Category: HSMC			
		L	T	P	C
		3	0	0	3
Prerequisites A basic understanding of mathematics and logical reasoning is required to analyze economic problems and financial data.					
Course Objectives: - Understanding the concept of Engineering Economics. - Implement various micro economics concept in real life. - Gaining knowledge in the field of macro economics to enable the students to have better. - Understanding of various components of macro economics. - Understanding the different procedures of pricing. - Learn the various cost related concepts in micro economics.					
Unit I	DEMAND & SUPPLY ANALYSIS				9
Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.					
Unit II	PRODUCTION AND COST ANALYSIS				9
Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.					
Unit III	PRICING				9
Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.					
Unit IV	FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)				9
Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.					
Unit V	CAPITAL BUDGETING (ELEMENTARY TREATMENT)				9
Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.					
Total periods : 45					
Text Books:					
1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.					
2.Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.					

References:

- 1.Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
- 2.Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
- 3.Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
- 4.Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012.
- 5.Dr. S. N. Maheswari and Dr. S.K. Maheshwari: Financial Accounting, Vikas, 2009.

Course Outcomes:**Blooms Taxonomy**

CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions

Apply (K3)

CO2: Evaluate the economic theories, cost concepts and pricing policies

Evaluate (K5)

CO3: Understand the market structures and integration concepts

Understand (K2)

CO4: Understand the measures of national income, the functions of banks and concepts of globalization

Understand (K2)

CO5: Apply the concepts of financial management for project appraisal.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	-	-	2	-	-	1	3	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO5	3	3	3	-	2	-	-	-	-	-	-	-	2	-	2
CO Avg.	2.5	2.8	3	-	2	-	-	-	-	2	-	-	1.7	2.7	2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23EMT004	HUMAN RESOURCE MANAGEMENT	Category: HSMC			
		L	T	P	C
		3	0	0	3
Prerequisites Basic knowledge of management principles and organizational behavior.					
Course Objectives: - To provide knowledge about management issues related to staffing, - To provide knowledge about management issues related to training, - To provide knowledge about management issues related to performance - To provide knowledge about management issues related to compensation - To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.					
Unit I	INTRODUCTION TO HUMAN RESOURCE MANAGEMENT				9
The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.					
Unit II	HUMAN RESOURCE PLANNING				9
Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization					
Unit III	TRAINING AND EXECUTIVE DEVELOPMENT				9
Types of training and Executive development methods – purpose – benefits.					
Unit IV	EMPLOYEE COMPENSATION				9
Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.					
Unit V	PERFORMANCE EVALUATION AND CONTROL				9
Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods.					
Total periods:45					
Text Books:					
1.Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007					
2.John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, N					
References:					
1.Luis R., Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, “Managing Human Resources", 7 th Edition, PHI, 2012.					
2.Dessler, "Human Resource Management", Pearson Education Limited, 2007					
Course Outcomes:					Blooms Taxonomy

CO 1: Students would have gained knowledge on the various aspects of HRM													Understand (K2)		
CO2: Students will gain knowledge needed for success as a human resources professional.													Understand (K2)		
CO3: Students will develop the skills needed for a successful HR manager.													Apply (K3)		
CO4: Students would be prepared to implement the concepts learned in the workplace.													Apply (K3)		
CO5: Students would be aware of the emerging concepts in the field of HRM													Analyze (K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	2	1	1	2	1	1	1	1	1	1
CO2	3	3	2	3	2	2	2	2	3	1	2	1	1	2	1
CO3	3	3	3	3	3	3	2	2	3	1	2	1	1	2	1
CO4	3	3	2	3	3	2	2	2	2	1	1	1	1	1	1
CO5	3	3	1	2	2	2	2	2	2	1	1	1	1	1	1
CO Avg.	2.8	2.8	1.8	2.6	2.4	2.2	1.8	1.8	2.4	1	1.4	1	1.0	1.4	1
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23EMT005	KNOWLEDGE MANAGEMENT	Category: HSMC			
		L	T	P	C
		3	0	0	3

Prerequisites

Basic understanding of organizational processes and information systems.

Course Objectives:

- Learn the Evolution of Knowledge management.
- Be familiar with tools.
- Be exposed to Applications.
- Be familiar with some case studies

Unit I	INTRODUCTION	9

Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

Unit II	I CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING												9		
Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance															
Unit III	KNOWLEDGE MANAGEMENT-THE TOOLS												9		
Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.															
Unit IV	KNOWLEDGE MANAGEMENT APPLICATION												9		
Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).															
Unit V	FUTURE TRENDS AND CASE STUDIES												9		
Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.															
Total periods : 45															
Text Books:															
1..Srikantaiah, T.K., Koenig, M., “Knowledge Management for the Information Professional” Information Today, Inc., 2000															
References:															
1.Nonaka, I., Takeuchi, H., “The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation”, Oxford Unive															
Course Outcomes:													Blooms Taxonomy		
CO 1:Understand the process of acquiry knowledge from experts													Understand (K2)		
CO2: Understand the learning organization.													Understand (K2)		
CO3: Use the knowledge management tools.													Apply (K3)		
CO4: Develop knowledge management Applications.													Create (K6)		
CO5: Design and develop enterprise applications													Create (K6)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-

CO3	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO4	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-
CO5	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-

1 - Low, 2 - Medium, 3 - High, ‘-’ No correlation

23EMT006	INDUSTRIAL MANAGEMENT	Category: HSMC			
		L	T	P	C
		3	0	0	3

Prerequisites

Basic knowledge of management principles and industrial operations.

Course Objectives:

- To study the basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.
- To study the planning; organizing and staffing functions of management in professional organization.
- To study the leading; controlling and decision making functions of management in professional organization.
- To learn the organizational theory in professional organization.
- To learn the principles of productivity and modern concepts in management in professional organization.

Unit I	INTRODUCTION TO MANAGEMENT	9

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg’s Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

Unit II	FUNCTIONS OF MANAGEMENT - I	9

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design

Unit III	FUNCTIONS OF MANAGEMENT - II	9

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mouton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

Unit IV	ORGANIZATION THEORY	9

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow’s hierarchy of needs theory; Herzberg’s motivation-hygiene theory; McClelland’s three needs motivation theory; Vroom’s valence-expectancy theory – Change Management: Concept of Change; Lewin’s

Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

Unit V	PRODUCTIVITY AND MODERN TOPICS												9		
Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).															
Total periods: 45 Periods															
Text Books:															
1.M. Govindarajan and S. Natarajan, “Principles of Management”, Prentice Hall of India, New Delhi, 2009															
2.Koontz. H. and Weihrich. H., “Essentials of Management: An International Perspective”, 8th Edition, Tata McGrawhill, New Delhi, 2010.															
References:															
1. Joseph J, Massie, “Essentials of Management”, 4th Edition, Pearson Education, 1987.															
2.Saxena, P. K., “Principles of Management: A Modern Approach”, Global India Publications, 2009.															
3.S.Chandran, “Organizational Behaviours”, Vikas Publishing House Pvt. Ltd., 1994.															
4.Richard L. Daft, “Organization Theory and Design”, South Western College Publishing, 11th Edition, 2012															
5.S. Trevis Certo, “Modern Management Concepts and Skills”, Pearson Education, 2018															
Course Outcomes:													Blooms Taxonomy		
CO 1: Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.													Understand (K2)		
CO2: Discuss the planning; organizing and staffing functions of management in professional organization													Understand (K2)		
CO3: Apply the leading; controlling and decision making functions of management in professional organization.													Apply (K3)		
CO4: Discuss the organizational theory in professional organization													Understand (K2)		
CO5: Apply principles of productivity and modern concepts in management in professional organization													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
CO2	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
CO3	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
CO4	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1

CO5	1	1	1	1	1	3	2	3	2	3	1	3	1	1	1
CO Avg.	1	1	1	1	1	3.0	2	3	2	3	1	3	1.0	1.0	1
1 - Low, 2 - Medium, 3 - High, ‘-’ No correlation															

MANDATORY COURSES I

23MCT001	INTRODUCTION TO WOMEN AND GENDER STUDIES	Category: MC			
		L	T	P	C
		3	0	0	0

Prerequisites

- Basic awareness of social issues and human rights.
- Interest in understanding gender, culture, and society.

Course Objectives:

- To introduce fundamental concepts related to sex, gender, patriarchy, and gender roles.
- To familiarize students with major feminist theories and their evolution.
- To understand global, national, and local women's movements.
- To study the relationship between gender and language.
- To examine gender representation in media and digital platforms.

Unit I	CONCEPTS	9

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binaryism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

Unit II	FEMINIST THEORY	9

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, ecofeminist.

Unit III	WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL	9

Rise of Feminism in Europe and America. Women's Movement in India.

Unit IV	GENDER AND LANGUAGE	9

Linguistic Forms and Gender. Gender and narratives.

Unit V	GENDER AND REPRESENTATION	9

Advertising and popular visual media. Gender and Representation in Alternative Media. Gender and social media.

Total periods:45 PERIODS

Course Outcomes:	Blooms Taxonomy
CO1: Explain key concepts related to gender, patriarchy, identity, and power.	Understand (K2)
CO2: Compare various feminist theories and their contributions.	Analyze (K4)
CO3: Discuss women's movements at global, national, and local levels.	Understand (K2)

CO4: Analyze how gender influences language, communication, and narratives.													Analyze (K4)		
CO5: Evaluate gender representation in advertising, visual media, alternative media, and social media.													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	3	2	2	1	2	-	1	2	1	-
CO2	2	2	-	-	-	3	2	2	1	2	-	1	2	1	-
CO3	2	1	-	-		3	2	3	2	2	-	2	2	1	-
CO4	2	2	1	-	1	3	2	3	2	2	1	2	2	1	-
CO5	3	2	1	-	1	3	3	3	2	3	1	2	2	2	-
CO Avg.	2.2	1.6	1	-	1	3.0	2.2	2.6	1.6	2.2	1	1.6	2.0	1.2	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation-															

23MCT002	ELEMENTS OF LITERATURE	Category: MC			
		L	T	P	C
		3	0	0	0

Prerequisites

- Basic understanding of English grammar and vocabulary
- Ability to read and interpret simple prose and poetry
- Familiarity with basic literary terms such as poet, narrator, plot, and character

Course Objectives:

- To make the students aware about the finer sensibilities of human existence through an art form. The students will learn to appreciate different forms of literature as suitable modes of expressing human experience.
- To make the students aware of the finer sensibilities of human existence through literature
- To help students appreciate different genres of literature as means of expressing human experiences
- To enhance analytical, critical thinking, discussion, and writing skills
- To develop the ability to interpret literary texts without bias

1. COURSE CONTENTS

Introduction to Elements of Literature

1. Relevance of literature

- Enhances Reading, thinking, discussing and writing skills.
- Develops finer sensibility for better human relationship.
- Increases understanding of the problem of humanity without bias.
- Providing space to reconcile and get a cathartic effect.

2. Elements of fiction

- a) Fiction, fact and literary truth.
- b) Fictional modes and patterns.
- c) Plot character and perspective.

3. Elements of poetry

- a) Emotions and imaginations.
- b) Figurative language.
- c) (Simile, metaphor, conceit, symbol, pun and irony).
- d) Personification and animation.
- e) Rhetoric and trend.

4. Elements of drama

- a) Drama as representational art.
- b) Content mode and elements.
- c) Theatrical performance.
- d) Drama as narration, mediation and persuasion.
- e) Features of tragedy, comedy and satire.

1. READINGS:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.
2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.
3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Univ Press, 1991.
4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.
5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

3.1 Textbook:

3.2 *Reference Books: To be decided by the teacher and student, on the basis of individual student so as to enable him or her to write the term paper.

3. OTHER SESSION:

4.1*Tutorials:

4.2*Laboratory:

4.3*Project: The students will write a term paper to show their understanding of a particular piece of literature

4. ASSESSMENT:

5.1HA:

5.2Quizzes-HA:

5.3Periodical Examination: one

5.4Project/Lab: one (under the guidance of the teachers the students will take a volume of poetry, fiction or drama and write a term paper to show their understanding of it in a given context; sociological, psychological, historical, autobiographical etc.

5.5Final Exam:

Total periods:45 PERIODS

Course Outcomes:													Blooms Taxonomy		
CO 1: Students will be able to understand the relevance of literature in human life and appreciate its aspects in developing finer sensibilities.													Understand (K2)		
CO2: Explain the major elements of fiction such as plot, character, theme, and narrative techniques.													Analyze(K4)		
CO3: Interpret poetic devices such as imagery, symbolism, metaphor, and other figurative forms.													Understand (K2)		
CO4: Analyze the features and dramatic techniques used in various forms of drama.													Analyze (K4)		
CO5: Evaluate the role of literature in shaping human emotions, social understanding, and cultural perspectives.													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	1	1	2	-	1	2	-	-
CO2	2	2	1	-	-	-	-	1	-	2	-	1	2	-	-
CO3	2	2	2	1	-	-	-	1	-	2	-	1	2	-	-
CO4	2	3	2	2	-	-	-	1	-	3	-	1	3	-	-
CO5	3	3	3	2	1	-	-	1	-	3	-	2	3	1	-
CO Avg.	2.2	2.2	2	1.7	1	-	-	1	1	2.4	-	1.2	2.4	1.0	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation-															

23MCT003	FILM APPRECIATION	Category: MC			
		L	T	P	C
		3	0	0	0
Prerequisites • Basic understanding of visual media (films, advertisements, or online videos). • Ability to read and interpret narrative content. • General awareness of cultural, social, and historical contexts.					
Course Objectives: • To introduce students to the core components and processes in filmmaking. • To familiarize students with the evolution of film language and major developments in world cinema. • To enable students to understand and apply major film theories for interpretation. • To provide exposure to global film movements and national cinema traditions. • To help students critically evaluate Indian cinema, regional films, and documentaries.					

Theme - A	The Component of Films	9
A-1: The material and equipment A-2: The story, screenplay and script A-3: The actors, crew members, and the director A-4: The process of film making... structure of a film		
Theme - B	Evolution of Film Language	9
B-1: Film language, form, movement etc. B-2: Early cinema... silent film (Particularly French) B-3: The emergence of feature films: Birth of a Nation B-4: Talkies		
Theme - C	Film Theories and Criticism/Appreciation	9
C-1: Realist theory; Auteurists C-2: Psychoanalytic, Ideological, Feminists C-3: How to read films? C-4: Film Criticism / Appreciation		
Theme - D	Development of Films	9
D-1: Representative Soviet films D-2: Representative Japanese films D-3: Representative Italian films D-4: Representative Hollywood film and the studio system		
Theme - E	Indian Films	9
E-1: The early era E-2: The important films made by the directors E-3: The regional films E-4: The documentaries in India		
READING:		
A Reader containing important articles on films will be prepared and given to the students. The students must read them and present in the class and have discussion on these.		
Course Outcomes:		Blooms Taxonomy
CO1: Describe the basic components and processes involved in filmmaking.		Understand (K2)
CO2: Explain the evolution of film language and major developments in world cinema.		Understand (K2)
CO3: Analyze major film theories and apply them to interpret films.		Analyze (K4)
CO4: Compare the characteristics of various national cinemas across different eras.		Analyze (K4)
CO5: Evaluate Indian films, regional cinema, and documentaries through critical appreciation.		Evaluate (K5)
CO-PO Mapping		

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	1	2	1	-	2	-	1	-	-	-
CO2	2	2	-	1	-	1	2	1	-	2	-	1	-	-	-
CO3	1	3	1	2	-	1	2	2	1	2	-	1	-	-	-
CO4	1	2	1	2	-	1	2	2	1	2	-	1	-	-	-
CO5	1	3	1	2	-	2	3	2	1	3	-	1	-	-	-
CO Avg.	1.4	2.2	1	1.8	-	1.2	2.2	1.6	1	2.2	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation-

23MCT004	DISASTER MANAGEMENT				Category: MC			
					L	T	P	C
					3	0	0	0

Prerequisites

- Basic understanding of geography and environmental science.
- Awareness of common natural and human-induced hazards.
- Ability to understand social, economic, and cultural systems.

Course Objectives:

- To introduce the fundamental concepts of hazards, vulnerability, disaster risks, and resilience.
- To familiarize students with disaster risk reduction strategies and global frameworks.
- To understand disaster management phases, policies, and institutional mechanisms in India.
- To learn tools, technology, and early warning systems used in disaster management.
- To analyze real-world disaster case studies and develop practical response skills.

Unit I	HAZRADS, VULNERABILITY AND DISASTER RISKS	9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, - -, Inter relations between Disasters and Sustainable development Goals

Unit II	DISASTER RISK REDUCTION (DRR)	9

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

Unit III	DISASTER MANAGEMENT	9
Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)		
Unit IV	TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT	9
Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management		
Unit V	DISASTER MANAGEMENT: CASE STUDIES	9
Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -		
Total periods:45 PERIODS		
Text Books:		
1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications		
2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunامي, Horizon Press Publications		
3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423		
4 Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]		
References:		
1 Taimpo (2016), Disaster Management and Preparedness, CRC Publications		
2 Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunامي, Horizon Press Publications		
3 Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423		
Course Outcomes:		Blooms Taxonomy
CO 1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)		Understand (K2)
CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction		Analyze (K4)
CO3: To develop disaster response skills by adopting relevant tools and technology		Apply (K3)

CO4: Enhance awareness of institutional processes for Disaster response in the country and													Understand (K2)		
CO5: Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	1	1	1	2	2	-	2	-	2	-	-	-
CO2	2	2	1	2	1	1	2	2	-	2	-	2	-	-	-
CO3	2	3	2	2	2	1	2	2	1	2	-	2	-	-	-
CO4	2	2	1	1	1	1	2	2		2	-	2	-	-	-
CO5	1	3	2	2	1	2	3	3	1	3	-	2	-	-	-
CO Avg.	1.8	2.2	1.5	1.6	1.2	1.2	2.2	2.2	1	2.2	-	2	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation-															

MANDATORY COURSES II

23MCT006	WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA	Category: MC			
		L	T	P	C
		3	0	0	0
Prerequisites • Basic awareness of health and hygiene • Willingness to participate in physical and mindfulness activities • Openness to learning traditional wellness practices					
Course Objectives: • To enjoy life happily with fun filled new style activities that help to maintain health also • To adapt a few lifestyle changes that will prevent many health disorders • To be cool and handbill every emotion very smoothly in every walk of life • To learn to eat cost effective but healthy foods that are rich in essential nutrients • To develop immunity naturally that will improve resistance against many health disorders					
Unit I	HEALTH AND ITS IMPORTANCE				2+4
Health: Definition - Importance of maintaining health - More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath. Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non-communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases -					

risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI-Importance and actions to be taken

Unit II	DIET	4+6

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes Different cooking methods, merits and demerits of each method

Unit III	ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH	4+4

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.

Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Panchaekarana Theory / (Five Element Theory) 96 fundamental Principles - UyirThathukkal (TriDosha Theory) - Udal Thathukkal

Prevention of illness with our traditional system of medicine Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.

Unit IV	MENTAL WELLNESS	3+4

Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioural response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions.

Stress management - Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement.

Sleep - Sleep and its importance for mental wellness - Sleep and digestion. Immunity - Types and importance - Ways to develop immunity

Unit V	YOGA	2+12

Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life.

Total periods:60

Text Books:

1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA

2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California

References:

1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England

2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001.

Course Outcomes:	Blooms Taxonomy
CO1: Learn the importance of different components of health	Understand (K2)
CO2: Gain confidence to lead a healthy life	Apply (K3)
CO3: Learn new techniques to prevent lifestyle health disorders	Apply (K3)
CO4: Understand the importance of diet and workouts in maintaining health.	Analyze (K4)
CO5: Calculate the various performance parameters of IC engines	Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	2	3	1	-	-	-	-	-	-	-
CO2	-	-	-	-	-	2	3	3	2	-	-	-	-	-	-
CO3	-	-	1	-	-	3	3	3	-	-	-	-	-	-	-
CO4	1	-	-	1	-	2	2	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-
CO Avg.	1.5	-	1	1.0	-	2.4	2.8	2.2	2	-	-	-	-	-	-

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23MCT007	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	Category: MC			
		L	T	P	C
		3	0	0	0
Prerequisites - Basic understanding of social sciences at the school level - Interest in science, technology, and historical evolution - Ability to read and interpret historical sources					
Course Objectives: - Introduce the concepts and perspectives involved in understanding the history of science and technology. - Familiarize students with major historiographical works on Indian science and technology. - Explore the development of science and technology in ancient, medieval, and colonial India. - Analyze post-independence science and technology policies and advancements. - Understand the relationship between science, technology, and society in the Indian context.					
Unit I	CONCEPTS AND PERSPECTIVES				
Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.					
Unit II	HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA				
Introduction to the works of D.D. Kosambi, Dharmapal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.					
Unit III	SCIENCE AND TECHNOLOGY IN ANCIENT INDIA				
Technology in pre-historic period Beginning of agriculture and its impact on technology Science and Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200					
Unit IV	SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA				
Science and the Empire Indian response to Western Science Growth of techno-scientific institutions					
Unit V	SCIENCE AND TECHNOLOGY IN COLONIAL INDIA				
Performance and Emission Testing, Performance parameters and calculations. Morse and Heat Balance tests. Multipoint Fuel Injection system and Common rail direct injection systems. Ignition systems – Magneto, Battery and Electronic. Lubrication and Cooling systems. Concepts of Supercharging and Turbocharging – Emission Norms					
Unit VI	SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA				
Science, Technology and Development discourse Shaping of the Science and Technology Policy Developments in the field of Science and Technology Science and technology in globalizing India Social implications of new technologies like the Information Technology and Biotechnology					
Total periods:45					

Course Outcomes:													Blooms Taxonomy		
CO1: Explain key concepts, perspectives, and methods used in the history of science and technology													Understand (K2)		
CO2: Summarize major historiographical contributions to the study of science and technology in India													Understand (K2)		
CO3: Describe the evolution of science and technology in ancient, medieval, and colonial India													Understand (K2)		
CO4: Analyze the development of science and technology in post-independent India and its socio-economic implications													Analyze (K4)		
CO5: Evaluate the interaction between science, technology, and society using historical evidence													Evaluate (K5)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	1	1	-	-	1	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO3	2	-	-	-	-	1	1	-	-	1	-	-	-	-	-
CO4	1	1	-	2	-	2	2	1	-	1	-	-	-	-	-
CO5	1	2	-	2	-	3	2	2	-	1	-	-	-	-	-
CO Avg.	1.4	1.3	-	2.0	-	1.7	1.5	1.5	-	1	-	-	-	-	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23MCT008	POLITICAL ECONOMIC THOUGHT FOR A HUMAN SOCIETY	Category: MC			
		L	T	P	C
		3	0	0	0
Prerequisites None.(Desirable: Universal Human Values 1, Universal Human Values 2)					
Course Objectives: This course will begin with a short overview of human needs and desires and how different political-economic systems try to fullfill them. In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.					
Unit I					9
Considerations for humane society, holistic thought, human being’s desires, harmony in self, harmony in relationships, society, and nature, societal systems					
Unit II					5
Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal					

democracy.															
Unit III	STEAM AND GAS TURBINES												2		
Fascism and totalitarianism. World war I and II. Cold war.															
Unit IV													5		
Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.															
Unit V													3		
Welfare state. Relation with human desires. Empowered human beings, satisfaction.															
Unit VI													6		
Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one’s lives. Relationship with nature.															
Unit VII													3		
Essential elements of Indian civilization.															
Unit VIII													4		
Technology as driver of society, Role of education in shaping of society. Future directions															
													2		
Conclusion															
Total periods:39															
References:															
1. Ballaney. P, “Thermal Engineering”, 25th Edition, Khanna Publishers, 2017.															
Course Outcomes:													Blooms Taxonomy		
CO1: Explain fundamental concepts relating to humane society, human needs, and socio-political harmony													Understand(K2)		
CO2:Compare and contrast major political and economic systems such as capitalism, fascism, communism, welfare state, and Gandhian thought													Analyze(K4)		
CO3:Evaluate the historical impact of political ideologies on human welfare, conflicts, and global developments													Evaluate(K5)		
CO4:Assess the relevance of Indian civilization, decentralization, and community-centered living for present society													Analyze(K4)		
CO5:Formulate informed views on how technology, education, and governance contribute to building a humane and sustainable society													Create(K6)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	2	2	2	-	2	-	2	-	-	-
CO2	1	2	-	-	-	3	2	2	-	2	-	2	-	-	-

CO3	1	2	-	-	-	3	2	3	-	2	-	3	-	-	-
CO4	-	1	-	-	-	3	3	2	-	2	-	2	-	-	-
CO5	-	2	-	-	-	3	3	3	1	3	2	3	-	-	-
CO Avg.	1	1.6	-	-	-	2.8	2.4	2.4	1	2.2	2	2.4	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23MCT009	STATE, NATION BUILDING AND POLITICS IN INDIA	Category: MC			
		L	T	P	C
		3	0	0	0

Prerequisites

- None.(Desirable: Prior exposure to civics, political science, or UHV courses)

Course Objectives:

- The objective of the course is to provide an understanding of the state, how it works through its main organs, primacy of politics and political process, the concept of sovereignty and its changing contours in a globalized world. In the light of this, an attempt will be made to acquaint the students with the main development and legacies of national movement and constitutional development in India, reasons for adopting a Parliamentary-federal system, the broad philosophy of the Constitution of India and the changing nature of Indian Political System. Challenges/ problems and issues concerning national integration and nation-building will also be discussed in the contemporary context with the aim of developing a future vision for a better India.

Unit I		6
Understanding the need and role of State and politics.		
Unit II		6
Development of Nation-State, sovereignty, sovereignty in a globalized world.		
Unit III		6
.Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government unitary-federal, Presidential-Parliamentary, The idea of India.		
Unit IV		6
.1857 and the national awakening.		
Unit V		7
1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India		
Unit VI		7
Goals, objective and philosophy. Why a federal system? National integration and nation-building.		
Unit VII		7
Challenges of nation-building – State against democracy (Kothari) New social movements. The changing nature of		

Indian Political System, the future scenario. What can we do?

Total periods:45

References:

1.Sunil Khilnani, The Idea of India. Penguin India Ltd., New Delhi.

2.Madhav Khosla, The Indian Constitution, Oxford University Press. New Delhi, 2012.

3.Brij Kishore Sharma, Introduction to the Indian Constitution, PHI, New Delhi, latest edition.

Course Outcomes:**Blooms Taxonomy****CO1:** Explain the need, role, and functions of the State and politics in society

Understand (K2)

CO2: Analyze the concept of nation-state, sovereignty, and their evolution in a globalized world

Analyze (K4)

CO3: Describe the structure and functioning of the major organs of the State and forms of government

Understand (K2)

CO4: Examine the evolution of the Indian national movement and constitutional development

Analyze (K4)

CO5: Evaluate India's challenges in nation-building and propose informed perspectives for a better political future

Evaluate/Create (K5/K6)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	-	-	-	-	3	2	2	-	2	-	2	-	-	-
CO2	1	2	-	-	-	3	2	2	-	2	-	3	-	-	-
CO3	1	1	-	-	-	2	1	2	-	2	-	2	-	-	-
CO4	1	2	-	-	-	3	2	2	-	2	-	3	-	-	-
CO5	-	2	-	-	-	3	3	3	1	3	-	3	-	-	-
CO Avg.	1	1.7	-	-	-	2.8	2	2.2	1	2.2	-	2.6	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23MCT010	INDUSTRIAL SAFETY	Category: MC			
		L	T	P	C
		3	0	0	0
Prerequisites None. (Desirable: Basic knowledge of physics, chemistry, and workplace operations.)					
Course Objectives: - To Understand the Introduction and basic Terminologies safety. - To enable the students to learn about the Important Statutory Regulations and standards. - To enable students to Conduct and participate the various Safety activities in the Industry. - To have knowledge about Workplace Exposures and Hazards. - To assess the various Hazards and consequences through various Risk Assessment Techniques.					
Unit I	SAFETY TERMINOLOGIES				9
Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators- Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry- Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS					
Unit II	STANDARDS AND REGULATIONS				9
Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006					
Unit III	SAFETY ACTIVITIES				9
Types, Impulse and reaction principles, Velocity diagrams, Work done and efficiency – optimal operating conditions. Multi-staging, compounding and governing. Gas turbine cycle analysis – open and closed cycle. Performance and its improvement - Regenerative, Intercooled, Reheated cycles and their combination.					
Unit IV	INTERNAL COMBUSTION ENGINES – FEATURES AND COMBUSTION				9
Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane SafetyToxic gas Release					
Unit V	HAZARD IDENTIFICATION TECHNIQUES				9
Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk AssessmentChecklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessmen					
Total periods:45					
Text Books:					
1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER					
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education					

References:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

Course Outcomes:**Blooms Taxonomy****CO1:** Understand the basic concept of safety.

Understand (K2)

CO2: Obtain knowledge of Statutory Regulations and standards.

Understand (K2)

CO3: Know about the safety Activities of the Working Place.

Apply (K3)

CO4: Analyze on the impact of Occupational Exposures and their Remedies

Analyze (K4)

CO5: Obtain knowledge of Risk Assessment Techniques.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	2	2	2	-	1	-	2	2	1	-
CO2	2	2	1		-	3	2	3	-	1	-	2	2	1	-
CO3	1	2	2	1	-	3	2	2	1	2	-	2	3	2	-
CO4	2	3	2	2	-	3	3	3	-	2	1	3	3	3	-
CO5	2	3	3	2	-	3	3	3	-	2	1	3	3	3	-
CO Avg.	1.8	2.2	2	1.7	-	2.8	2.4	2.6	1	1.6	1	2.4	2.6	2.0	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

VERTICAL I
PETROLEUM PROCESS TECHNOLOGY

23CHE001	PETROLEUM CHEMISTRY AND REFINING FUNDAMENTALS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: The course is aimed 1) To enable the students to learn the fundamental and methodologies in the petroleum refining processes. 2) To enable students to examine how each refinery process works 3) To enable students to express the objectives of petroleum refining and classify the processes used in petroleum refining 4) To enable students learn how physical and chemical principles are applied to achieve the objectives of each refinery process.					
Unit I	CRUDE CHEMISTRY AND PRODUCTS				9
Origin, Formation and Evaluation of Crude Oil -Indian petroleum industries- types of Hydrocarbon - composition of crude oil (PONA,S,N ₂ etc) -Thermo-physical and physical properties of crude oil- petroleum standards- chemical analysis data- Testing methods of petroleum products-Chemical quality of products-Types of crude-Crude assay- selection of crude based on product yield					
Unit II	BASICS FOR REFINING				9
Properties of gas-Ideal gas laws-partial pressure-specific gravity-density-Properties of liquid- viscosity and index-boiling point-pressure of fluid at rest-flow resistance-static/induced pressure- specific/latent heat/condensation-modes of heat transfer-diffusion mass transfer-properties of solid					
Unit III	PETROLEUM THERMODYNAMICS AND CALCULATION				9
First/second law-behavior of gas and liquid — PVT relationship- equation of state-VLE- equilibrium constant-Multi component liquid vapor composition calculation-specific gravity calculation-TBP distillation-ASTM-conversion to pseudo-components-Molecular weight calculation-pseudo-critical properties-calculation of enthalpy of petroleum fractions-Generalized equation for thermo physical properties of petroleum					
Unit IV	REFINERY UNIT OPERATIONS AND CALCULATION				9
Distillation-types-column internals-multi component distillation-relative volatility- azeotropic mixture- absorption- desorption- adsorption- refrigeration - extraction- drying curve-humidification principle-					

crystallization-stripping operation-.boiling curve- application of all operation in refinery and its basic design calculations

Unit V	REFINERY PROCESSES AND CATALYST FUNDAMENTAL	9
Treating processes of petroleum products- Thermal/catalytic/hydro cracking-reforming/ isomerization /alkylation -principles and reactions- Catalyst phenomenon and theory- surface area/void volume/porosity- catalyst classification and preparation/selectivity/yield/reactivity- heterogeneous reactions- catalytic reactor types (packed bed/moving bed/fluidized bed)- residence time-space velocity- Catalyst loading techniques		
Total periods:45		
Text Books:		
1. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology.		
2. Modern Petroleum Refining Processes, BK Bhaskara Rao, Oxford & IBH Publishing Co. Pvt. Ltd		
3. The Chemistry and technology of Petroleum, James G. Speight, CRC Press, Taylor & Francis Group		
4. Prasad, R., "Petroleum Refining Technology", Khanna Publishers, New Delhi, 2000		
5. Jean Vidal, Thermodynamics Application in chemical Engineering and the petroleum industry, Institute Francaise du petrole publications, France 2003		
6. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7 th Edition, McGraw-Hill, 2005		
7. Treybal, R.E., "Mass Transfer Operations", 3 rd Edn., McGraw-Hill, 1981		
References:		
W. L. Nelson, Petroleum Refinery Engineering, McGraw-Hill Book Co, 1969		
J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics, CRC Press, 5 th Edition, 2007		
Wayne C. Edmister, "Applied Hydrocarbon Thermodynamics", Gulf Publishing Co., 2 nd edition, 1988		
R.N. Watkin, "Petroleum Refinery Distillation", Gulf Publishing Co, Houston, Texas, USA, 2 nd edition, 1981		
Handbook of Petroleum Analysis, James G. Speight, Wiley-Interscience, John Wiley & Sons, Inc., Publications		
Holland, C. D. (1963). Multicomponent distillation. Prentice-Hall		
Course Outcomes:		Blooms Taxonomy
CO 1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.		Understand (K2)

CO2: Understand the insights of primary treatment processes to produce the precursors													Apply (K3)		
CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products													Understand (K2)		
CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products													Apply (K3)		
CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes and Learn the importance of optimization of process parameters for the high yield of petroleum products													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	-	1	1	1	1	1	1	2	2	1	1
CO2	2	1	1	1	2	1	1	1	1	1	2	2	2	1	1
CO3	1	1	2	1	2	1	-	1	1	1	1	1	2	1	1
CO4	1	2	2	2	1	1	2	2	2	1	2	1	2	2	2
CO5	1	2	2	1	1	1	1	2	2	-	1	1	2	1	2
CO Avg.	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHE002	CHEMICAL PLANT DESIGN	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: ➤ To understand the intricacies in equipment sizing and selection amongst options therein ➤ To leverage lessons learnt in designing chemical process unit with safety as paramount.					
Unit I	ROTARY EQUIPMENT				9
Pumps: Various types: Centrifugal, Reciprocating& Other Positive displacement types — Plunger, Piston, Diaphragm, Gear, Screw, Lobe, Vane, etc.; Compressors: Various types: Axial, Centrifugal, Reciprocating, and other positive displacement type such as Rotary Screw, Scroll, etc. Further, compressors are classified into two namely Oil free and Oil flooded lubricated; Fans: Various types: Axial fans (including Propeller, Tube-axial, and Vane-axial) and Centrifugal fans. Further fans are classified as Induced draft and Forced draft types; Steam Turbines: : Various types: Back Pressure and Condensing Types with and without extraction, Impulse & Reaction types; Gas Turbines : Various types: Turbojet, Turboprop, Turbofan and Turboshaft Engines; Motor :Various					

types: AC motors (Synchronous & Asynchronous motors), DC motors (brushed and brushless), Variable Frequency and Variable Speed motors and Special purpose motors, **Generator: Various types:** AC and DC generator; **Other Special Equipment: Various types:** Power Recovery Turbines, Heat Pumps, Ejector pump, NASH vacuum pump **Case Studies** — From Industries on operations and maintenance aspects viz. Trouble shooting, Energy improvement, Capacity augmentation, Design tips, Equipment safety, Catastrophic incidents, etc

Unit II	STATIC EQUIPMENT - HEAT TRANSFER EQUIPMENT	9
Heat Exchangers — Shell and Tube, Double Pipe, Plate & Frame type, Tube in tube Scraped surface, and Fin tube, Coolers, Condensers, Fin Fan Coolers; Fired Heaters & Boilers — With or without air preheaters, Balanced draft or simply natural draft or even only forced draft, With and without waste heat generation, Refrigeration & Air Conditioning — HVAC (Heating, Ventilation, and Air Conditioning); Miscellaneous — Chilled water system with vapour compression refrigeration, Ejector refrigeration system, direct contact heat exchanger (such as cooling towers, Jet condensers, direct contact feed), Incinerator. Case Studies — From Industries on operations and maintenance aspects viz. Fouling control, Pinch study for energy recovery, Capacity creep, Design tips, Equipment safety, Catastrophic incidents, etc.		
Unit III	STATIC EQUIPMENT - MASS TRANSFER	9
Mass Transfer Operations: Multi Component Distillation columns, Extractive distillation, Reactive Distillation, Azeotropic distillation, Divided wall columns, Dryers, Adsorption Isotherm, Pressure Swing Adsorption, Importance of recycles and Optimization needs, Absorption processes & operating variables, Liquid — Liquid Solvent Extraction ; Humidification & dehumidification, Evaporation, Precipitation, Crystallizers, Membrane filtration; Reactors — CSTR, Slurry phase reactor, Tubular, Trickle Bed Reactor, etc., thermodynamically controlled reaction and kinetically controlled reaction, Reaction Kinetics, Importance of Reactor internals. Case Studies — From industries across life cycle such as Trouble shooting, enhance conversion & selectivity, IoT use, Debottlenecking, Design tips, Safety Incidents “Fit - For Purpose” Assessment, etc.		
Unit IV	EQUIPMENT ANCILLARIES	9
Special equipment — Static Mixer, Agitators, Jet Mixing, Ejectors, Eductors, Structured Packing, Grid Packing and Random Packing, Demisters, Vortex Breaker, Calming Baffles, Schoepentoeter, Vapour horn device, Cyclone separators; Package units — Inert gas generators, Feed stream filters (Mechanical, Chemical), Scrubbers, Spray Nozzles, Guard beds, Flare stack, Ground Flare, Flame arrestors, Strainers, Spring supports, Expansion joints, Electrostatic Precipitators; Steam Traps — Thermodynamic, Inverted Bucket type, Thermostatic — Float, Bimetallic type, etc., Case Studies – From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.		
Unit V	STATIC EQUIPMENT - PRESSURE VESSELS, INTERNALS & SAFETY VALVES	9
Pressure Vessels — Vertical / Horizontal, Knock Out Drums, Steam and Blow down drum, Cold & Hot Separators, Surge drum, Deaerators, Water Seal Pot, Molecular seals, Shock Absorbers, Pressure snubber, Silencer, Slug Catcher, Desalter, Coke drum; Vessel & Columns - associated structural accessories such as		

Platforms, Ladders, Staircase etc. **Internals** –Column internals such as Trays (Sieve, Valve, Bubble Cap, Baffle, Dual flow, Multi down comer, Chimney tray etc.), Packings (structured, grid, random, etc.), Packed tower internals — Bed support plates, Liquid distributors, Bed limiters etc.; Mist eliminators, Demisters, Coalescing pads, Vortex breakers etc. **Safety Valves:** Normal, balanced bellows, pilot operated, etc., Rupture Discs, and Design codes governing Safety valve design, **Case Studies**– From industrial operations & maintenance activities– ASME codes, Trouble shooting, Efficiency tracking, Use of IoT, Debottlenecking, and Design tips, Safety & Environmental Incidents, etc.

Total periods:45

Text Books:

1. Chemical Engineering Handbook - Robert H. Perry; Don W. Green and James O. Maloney
2. Heat Transfer – D.Q. Kern
3. Mass Transfer Operations – Robert E. Treybal
4. Principles of Mass Transfer and separation Processes – BK Dutta
5. Fluid Mechanics, Heat Transfer, and Mass Transfer (Chemical Engineering Practice) – KSNRaju

References:

Applied Process Design for Chemical and Petrochemical Plants – **Ernest E. Ludwig**

Course Outcomes:	Blooms Taxonomy
CO 1: understand the basic on designing chemical process unit for rotary equipment.	Understand (K2)
CO2: learn the operations of boilers, heat exchangers, refrigeration and air conditioners	Apply (K3)
CO3: knowledge on operations of reactors, humidifiers and mass transfer operations	Understand (K2)
CO4: learn the different types of equipments in process industries	Apply (K3)
CO5: understand the knowledge on usage of different valves such as pressure, safety and internal	Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO2	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO3	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO4	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1
CO5	2	2	2	2	2	-	1	-	2	2	2	2	2	2	1
CO Avg.	2	2	2	2	2	-	1	-	2	1	2	2	2	2	1

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHE003	DESIGN SAFETY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: ➤ To understand the process safety systems both to prevent incident & to minimize loss ➤ To apply the principles ‘safe at risk’ to assess likely unsafe conditions in unit operation.					
Unit I	SAFETY SYSTEMS				9
Safety systems: Deployment of sensors (Toxic, HC and Thermal) at critical locations, Fire network including elevated fire monitors, Egress system, Escape route and Assembly point, Water curtain, eye wash requirement, Clean and cooler water supply ;Dovetail Early Event Detections system to forecast and forewarn on ‘unsafe’ conditions emerging in process units, Cause & Effect diagram, Alarm rationalization, Partial or Total Plant Trips review; Setting up IOW (Integrity OperatingWindow), Utility stations at strategic locations in process units (for supply of LP steam, Nitrogen, Industrial Air, Service water), Fire Proofing of structures, ROVs (Remote Operated Valves), EIVs (Emergency Isolation Valves), Redundancy in trips (1 oo 1; 2 oo 3) and avoidance of spurious trips ;SIL (Safety Integrity Level) in process safety, HIPS (High Integrity Protection System),Shutdown system reset — Field or Controlled room, Centralized Vs Decentralized Control centre, Need of Chemical filter in Control Room Air conditioning, Cyber-attack prevention, Mutual aid plan. Case Studies – From Peer Industries on Performance Benchmark, Process safety Management, Safety Culture, Asset Integrity, Litigations, Safety & Environmental Incidents, etc.					
Unit II	ELECTRICAL SYSTEMS				9
Power systems — KV level, 3 phase and single phase, LT, HT generation and distribution network systems, MCC / PCC (motor control centre and power control centre) substations, Electrical Energy Audits, Exergy analysis, Cogen design aspects ; Emergency Power needs based onprocess criticalities (including power back up for fire water and plant safe shut down), Loadshedding, Essential and Non-essential power load ;Uninterrupted Power System (UPS), Load assessment for UPS, Battery bank ;Earth pit design and maintenance aspects, Earth — Neutral Differential & impacts of stray voltage, Fault Level and its relevance in industry, Start-up load, Power from two independent Sources, Relay / Fuse Coordination. Electrical load distribution and its influence on safety relief / flare load in an industrial complex, Interphase with DCS (Distributed Control System), PLCs (programmable logic controls), I/P (Current to Pneumatic transmission) convertor failures ;An overview on electrical failures viz. cable fault, over load, over voltage due to surges, lightning strokes, aging of conductor, internal &					

external stresses on the conductors, spike in power banks, etc., **Case Studies** — Industries experiences on Steam — Power balance for efficiency enhancement, smart debottlenecking to minimize cable routing & MCC / PCC use, Safety & Environmental Incidents, etc.

Unit III**FLARE SYSTEM****9**

LP, HP, LLP and H₂S flares, Types — Single Point Flares (Sonic & Subsonic), Multi Point Flares, Coanda Flares, Vent Tips, Enclosed Flares and Air Assisted Gas Flares ;Pilot gas system, Electronic ignition, Flare tip design, Flare noise reduction, Fire Ball prevention, Smokeless flare at worst weather conditions, Radiation impact zone, Flare release scenarios (fire, blocked mode, partial and total power failure), Nitrogen purge, flare header network design; Safety margins in design, Assessing flare loss in a multi units complex where metering individual headers is near impossible ;Flare gas recovery and Zero Flare release, Flare gas quality tracking and hydrogen management in refineries & petrochemicals. **Case Studies** — Industries experiences viz. Flare tips & header maintenance, Trouble shooting, Smart debottlenecking of units to limit flare load within capacity, Safety & Environmental Incidents, etc.

Unit IV**RISK MITIGATION MEASURES****9**

HAZOP (Hazard and Operability Study), HAZID (Hazard identification), HAZAN (Hazard Analysis), EERA (Emergency escape route analysis), SIL (Safety Integrity levels) study, QRA (Quantitative Risk Assessment)and Dispersion studies ;Trip reset (Field and Control Room) and MSDS (Material Safety Data Sheet) for all streams being handled, Bow Tie Analysis, Risk Evaluation using 8 x 8 Matrix, FMEA (Failure Modes And Effects Analysis),Insurance premium assessment and measures to minimize ;Best practices — Updated documentation, SOPs (Standard Operating Procedures), SMPs (Standard Maintenance Procedures), PSM audits, Competency mapping and enhancement, employee loyalty programme, etc. Business risk — Risk in transportation of feed and products especially in sea routes (marine pollution); HSE norms non-compliance; Act of force majeure; etc. **Case Studies** — Industries experiences such as Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

Unit V**PROCESS CONTROL & INSTRUMENTATION****9**

Pneumatic (analogue controls) to DCS journey, Single loop Vs Multi loop controls, I/O cards, Graphic design & grouping to minimize user latency in process control ;Designed for safety through redundancy right from dedicated impulse lines to card level, PLC (Programmable Logic Controls), Cascaded Control, Process Historian, Online reporting by exception, Inferential predictions ;Use of AI / ML in controlling plant within best operating zone, QMIs (Quality Measuring Instruments), Alarm rationalization, Operator Fatigue ;Functional designs in delayed (by a few seconds) trip, Machine monitoring viz. signature analysis (vibration and axial displacement), surge control with differing mol

wt of process gas, tribology analysis ;Emphasis on lab instrumentation to get “tell-tale” indications on existence of unsafe conditions, hand held instrumentations to work in confined space, communication system (field & control room, etc.) etc. CCTV at select places to monitor and alert well in advance. Centralized fire control panel for the whole premises by way of wired network of safety sensors. **Case Studies** — From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

Total periods:45**Text Books:**

1. Chemical Process Safety: Fundamentals With Applications - DANIEL A CROWL

2. Fundamentals of Process Safety Engineering - Samarendra Kumar Biswas

References:

1. Chemical Process Safety - Aarti Kashyap

2. Process Safety - Klein James A and Bruce K Vaughan

Course Outcomes:**Blooms Taxonomy****CO 1:** learn the safety systems both to prevent incident & to minimize loss

Understand (K2)

CO2: understand the safety in electrical systems

Apply (K3)

CO3: knowledge on flare systems and their safety

Understand (K2)

CO4: get thorough knowledge on risk analysis and mitigation

Apply (K3)

CO5: knowledge on the control systems and their safety usage in different process industries

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	3	2	1	1	1	1	2	1	1	2	2	2
CO2	2	2	3	3	2	1	1	1	1	2	2	2	2	2	2
CO3	2	2	3	3	3	1	1	1	1	2	1	1	2	2	2
CO4	2	2	3	3	3	1	1	1	1	1	2	2	2	2	2
CO5	2	2	3	2	2	1	1	1	1	2	1	2	2	2	2
CO Avg.	2	2	3	3	2	1	1	1	1	2	1	2	2	2	2

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHE004	REFINERY ADVANCEMENTS AND ENVIRONMENTAL REGULATIONS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: The course is aimed - To enable the students to learn the advanced techniques, automation, units integration and instrumentation techniques in refinery. - To enable students to understand the environmental regulations, safety and government policies on refinery. - To enable students learn the energy saving techniques and refinery economics.					
Unit I	ENVIRONMENTAL REGULATION AND GOVERNMENT POLICIES				9
Classes of petroleum based on flash point- storage tank design- GAS/LIQUID/SOLID wastes form refinery units- environmental standards on air and water pollution and control-Solid waste management- Sludge conditioning and treatment and disposal- Effluent treatment plant-TTP- greenhouse gases-Bharat stages and its regulations- Recent modification for BS-6- Policies on biofuel-EBP-Bio-diesel.					
Unit II	CORROSION AND SAFETY				9
Corrosion- reaction and types- refinery corrosion tests- controlling parameters- corrosion control in equipment and pipelines-Types of fire- Safety triangle- Firefighting equipment-PPE- HAZOP studies- Petroleum disasters case study- process safety protocol- pressure relief systems- flare systems- CBD/OWS- MSDS for units- oil spilling and skimming					
Unit III	ADVANCEMENTS IN REFINERY				9
Instrumentation- Flow/pressure/temperature/level transmitter-Control systems and logics — controller types- mode of controllers- cascade, split range, ratio etc. - P/PI/PID controllers and control tuning-process optimization by APC/DMC- DCS/PLC systems					
Unit IV	REFINERY UNIT INTEGRATION AND RECENT TRENDS				9
Overall modern refinery flow sheet- products routing- naphtha utilization route up and integration- Diesel/gasoline/ATF/kerosene route up to blending header- Blending processes- line blending- Blending of diesel and MS calculation- LP model for blending operation- Recent trends in ADU with pre flash- RFCC-OHCU-Prime G+-catalytic dewaxing- PSA technology-DWC technology- Blue H2 process-Pre reforming- moving bed in CRU and isom-Advanced lubeprocessing					
Unit V	ENERGY SAVING AND REFINERY ECONOMICS				9
Furnace efficiency calculation-steam utilization- plume length- insulation of pipelines- heat tracing-steam traps- Standard Refinery Fuel Tonnage- Fuel and loss- operational cost- margin cost- refining capacity-complexity factor- crude oil evaluation and procurement-monthly production planning- cracks-Gross Refinery Margin-operation optimization by Linear Programming model-shutdown planning- Refinery Transfer Price-taxation-pricing					
Total periods:45					

Text Books:

1. W. L. Nelson, Petroleum Refinery Engineering,, McGraw-Hill Book Co , 1969

2. J. H. Gary, H. Hanwerk and M. J. Kaiser, Petroleum Refining Technology and Economics,CRC Press , 5th Edition, 2007

3. Fundamentals of Petroleum Refining, M.A. Fahim, T.A. Al-sahhaf, A.S. Elkilani; Elsevier Science and Technology

4. Coughanowr, D. R., & Leblanc, S. E. (2008). Introductory concepts. Process Systems Analysis and Control, 3rd Ed, 1-6

References:

1. Luyben, W. L., Tyréus, B. D., & Luyben, M. L. (1998). Plant wide process control (Vol. 43). New York: McGraw-Hill

2. Stephanopoulos, G. (1984). Chemical process control (Vol. 2). New Jersey: Prentice hall.

3. Instrumentation and Control Systems, K.Padmaraju, Y.J. Reddy, McGraw Hill Education, 2016

Course Outcomes:**Blooms Taxonomy****CO 1:** understanding the regulations and government policies in refining industries

Understand (K2)

CO2: acquire some knowledge on advanced techniques, automation and instrumentation techniques

Understand (K2)

CO3: understand the different controllers and automated control systems in refineries

Apply (K3)

CO4: gathers knowledge on unit integrations in refineries

Apply (K3)

CO5: understand the basis on energy saving techniques and refinery economics

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	2	1	2	1	2	2	2	2	1
CO2	1	1	1	1	1	2	2	1	2	2	2	2	1	2	1
CO3	1	2	1	2	1	2	2	1	2	1	2	2	1	2	1
CO4	2	2	1	2	2	2	2	1	2	1	1	2	1	2	1
CO5	2	2	1	2	2	2	2	2	2	1	1	2	1	2	1
CO Avg.	1.4	1.6	1	1.6	1.4	2	2	1.2	2	1.2	1.6	2	1.2	2	1

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHE005	PROCESS PLANT UTILITIES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: ➤ To understand the design and management of utilities system in any chemical industry ➤ To apply energy conservation techniques right at design and strive net zero emission					
Unit I	BASIC UTILITIES				9
Air (Industrial Service and Instrument), Cold Box air Liquification Plant, Nitrogen, Inert gas generation; Water (Potable, Service, Utility, Cooling Boiler Feed water, DM water, Desal water, RO permeate, etc.); Steam (High Pressure, Medium, Low and Very Low-pressure system), Condensate Polishing, Hot oil system, Thermic fluids for energy supply to Process equipment. Associated control equipment to monitor and prevent Water Pollution, Air Pollution control equipment, Solid waste storage area as per Waste management Rules. Also, discuss about the need to control slop generation in chemical industries. Case Studies — From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.					
Unit II	POWER GENERATION & DISTRIBUTION				9
Power Generation & Distribution: Gas turbines (types of fuel Vs operational reliability), Open and closed cycle, Steam Turbine generators, Power Recovery Turbo generators, IC Engines Power Generators, Renewables Power — Solar, Wind, Waves, Geo thermal, Biomass, Fuel Gas / Fuel Oil network, Impacts of utility failures (partial and or full). Case Studies — From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.					
Unit III	WASTEWATER TREATMENT				9
Wastewater Treatment: Bioremediation, WWTP (Wastewater Treatment Plants along with separation system and biochemical processes to reduce BOD / COD (Biochemical Oxygen Demand and Chemical Oxygen Demand), Recalcitrant material adding to COD, Considerations in deployment of RO Membrane and reuse of treated water. Case Studies — From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.					
Unit IV	GAS PROCESSING				9
LNG/ CNG, Refinery Gas Treating, Sour Gas Processing, Amine Absorption and Regeneration Processes, Sulphur Recovery & Removal, Gas dehydration & Dew pointing. Case Studies — From					

Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

Unit V**COOLING WATER SYSTEM****9**

Cooling water System: Cooling towers (CT), Wet and Dry Bulb and its relation to CT performance, Induced Vs Natural Draft CT, COC (Cycle of Concentration), Minimize / eliminate drift loss, CW network, assessment of cooling effectiveness in multiple parallel exchangers with availability of combined flow. **Case Studies** — From Industries on operations & maintenance aspects viz. Trouble shooting, Efficiency / Effectiveness tracking, Debottlenecking, Design tips, Safety & Environmental Incidents, etc.

Total periods:45**Text Books:**

1. Introduction to Process Engineering and Design – Shuchen B Thakore & Bharat I Bhatt(2017) McGraw Hill 2nd Edition

2. Plant Utilities - D. B. DHONE Publisher Nirali Prakashan, 2018

References:

1. A Working Guide to Process Equipment - Norman Lieberman, Elizabeth Lieberman

Course Outcomes:**Blooms Taxonomy**

CO 1: gain knowledge in the importance of process plant utilities

Understand (K2)

CO2: Understand the Requisites of Industrial Water and treatment methodologies

Understand (K2)

CO3: be familiar on various types of steam generators and boiler corrosion

Apply (K3)

CO4: Understand the concept of refrigeration used in industries

Apply (K3)

CO5: Learn the classification of compressors and humidification equipments

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	1	1	1	1	2	2	2	2	2	2
CO2	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO3	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO4	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO5	2	2	2	2	2	2	1	1	1	2	2	2	2	2	2
CO Avg.	2	2	2	2	2	1.2	1	1	1	2	2	2	2	2	2

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHE006	PETROCHEMICAL TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Mass Transfer					
Course Objectives: The course is aimed - To enable the students to learn the operation and methodologies in petrochemical industries - To enable students to learn the application of petrochemicals in all process fields. - To enable students learn each products of petrochemical industries and its applicationwith production techniques in detail					
Unit I	PETROCHEMICALS EVOLUTION				9
Petrochemical Industries and their feedstock selection .History, Economics, Growth of petrochemical industry.-structure of Petrochemical complexes- Classification of petrochemicals- Basic building processes- Integration with refinery-flow scheme					
Unit II	INTERMEDIATES FOR PETROCHEMICALS INDUSTRIES				9
Production Methods - Reforming and cracking of feed stocks; Sources: Chemicals from synthesis gas, olefins and aromatics-Ethylene, Propylene, C ₄ hydrocarbons, higher olefins, Benzene, Toluene, Xylene and their derivatives					
Unit III	COMPLEX PETROCHEMICAL PRODUCTS				9
Acrylonitrile, Acrylic acid, dimethyl terephthalate, ethanol, ethylene glycol, linear alkyl benzene, methyl tertiary butyl ether, vinyl acetate, vinyl chloride, Maleic and phthalic anhydride, ethyl benzene, Phenol, Cumene, Styrene, Bisphenol, Aniline — Process flow scheme- various technology- advantages-yield pattern-process variables					
Unit IV	POLYMERS				9
Polymers production: Fibers, Rubbers and Plastics. Acrylonitrile butadiene styrene (ABS), polyethylene-LDPE, HDPE, Polypropylene, PVC, PS, SAN, SBR, PAN, Nylon and Polycarbonates					
Unit V	GLOBAL CHEMICALS				9
Petrochemicals-Lubricants, additives, adhesives, agrochemicals, cosmetics raw materials, electronic chemicals, detergents, paint, healthcare and pharmaceuticals, Fertilizers-Ammonia, Urea, NPK etc.					
Total periods:45					
Text Books:					
1. Bhaskara Rao,B.K.“ATextonPetrochemicals”,2nd Edition, Khanna Publishers,NewDelhi,1998					

2. H. Steiner, "Introduction to petrochemicals", Pergamon Press, NewYork, 1961
3. Wiseman.P., "Petrochemicals", UMIST Series in Science and Technology, JohnWiley & Sons, 1986
4. ID Mall, 'Petrochemical process Technology', Macmillan India Limited, 2007
5. A. Chawvel and G. Lefebvre, "Petrochemical Process", Vol. I & II, Gulf Publishing Co., Houston, London

References:

1. Brownstein A.M. 'Trends in Petrochemical Technology', Petroleum Publishing Company, 1976
2. G. Margaret Wells, 'Handbook of Petrochemicals and Processes' 2nd Revised Edition, Gower Publishing Company
3. Groogins, "Unit Process in Organic Synthesis", McGraw Hill Book Company, New York
4. Robert A. Meyers, "Handbook of Petrochemicals Production Processes", McGraw-Hill Education: New York, 2nd edition, 2019 (ISBN: 9781259643132)

Course Outcomes:													Blooms Taxonomy		
CO 1: able to understand the basic knowledge on petrochemical industry and their growth, history													Understand (K2)		
CO2: understand the different methods of production in petrochemical products and their derivatives													Understand (K2)		
CO3: gather knowledge on the production of complex petrochemical products													Apply (K3)		
CO4: able to understand the petrochemical industries and its application with production techniques in polymers													Apply (K3)		
CO5: to understand the application of petrochemicals in all process fields													Understand (K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2	2	1	2	2	1	1	1	2	2	1
CO2	2	2	1	1	2	2	1	2	2	2	1	1	2	2	2
CO3	2	2	1	1	2	2	1	2	2	1	1	1	2	2	1
CO4	2	2	2	1	2	2	1	1	3	1	2	1	2	2	1
CO5	1	2	1	1	2	2	1	1	3	1	2	1	2	2	1
CO Avg.	1.8	1.8	1.4	1	2	2	1	1.6	2.4	1.2	1.4	1	2	2	1.2
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

VERTICALS II
ENERGY ENGINEERING

23CHE007	RENEWABLE ENERGY RESOURCES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Unit I					9
Biomass sources and classification; Biomass characteristics & preparation; Chemical composition and properties of biomass; Size reduction, Briquetting of loose biomass, Drying, Storage and handling of biomass					
Unit II					9
Biogas technology: Feedstock for producing biogas; Microbial and biochemical aspects and operating parameters for biogas production, Kinetics and mechanism. Dry and wet fermentation, Digestors for rural application-High rate digesters for industrial waste water treatment					
Unit III					9
Pyrolysis and thermo-chemical conversion: Thermo-chemical conversion of lignocellulosic biomass. Incineration for safe disposal of hazardous waste, Biomass processing for liquid fuel production, Pyrolysis of biomass-pyrolysis regime, effect of particle size, temperature, and products obtained					
Unit IV					9
Gasification of biomass: Thermochemical principles: Effect of pressure, temperature and introducing steam and oxygen. Design and operation of Fixed and Fluidised Bed Gasifiers, Safety aspects.					
Unit V					9
Combustion of biomass and cogeneration systems: Combustion of woody biomass-theory, calculations and design of equipment, Cogeneration in biomass processing industries. Case studies: Combustion of rice husk, Use of bagasse for cogeneration.					
Total periods:45					
Text Books:					
1. Anju Dahiya, Bioenergy: Biomass to biofuels First Edition, Academic Press, 2014.					
2. Li, Yebo, and Samir Kumar Khanal. Bioenergy: principles and applications. John Wiley & Sons, 2016.					
References:					
1. Vaughn C Nelson, Kenneth L. Starcher. Introduction to bioenergy. CRC Press, 2017					
2. Wall, Judy D., Caroline S. Harwood, and Arnold Demain. "Bioenergy." Bioenergy.. ASM Press, 2008					

Course Outcomes:													Blooms Taxonomy		
CO1- understand the fundamental knowledge on classification, characterization and sources of biomass													Understand (K2)		
CO2- learn the production of biogas													Understand (K2)		
CO3- gather knowledge on the operations of incineration, pyrolysis													Apply(K3)		
CO4- understand the process in gasification of biomass													Understand (K2)		
CO5- knowledge on the types of combustion of biomass													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2	1	2	2	1	1	1	1	2	1	2
CO2	2	-	2	1	2	1	2	2	1	1	1	2	2	2	2
CO3	2	1	2	1	2	1	2	2	2	1	1	2	2	1	2
CO4	2	1	2	1	2	1	2	2	1	1	1	2	2	2	2
CO5	2	2	2	2	2	1	2	2	1	1	1	2	2	1	2
CO Avg.	2	1	2	1	2	1	2	2	1	1	1	1	2	1	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE008	RENEWABLE ENERGY RESOURCES	Category: PCC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Course Objectives: •					
Unit I					9
Introduction: Energy: Past, Today, and Future. A brief history of energy consumption. Energy &Environment. Renewable Energy – Quality, quantity, availability, advantageous and limitations					
Unit II					9
Solar energy: Sun and its Energy: Basics of Solar Energy. Solar Energy in the Past. Solar ThermalEnergy Solar Photovoltaic					
Unit III					9
Bio energy & Geothermal energy: Conversion. Bio degradation. Biogas generation. Fuelproperties. Biomass gasifier. Geothermal Resources, Geothermal Technologies					

Unit IV													9		
Wind energy: Wind Resources. Wind Turbines. Environmental Impact. Data and energy estimation.Conversion. Wind mill Performance and applications															
Unit V													9		
Tidal energy; Ocean Energy Potential against Wind and Solar. Wave Characteristics and Statistics.Wave Energy Devices. Tide Energy Technologies. Ocean Thermal Energy. Osmotic Power															
Total periods:45															
Text Books:															
1.Mukherjee, D., and S. Chakrabarti. <i>Fundamentals of renewable energy systems</i> . New AgeInternational, 2004.															
2.Jenkins, Nicholas, and Janaka Ekanayake. <i>Renewable energy engineering</i> . CambridgeUniversity Press, 2017.															
References:															
1.Kishore, V. V. N., ed. <i>Renewable energy engineering and technology: principles andpractice</i> . The Energy and Resources Institute (TERI), 2010.															
2.Tiwari, Gopal Nath, and Rajeev Kumar Mishra. <i>Advanced renewable energy sources</i> . RoyalSociety of Chemistry, 2012															
Course Outcomes:												Blooms Taxonomy			
CO1- understand the fundamental knowledge on history, consumption of energy												Understand (K2)			
CO2- learn the production of solar energy												Apply(K3)			
CO3- gather knowledge on the geothermal and bio energy												Apply(K3)			
CO4- understand the production of wind energy and their utilization												Understand (K2)			
CO5- knowledge on the production and utilization of tidal energy												Apply(K3)			
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	1	2	1	1	1	2	2	2	2
CO2	1	1	2	2	2	2	1	2	1	1	1	2	2	2	2
CO3	1	2	2	2	2	2	1	1	1	1	1	2	2	2	2
CO4	1	2	2	2	2	2	1	1	1	1	1	2	2	1	1
CO5	1	2	2	2	2	2	1	1	1	1	1	2	2	2	1
CO Avg.	1	1.6	1.8	1.8	1.8	2.0	1	1.4	1	1	1	2	2.0	1.8	1.6
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE009	PINCH TECHNOLOGY	Category: PCC			
		L	L	L	L
		3	3	3	3
Prerequisites					
•					
Unit I					9
Thermodynamic review of the process, Pinch Concept, significance of pinch, pinch in grid representation, Threshold problems, capital cost implication of the pinch.					
Unit II					9
Targeting: Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, continuous targeting.					
Unit III					9
Pinch Methodology: Problem representation, temperature enthalpy diagram, simple match matrix. Heat content diagram, Temperature interval diagram					
Unit IV					9
Pinch Design and Optimization: Networks for maximum energy recovery, Pinch design method, Flexibility criteria of the pinch, C _p table, heuristics, optimization of heat exchanger network: optimality for a minimum area network					
Unit V					9
Energy and Resource Analysis of various processes, Batch process, distillation process, evaporation process, reaction process, process using mass separating agent.					
Total periods:45					
Text Books:					
1. V. Uday Shenoy" Heat Exchanger network synthesis" Gulf Publishing Co, USA, 1995					
References:					
1.D.W. Linnhoff et al., "User Guide on Process Integration for the efficient use of Energy",Institution of Chemical Engineers, U.K., 1994.					
2.James M. Douglas “Conceptual Design of Chemical Process”, McGraw Hill, New York,1988.					
3.Anil Kumar, “Chemical Process Synthesis and Engineering Design”, Tata McGraw Hill NewDelhi, 1977					
Course Outcomes:					Blooms Taxonomy
CO1. Understand the pinch concept and process thermodynamics					Understand (K2)
CO2. Identify minimum energy targets					Apply(K3)
CO3. Classify different choices and constraint during heat exchange networking					Apply(K3)
CO4. Apply strategies for retrofitting existing process plant, integration of energy demands ofmultiple processes					Understand (K2)
CO5: Analyze the concepts in various chemical processes.					Understand (K2)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	2	1	2	2	1	1	1	1	2
CO2	1	2	1	1	2	2	1	1	2	2	1	1	1	2	2
CO3	1	2	2	1	3	3	1	1	2	2	1	1	1	2	2
CO4	1	2	2	1	3	3	2	2	2	2	1	1	1	2	2
CO5	1	2	2	2	3	3	2	1	2	2	1	1	1	2	2
CO Avg.	1	1.8	1.6	1.2	2.4	2.6	1.6	1.2	2	2	1	1	1.0	1.8	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHE010	HYDROGEN AND FUEL CELL TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Course Objectives: ○ To create awareness about alternate clean fuel available. To familiarize the students withthe concepts and chemistry of fuel cell					
Unit I	INTRODUCTION				9
Overview of fuel cells: Low and high temperature fuel cells; Fuel cell thermodynamics - heat, work Potentials, prediction of reversible voltage, fuel cell efficiency, Types of fuel cells.					
Unit II	FUEL CELL KINETICS				9
Fuel cell reaction kinetics - electrode kinetics, overvoltage, Tafel equation, charge transfer reaction,exchange currents, electro catalysis - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte					
Unit III	CHARACTERIZATION TECHNIQUES				9
Fuel cell characterization - in-situ and ex-situ characterization techniques, i-V curve, frequency response analysis; Fuel cell modeling and system integration: - 1D model – analytical solution and CFD models.					
Unit IV	RENEWABLE SOURCES				9
Balance of plant; Hydrogen production from renewable sources and storage; safety issues, cost expectation and life cycle analysis of fuel cells.					
Unit V	APPLICATIONS OF FUEL CELL				9
Fuel cell power plants: fuel processor, fuel cell power section (fuel cell stack), power conditioner; automotive applications, portable application					
Total periods:45					

Text Books:

1. Gregor Hoogers, "Fuel Cell Technology Handbook", CRC Press, 2003.
2. R.P. O'Hayre, S. Cha, W. Colella, F.B. Prinz, "Fuel Cell Fundamentals", Wiley, 2006.
3. A. J. Bard, L. R. Faulkner, "Electrochemical Methods", Wiley, 2004

References:

1. S. Basu, "Fuel Cell Science and Technology", Springer, 2007.
2. H. Liu, "Principles of Fuel Cells", Taylor & Francis, 2006.

Course Outcomes:**Blooms Taxonomy****CO 1:** aware of alternate energy sources and its importance of it.

Apply(K3)

CO2 : understand the fuel cell kinetics

Apply(K3)

CO3: able to understand the characterization techniques

Apply(K3)

CO4: Analyze the renewable sources and storage

Understand (K2)

CO5: Understand the applications of fuel cells in various fields.

Understand (K2)

CO - PO & PSO Mapping

Understand (K2)

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	2	2	2	1	1	1	2	2	2	2
CO2	2	2	2	3	1	2	2	2	1	2	1	2	2	2	2
CO3	2	2	2	3	3	2	2	2	1	2	1	2	2	2	2
CO4	2	2	2	3	3	2	2	2	1	2	2	2	2	2	2
CO5	2	2	2	3	3	2	2	2	1	1	1	2	2	2	2
CO Avg.	2	2	2	3	3	2	2	2	1	1	1	2	2	2	2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CHE011	POWER PLANT ENGINEERING	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites:Nil					
Unit I					9
Power Plants - Features, Components and Layouts - Working of Power Plants, Power PlantEconomics					
Unit II					9
Boiler Classification - Boiler Types - Fire Tube & Water Tube Boilers - Fluidized Bed Boilers -Positive Circulation Boilers - Thermal Liquid Heaters & Vaporizers					
Unit III					9
Steam Turbines: Classification - Features - Working – Performance; Losses in Steam Turbines -Trouble					

Shooting															
Unit IV														9	
Gas Turbines: Classification and Comparison of Different Types Gas Turbine Power PlantsComponents - Economics & Future of Combined Cycles															
Unit V														9	
Integrated Gasification Combined Cycle (IGCC) – Indirect Fired Combined Cycle (IFCC) –Magneto Hydrodynamics (MHD) – Fuel Cells – Micro turbines– RDF based power plants.															
Total periods:45															
Text Books:															
1. Thomas C. Elliott ,”Standard Hand Book of Power Plant Engineering”															
References:															
1.E L Wakil, “Power Plant Engineering”, McGraw-hill Book Co, N.Y. 2001															
2.Arora and Domkundwar, A course in Power Plant Engineering, Dhanpat Ra, N.Delhi.2003															
3.Nag, P.K., “Power Plant Engineering”, 2 nd Edition, TMH, 2001															
Course Outcomes:													Blooms Taxonomy		
CO1- understand the fundamental knowledge on components, layouts and working of power plants													Apply(K3)		
CO2- learn the types, classification and usage of boilers													Apply(K3)		
CO3- gather knowledge on classification and usage of steam turbines													Apply(K3)		
CO4- understand the types of gas turbines													Apply(K3)		
CO5- knowledge on the application of integration of various process in power plants													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	2	2	1	1	1	1	1	2	2	2
CO2	2	2	2	2	2	2	2	2	1	1	2	1	2	2	2
CO3	2	2	2	2	2	2	2	2	1	1	1	1	2	2	2
CO4	2	2	2	2	2	2	2	2	2	1	-	1	2	2	2
CO5	2	2	2	2	2	2	2	3	2	1	1	1	2	2	2
CO Avg.	2	1.8	1.8	2.0	2	2.0	2	2	1.4	1	1.2	1	2.0	2.0	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE012	NON-RENEWABLE ENERGY SOURCES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites:NIL					
Unit I					9
Origin of Petroleum, Composition, Extraction of Petroleum. Products of Petroleum refining: Diesel; Gasoline; LPG; Fuel oil; Tar; and Bitumen. Environmental Issues associated with petroleum resources.					
Unit II					9
Types of coal; Composition of coal; Oxygen content, Proximate and Ultimate Analysis of coal; Carbonization, Coal for generation of electricity, coal liquefaction, coal blending. Environmental Issues associated with usage of coal					
Unit III					9
Resources of for Natural Gas, Properties and classification of natural gas, transporation of natural gas, products from natural gas, liquefied natural gas, chemicals from natural gas, shale gas; Environmental Issues associated with usage of coal.					
Unit IV					9
Nuclear models, binding energy, Radio activity, half-life, mechanism of nuclear fission and fusion, decay chains, neutron reactions. Nuclear Fuels; Nuclear fuel reserves of Uranium and Thorium, Nuclear fuel cycles, characteristics, production and purification, other fuels Zirconium, Beryllium					
Unit V					9
Nuclear reactors and classification, boiling water reactors (BWR), pressurized heavy water reactor (PHWR), fast breeder reactor (FBR), basics of nuclear fusion reactor. Nuclear Power Plant -Waste Management and Safety					
Total periods:45					
Text Books:					
1.Breeze, Paul. Nuclear power. Academic Press, 2016.					
2.Viswanathan, Balasubramanian. Energy sources: fundamentals of chemical conversionprocesses and applications. Newnes, 2016.					
3.Rao, S., and B. B. Parulekar. "Energy Technology: Non-conventional, Renewable andConventional. " Khanna Publication, 3rd (2012).					
Course Outcomes:					Blooms Taxonomy
CO1- understand the fundamental knowledge on petroleum and its products					Understand(K2)
CO2- learn the usage of coal, types and its composition					Apply(K3)
CO3- gather knowledge on the properties, classification and products of natural gas					Understand(K2)
CO4- understand the fundamentals of nuclear engineering					Apply(K3)
CO5- knowledge on the usage of nuclear reactors, nuclear waste management and safety usage.					Apply(K3)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	1	1	1	1	2	1	2	-	1	2	2	2
CO2	2	2	2	1	1	1	1	2	1	2	-	1	2	2	2
CO3	2	2	2	1	1	1	1	2	1	2	1	2	2	2	2
CO4	2	2	2	1	1	1	1	2	1	2	1	2	2	2	2
CO5	2	2	2	1	1	1	1	2	1	2	3	3	2	2	2
CO Avg.	1.8	2	2	1.0	1	1.0	1	2	1	2	1.7	1.8	2.0	2.0	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

VERTICAL III**BIOCHEMICAL ENGINEERING**

23CHE013	BIOCHEMISTRY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: Nil					
Course Objectives: To enable students learn the fundamentals of Biochemical Processes and Biomolecules					
Unit I	INTRODUCTION TO BIOMOLECULES - CARBOHYDRATES				9
Basic principles of organic chemistry, role of carbon, types of functional groups, chemical, nature of water, pH and biological buffers, bio molecules structure and properties of Carbohydrates (mono, di, oligo & polysaccharides) Proteoglycans, glucosaminoglycans. mutarotation, glycosidic bond, reactions of monosaccharides, reducing sugars. Starch, glycogen, cellulose and chitin. Proteoglycans, glucosaminoglycans. hyaluronic acid, chondroitin sulfate					
Unit II	STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES				9
Structure and properties of Important Biomolecules. Lipids: fatty acids, glycerol, saponification, iodination, hydrogenation, phospholipids, glycolipids, sphingolipids, cholesterol, steroids, prostaglandins. Protein: Amino Acids, Peptides, Proteins, measurement, structures, hierarchy of organization primary, secondary, tertiary and quaternary structures, glycoproteins, lipoproteins. Determine of primary structure. Nucleic acids: purines, pyrimidines, nucleoside, nucleotide, RNA, DNA-Watson-Crick structure of DNA, reactions, properties, measurement, nucleoprotein complexes					
Unit III	METABOLISM CONCEPTS AND CARBOHYDRATE METABOLISM				9
Functions of Proteins, Enzymes, introduction to biocatalysts, metabolic pathways, primary and secondary metabolites. Interconnection of pathways and metabolic regulation. Glycolysis, TCA cycle, gluconeogenesis,					

pentose phosphate shunt & glyoxalate shunt.

Unit IV	INTERMEDIARY METABOLISM AND REGULATION	9
Fatty acid synthesis and oxidation, reactions of amino acids, deamination, transamination and decarboxylation, urea cycle, Bioenergetics - High energy compounds, electronegative potential of compounds, respiratory chain, ATP cycle, calculation of ATP yield during oxidation of glucose and fatty acids		
Unit V	PROTEIN TRANSPORT AND DEGRADATION	9
Protein targeting, signal sequence, secretion; Folding, Chaperone and targeting of organelle proteins, Protein degradation, receptor-mediated endocytosis, turnover.		

Total periods:45

Text Books:

1. Lehninger Principles of Biochemistry 6th Edition by David L. Nelson, Michael M. Cox W.H. Freeman and Company 2017
2. Satyanarayana, U. and U. Chakerapani, "Biochemistry" 3rd Rev. Edition, Books & Allied(P) Ltd., 2006.
3. Rastogi, S.C. "Biochemistry" 2nd Edition, Tata McGraw-Hill, 2003.
4. Conn, E.E., et al., "Outlines of Biochemistry" 5th Edition, John Wiley & Sons, 1987.
5. Outlines of Biochemistry, 5th Edition: By E E Conn, P K Stumpf, G Bruening and R Y Doi. pp693. John Wiley and Sons, New York. 1987.

References:

1. Berg, Jeremy M. et al. "Biochemistry", 6th Edition, W.H. Freeman & Co., 2006.
2. Murray, R.K., et al "Harper's Illustrated Biochemistry", 31st Edition, McGraw-Hill, 2018.
3. Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010.

Course Outcomes:	Blooms Taxonomy
CO1 – understand the basic concepts on carbohydrates.	Understand(K2)
CO2 – learn the concepts of proteins	Apply(K3)
CO3 – gather knowledge on importance of nucleic acids	Understand(K2)
CO4 – understand the knowledge on lipids	Apply(K3)
CO5 – gather knowledge on intermediary metabolism and their pathways	Apply(K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	1	2	1	2	2	1	1	2	2	2
CO2	2	-	-	-	-	1	2	1	2	2	1	1	2	2	2
CO3	2	-	-	1	1	1	2	1	2	2	1	1	2	2	2
CO4	2	-	-	1	1	1	2	1	2	2	1	1	2	2	2
CO5	2	1	1	1	2	1	2	1	2	2	2	2	2	2	2
CO Avg.	2	1	1	1.0	1.3	1.0	2	1	2	2	1.2	1.2	2.0	2.0	2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CHE014	BIOPROCESS TECHNOLOGY	Category:PEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To understand the fundamentals of bioprocesses - To understand the production process of biomolecules - To have a strong foundation in bioreactors					
Unit I					9
Biologists and Engineers, comparison of chemical and biochemical processing overview of biological basics, About cells and its growth, the stoichiometry of microbial growth and product Bioprocesses: Regulatory Constraints					
Unit II					9
Media formulation, Media Sterilization: Methods of heat sterilization of media, thermal death kinetics, design criteria, batch and continuous sterilization. Air Sterilization: Methods of air sterilization, mechanism of air sterilization, solid and liquid handling. Industrially fermented broth					
Unit III					9
Purpose and importance of bioreactors, Classification of bioreactors, bioreactors for animal cells, bioreactors for plant cells, bioreactors for immobilized cells, operations of bioreactors, stirred tank reactor, plug flow reactor (PFR), fluidized bed reactor, bubble column, airlift reactor, Agitation, and Aeration: Mechanical agitation, power consumption in agitation, bubble aeration, bioreactors for waste management					
Unit IV					9
Aspects of rheology, Fluid flow in packed-bed and Fluidized bed columns, Gas-liquid mass transfer in cellular systems Diffusivity and mechanism of mass transfer - derivation of the equations of mass transport by diffusion-stationary and unsteady mass transport by diffusion, mass transfer coefficient, macroscopic balances for mass transport. Mechanisms and applications of heat transfer-mode of heat transfer-conduction, convection and radiation, Application of Heat and Mass transfer in biochemical processes					
Unit V					9
Introduction to Bioethics. Social and ethical issues, the process of biotechnology involved ingenerating new forms of life for informed decision making, Definition of Biosafety. Biosafety for human health and environment. Social and ethical issues. Use of genetically modified organisms and their release into the environment.					
Total periods: 45					
Text Books:					
1. Bailey, J. E., and D. F. Ollis. Biochemical Engineering Fundamentals. 2nd ed. New York,McGraw-Hill, 1986					
2. H. W. Blanch and D. S. Clark, Biochemical Engineering, Marcel, Dekker Inc., 1996.					

3. Pauline M. Doran. Bioprocess Engineering Principles. 2nd ed. Elsevier Science & Technology Books. 1995

References:

1. Transport Phenomena, by Bird R.B., Steward W.E., and Lightfoot E.N., John Wiley & sons, Inc., New York, 2002

2. C J Geankoplis, Transport Processes and Separation Processes Principles, 4th Edition, New Jersey, PHI Publishers, 2010

Course Outcomes:

Blooms Taxonomy

CO 1: understand the fundamental knowledge on bioprocess technology

Understand(K2)

CO2: learn the production process of biomolecules

Understand(K2)

CO3: gather knowledge on the operations of bioreactors and their purposes

Apply(K3)

CO4: understand the transportation processes in reactors and their behaviors

Apply(K3)

CO5: knowledge on the biosafety and information on bioethics.

Apply(K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	2	2	1	1	1	2	2	2	2
CO2	2	2	2	2	1	1	2	2	2	1	1	2	2	2	2
CO3	2	3	3	2	2	1	2	2	2	1	1	2	2	2	2
CO4	2	3	3	2	2	1	2	2	2	1	2	2	2	2	2
CO5	2	1	1	2	2	1	2	3	3	2	2	2	2	2	2
CO Avg.	2	2	2	2.0	1.6	1.0	2	2.2	2	1.2	1.4	2	2.0	2.0	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHE015	FERMENTATION TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites: Nil

Course Objectives:

- To understand fermentation and its kinetics
- To understand structural, functional properties of microbes
- To design fermenter with auxiliaries

Unit I

FERMENTATION PROCESSES

9

Importance of fermentation, Fermentation and redox potential, solid-liquid fermentation, solid state fermentation, Kinetics of fermentations, Biosensors for fermentations, Production processes in fermentation

Unit II

MICROBIAL GROWTH KINETICS

9

Diversity of patterns of microbial growth in situ and ex situ, Microbial growth under homogeneous conditions,

Heterogeneous microbial growth, Growth kinetics, Derivation of mathematical models, and identification															
Unit III	DESIGN OF FERMENTERS												9		
fermentation processes, Fermentation processes and microorganisms, Kinetics and stoichiometry, Mass balances and design for batch, continuous and fed-batch reactors, Comparison of batch, continuous and fed-batch reactors, Heat generation and heat balances, examples of industrial fermentation processes															
Unit IV	INSTRUMENTATION AND CONTROL												9		
Common Instruments for Process Automation — Temperature, Gas Flowrate, Liquid Flowrate, Off- Gas Analysis, pH, Dissolved Oxygen, Pressure, Foam Level, Stirring , Redox Potential, Advanced Instrumentation for Bioprocess Control and Automation - Flow Injection Analysis, Sequential Injection Analysis Fluorescence, Mass Spectrometry, Near Infrared Spectroscopy, Soft sensors, Biomass, Bioreactor automation															
Unit V	FERMENTATION AND COMMODITY PRODUCTS												9		
Engineering of Secretory Pathways, production of heterologous proteins, fungal, yeast fermentation of industrial products															
Total periods: 45															
Text Books:															
1,Essentials in Fermentation Technology, Aydin Berenjian, Springer ,2019.															
2.Principles of Fermentation Technology (Second Edition), Peter F. Stanbury, Allan Whitakerand Stephen J. Hall, Pergamon, 1995															
References:															
1.Fermentation and Biochemical Engineering Handbook; Editors-in-Chief: Henry C. Vogeland Celeste M. Todaro, Third Edition, Elsevier, 2014.															
2.Fermentation Biotechnology: Principles, Processes, and Products (Prentice Hall advancedreferences series), Owen P. Ward, Prentice Hall, 1989															
Course Outcomes:													Blooms Taxonomy		
CO1- understand the structural, functional properties of microbes													Understand(K2)		
CO2- learn the growth kinetics of microorganisms													Understand(K2)		
CO3- understand the basic concepts in designing of fermenters													Apply(K3)		
CO4- gather knowledge on the operation of control systems in fermentation and bioprocessindustry													Apply(K3)		
CO5- acquire knowledge on the commodity, fermentation production and their productionpathways													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	2	2	2	2	1	1	2	1	-	-
CO2	1	2	1	2	2	2	2	2	2	1	1	2	1	2	1
CO3	1	2	3	3	3	2	2	2	2	1	2	2	1	2	1

CO4	1	2	3	3	3	2	2	2	2	2	2	2	1	2	1
CO5	1	2	2	2	3	2	2	2	2	2	2	2	1	2	1
CO Avg.	1	1.8	2	2.2	2.4	2.0	2	2	2	1.4	1.6	2	1.0	2.0	1
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHE016	DOWNSTREAM PROCESSING					Category: PEC			
						L	T	P	C
						3	0	0	3

Prerequisites: NIL**Course Objectives:**

- ☐ To learn the fundamentals of bio separations
- ☐ To design unit operations steps for various downstream purification steps
- ☐ To gain knowledge on theory, design, and application of bioprocessing

Unit I	INTRODUCTION	9

Introduction to By-products and Bioseparation: Range and characteristics of bio products, Characteristics of Fermentation Broth, Selection of unit operation with due consideration of the physical, chemical and biochemical aspects of biomolecules. Stages of Downstream Processing

Unit II	CENTRIFUGATION AND FILTRATION	9

Primary Separation: Removal of insoluble and Biomass (and particulate debris) separation techniques, Flocculation and sedimentation, Centrifugation-Ultracentrifugation, Gradient centrifugation, Filtration: Theory of Filtration, Pre-treatment of Fermentation Broth, Filter Media and Equipment, Conventional and Cross-flow Filtration, Continuous Filtration, Filter cake resistance, specific cake resistance, Washing and dewatering of filter cakes

Unit III	ABSORPTION	9

Gas Absorption: Solubility of gases in liquids, Effect of temperature and pressure on solubility, Ideal and Non-ideal solutions, Choice of solvent for gas absorption, absorption factor, stripping factor, minimum gas liq ratio, Single stage gas absorption Cross Current, Co- current, Countercurrent, Multistage Counter current Operation, Absorption with Chemical Reactions, Related problems

Unit IV	EXTRACTION	9

Liquid-Liquid Separation Process: Single Stage Operation, Equipments for liquid-liquid extraction. Types of extraction processes: Reactive extraction, Aqueous two-phase systems, Reverse micellar extraction, solid-liquid extraction, Supercritical fluid Extraction. Different types of extractors and designing of extractors. Distillation: Simple, Steam and Equilibrium distillation, Fractionation, McCabe Thiele method, azeotropes

Unit V	CHROMATOGRAPHY AND MEMBRANE SEPARATION												9		
Theory of chromatography, Shape and yield of a chromatographic peak, Binary chromatography, Hydrodynamic chromatography. Membrane-based bioseparation - Classification of membrane processes, Ultrafiltration, Microfiltration, Dialysis, Liquid membrane processes, Membrane chromatography, Electrophoresis, Affinity ultrafiltration, Field-flow fractionation															
Total periods: 45 PERIODS															
Text Books:															
1,Treybal R.E. , Mass transfer operation, 3 Ed., McGraw Hill New York, 1980.															
2.Roger G. Harrison, Paul Todd, ScottR. Rudge, Demetri P. Petrides, Bioseparations Scienceand Engineering, Oxford University Press															
3.B.Shivshankar, Bioseparations: Principles and Techniques, Eastern Economy Edition, PHILearning Pvt. Ltd., Publishing House, New Delhi, 2012															
4.Bioseparation & bioprocessing (2nd Ed) 2-Volume set, Ed SUBRAMANIAN Ganapathy,Wiley-VCH, (09-2007)															
References:															
1.P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing forBiotechnology, Wiley Interscience Publication, 1988.															
2,R. K. Scopes, Berlin, Protein Purification: Principles and Practice, Springer, 1982.Scopes Ak, Protein Purification, IRL Press, 1993															
3.Biotechnology: Bioprocessing, Rhem and Reed, Vol. 3, 1993															
4.Separation and purification techniques in biotechnology, Fredreich Dechow, 1989															
5.T. Schepler et al, Biotreatment, Downstream Processing and Modeling (Advances inBiochemical Engineering /Biotechnology, Vol 56) by Springer Verlag															
Course Outcomes:													Blooms Taxonomy		
CO1- understand the basic concept of bioseparation processes													Understand(K2)		
CO2- acquire knowledge on theory, design, and application of bioprocessing													Apply(K3)		
CO3- to understand the basic concepts absorption and their problems in bioprocessing													Understand(K2)		
CO4- gather knowledge on extraction of bioproducts using different methods													Apply(K3)		
CO5- acquire knowledge on chromatography techniques and their analysis, membrane separationprocess													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	1	2	2	2	2	2	2	2	1	2
CO2	2	2	2	2	3	1	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	1	2	2	2	2	2

CO5	2	3	2	3	3	2	2	2	2	1	2	2	2	2	2
CO Avg.	2	2	1.8	2.0	2.6	1.6	2	2	2	1.6	2.0	2	2.0	1.8	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHE017	ENZYME TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites: NIL

Course Objectives:

- To understand Enzymes, homogeneity, and heterogeneity
- To understand structural, functional properties, and metabolic pathways
- To learn immobilization procedures, and types.
- To design enzyme reactors

Unit I	INTRODUCTION	9

Catalysis and biocatalysis, Enzyme classification and nomenclature, enzyme structure, functionality and relationship, enzyme activity, enzyme sources, synthesis, recovery and purification, enzymes as process catalysts

Unit II	HOMOGENEOUS ENZYME KINETICS	9

Hypothesis of enzyme kinetics, rapid equilibrium and steady-state hypothesis, determination of kinetic parameters, various types of kinetic inhibition, reactions with more than one substrate, effect of environmental variables- pH, temperature, and ionic strength

Unit III	BASICS OF IMMOBILISATION	9

Immobilisation — Functional properties, Classification of Immobilisation techniques — Adsorption, matrix entrapment, crosslinking, covalent binding- advantages & disadvantages of each method, selection and characterisation of matrices for immobilisation, effect of physico chemical parameters on immobilised enzymes

Unit IV	HETEROGENEOUS ENZYME KINETICS	9

Mass transfer effects in heterogeneous biocatalysis, partition effects, Immobilised enzyme kinetics external (film) diffusion, internal (pore) diffusional kinetics, Thiele modulus and Effectiveness factor. Effects of electrostatic potential of the micro environment

Unit V	ENZYME REACTORS & APPLICATION OF IMMOBILISED ENZYMES	9

Design of reactors with immobilised enzymes, Design of advanced immobilized enzyme systems, Application of immobilised enzymes in food industry, textile industry, Pharmaceutical industry & in medicine, in the production of biofuels, detergent industry, production of various bio-products, as biosensors

Total periods: 45

Text Books:

1. "Enzyme Technology" by M.F. Chaplin and C. Bucke, Cambridge University press, 1990. (Website for the book,

www.lsbu.ac.uk/biology/enztech/)

2. "Biocatalysts and Enzyme Technology" by K. Buchholz, V. Kasche and U.T. Bornscheur, Wiley, 2005

References:

1. "Enzyme Technology", by Shanmugam, S. and Satish Kumar, T., IK International Pvt. Ltd, New Delhi, 2008

2. Enzyme Biocatalysis: Principles and Applications' by A. Illanes, Springer, 2008

Course Outcomes:													Blooms Taxonomy		
CO1 – understand the basic knowledge on classification of enzymes and their nomenclature													Understand(K2)		
CO2 - understand Enzymes, homogeneity, and heterogeneity													Understand(K2)		
CO3 - understand structural, functional properties, and metabolic pathways of enzymes													Apply(K3)		
CO4 - learn immobilization procedures, and their different types.													Apply(K3)		
CO5 – knowledge on designing enzyme reactors													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	1	-	1	1	2	1	1	-	1	2	1	1
CO2	2	-	1	1	1	1	1	2	1	1	-	1	2	1	1
CO3	2	-	1	1	1	1	1	2	1	1	-	1	2	1	1
CO4	2	2	2	1	2	1	1	2	1	1	-	1	2	1	1
CO5	2	2	3	2	2	2	1	2	2	1	2	1	2	1	1
CO Avg.	2	2	1.7	1.2	1.5	1.2	1	2	1.2	1	2.0	1	2.0	1.0	1
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CHE018	BIOREACTOR DESIGN	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					
Course Objectives:					
➤ To understand the fundamentals of bioreactor design					
➤ To design single and multiple bioreactors					
➤ To design a bioprocess system.					
Unit I	BIOREACTOR DESIGN & MEDIA REQUIREMENTS				9
Microbial growth and product formation kinetics, Bioreactor Selection, Reactor operational mode and selection					

Unit II	DESIGN EQUATIONS FOR BIOREACTORS	9
Basic Design Equations/ Mole Balances: Batch, Fed-Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors, Microbial death kinetics, Design criterion for sterilization, Batch and continuous sterilization of medium, Multiple reactions-series, parallel and mixed-mode, Air sterilization		
Unit III	BIOREACTOR REQUIREMENTS	9
Process-General requirements; Basic design and construction of bioreactors and their ancillaries; Material of construction, Vessel geometry, Bearing Assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors, Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression		
Unit IV	DESIGN OF BIOREACTORS	9
Process and mechanical design of Bioreactors, volume, sparger, agitator-type, size and motor power, heat transfer calculations for coil and jacket, sterilization system, scale-up, scale down, bioinstrumentation and control.		
Unit V	NOVEL BIOREACTORS DESIGN	9
Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Airlift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for wastetreatment processes; SSF bioreactors. bioreactor design considerations for plant and animal cell cultures		
Total periods: 45		
Text Books:		
1.Bioprocess Engineering -Kinetics, Mass Transport, Reactors and Gene Expression Wolf R.Vieth A Wiley-Interscience Publication 1994		
2.Chemical Kinetic Methods: Principles of relaxation techniques Kalidas C New AgeInternational 1996		
Chemical Reactor Analysis and Design Forment G F and Bischoff K B John Wiley 1990		
References:		
1. Bioprocess Engineering -Kinetics, Biosystems, sustainability and reactor Design, Shijie Liu,Elsevier Publication 2013		
Course Outcomes:		Blooms Taxonomy
CO1: Compare kinetics and reaction rates for various bioreactor designs, based on operationalmode and type of substrate.		Understand(K2)
CO2: Differentiate and estimate productivity in commercial bioreactors- packed bed, fed batchreactors		Understand(K2)
CO3: Helps to understand various requirements such as material of construction, valves, agitator,sensors etc		Apply(K3)
CO4: Understanding the mechanical design and heat transfer calculations for various type ofbioreactor		Apply(K3)
CO5: Analyze immobilization techniques in reactors and use it for various applications		Understand(K2)
CO - PO & PSO Mapping		

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	3	3	2	2	2	2	2	2	2	2	2	2
CO2	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2
CO3	2	2	2	3	3	2	2	2	2	2	2	2	2	3	2
CO4	2	2	3	3	3	2	2	2	3	2	2	2	2	3	2
CO5	2	2	3	3	3	2	2	2	3	2	2	3	2	3	2
CO Avg.	1.8	2	2.4	3.0	3.0	2.0	2	2	2.4	2	2.0	2.2	2.0	2.8	2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

VERTICALS –IV

ENVIRONMENTAL AND SAFETY ENGINEERING

23CHE019	AIR POLLUTION ENGINEERING	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: To enable the students to learn about Air Pollution, effects of air pollution, Global effects, Sampling of pollutants, Meteorology and air pollution, Atmospheric stability, Plume rise and dispersion and Prediction of air quality					
Unit I	INTRODUCTION				9
Introduction to Air Quality; An Overview of the Clean Air Act Amendments; Air Pollution Regulatory Framework - Regulatory System – Laws and Regulations – Clean air Act – Provisions for Recent Developments. Ambient Air Quality Standards in India; Properties of Air Pollutants; Sources and effects of air pollution, emission standards, Air Quality Index					
Unit II	GASEOUS POLLUTANTS				9
Absorption- Principles, Description of equipment-Packed and Plate columns -Design and Performance equations; .Adsorption- Principle Adsorbents, Equipment descriptions - PSA - Adsorption cycle - Solvent recovery system-Continuous Rotary bed, Fluidized bed, Design and Performance equations ; Incinerators, Hydrocarbon incineration kinetics- Equipment description- Design and Performance equations					
Unit III	PARTICULATE AIR POLLUTION				9
Particle Collection mechanisms– Fluid particle Dynamics – Particle size Distribution – Efficiency –Gravity Settling chambers Cyclones- Electrostatic precipitators and Bag houses					

Unit IV	AIR POLLUTION CONTROL												9		
Principles of Pollution Prevention- Characteristics and control of VOCs and HCs, Characteristics and control of sulphur oxides and nitrogen oxides, Control of mobile source pollutants - Control of particulate matters — Techniques of air pollution control - equipments															
Unit V	AIR POLLUTION MODELLING												9		
Meteorology and winds- Stability of the atmosphere, lapse rates & inversions- Air pollution dispersion models, Gaussian equation and variation, Industrial Air Pollution Sources and Prevention															
Total periods: : 45 PERIODS															
Text Books:															
1.Richardw.Boubeletal.,“Fundamentals of Air Pollution”,Academic Press,New York,1994.															
2.NoelDeNevers,“Air Pollution Control Engg.”,McGraw Hill,New York,1995.															
3.M.N.Raoetal.,“Air Pollution”TataMcGraw Hill,1989															
References:															
1.David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.															
2.Stern, A.C., Air Pollution (Vol.I – Vol.VIII), Academic Press, 2006.															
3.Davis, W.T., Air Pollution Engineering Manual, John Wiley & Sons,Inc.,2000.															
4.Heck, R.M., and Farrauto, R.J., Catalytic Air Pollution Control: Commercial Technology, 2nd Edition John Wiley Sons, 2012															
5.Pierce, J.J., Environmental pollution and control, Butterworth-Heinemann, 4th edn, 1997.															
6.Nevers, N., Air Pollution Control Engineering, McGraw Hill, New York, 2011.															
7.Anjaneyulu, Y., Air Pollution and Control Technologies, Allied Publishers (P) Ltd., India,2002.															
8.Wang, L.K., Parelra, N.C., Hung, Y.T., Air Pollution Control Engineering, Tokyo, 2004															
9.David, H.F., Liu, Bela G., Liptak Air Pollution, Lweis Publishers, 2000.															
Course Outcomes:												Blooms Taxonomy			
CO1- Understand the nature and characteristics of air pollutants, and basic concepts of air quality management.												Understand(K2)			
CO2: Identify, formulate and solve air pollution problems using air pollution control devices to meet applicable standards												Apply(K3)			
CO3: Understand the knowledge about particulate air pollutants and control devices.												Understand(K2)			
CO4: Relate the air quality behaviour and its measurement												Apply(K3)			
CO5: Control the air pollution in industries using various models												Apply(K3)			
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	1	2
CO2	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2

CO3	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2
CO4	2	3	2	2	3	2	2	2	2	2	2	1	2	2	2
CO5	2	3	3	2	3	2	2	2	2	2	2	1	2	2	2
CO Avg.	2	2.6	2	2.0	2.6	2.0	2	2	2	2	2.0	1.2	2.0	1.8	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHE020	WASTE WATER TREATMENT					Category: PEC			
						L	T	P	C
						3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process

Unit I	WASTE WATER TREATMENT AN OVERVIEW	9

Terminology – Regulations – Health and Environment Concerns in waste water management – Constituents in waste water; inorganic, Organic and heavy metal constituents

Unit II	CHEMICAL UNIT PROCESSES	9

Role of unit processes in waste water treatment- Principles of Chemical treatment – Coagulation - flocculation– Precipitation–flotation – solidification and stabilization –disinfection

Unit III	BIOLOGICAL TREATMENT	9

Objectives of biological treatment – significance – Principles of aerobic and anaerobic treatment - kinetics of biological growth – Factors affecting growth – attached and suspended growth - Determination of Kinetic coefficients for organics removal – Biodegradability assessment - selection of process- reactors-batch-continuous type

Unit IV	TREATMENT METHODS	9

Activated Sludge process and variations, Sequencing Batch reactors, Membrane Biological Reactors-Trickling Filters- RBC-Moving Bed Reactors- fluidized bed reactors, aerated lagoons, waste stabilization ponds- Design of units – UASB, up flow filters, Fluidized beds MBR, septic tank and disposal

Unit V	ADVANCED WASTE WATER TREATMENT	9

Technologies used in advanced treatment – Classification of technologies- Removal of Colloids and suspended particles– Membrane Filtration – Ion Exchange – Advanced oxidation process – Zero liquid Discharge. - Software Applications

Total periods: 45 PERIODS**Text Books:**

1. Waste water Engineering Treatment and Reuse: McGraw Hill, G. Tchobanoglous, FIBiston, 2002.
2. Industrial Waste Water Management Treatment and Disposal by Waste Water McGraw Hill III Edition 2008.
3. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007

References:

1. Casey, T.J., Unit Treatment Processes in Water and Wastewater Engineering, John Wiley & Sons, 2006.
2. Metcalf & Eddy, Inc. Wastewater Engineering - Treatment, Disposal, and Reuse, Fourth Edition, Tata McGraw-Hill, 1995. 14
3. Cheremisinoff, P.N., Handbook of water and wastewater technologies, BH Publications, 2002.
4. Sincero, P.A., and Sincero, A.G., Physical Chemical treatment of water and wastewater, IWA Publications, 2002.
5. Spellman, R.F., Handbook of water and wastewater treatment plant operations, CRC Press/Taylor & Francis Publications, 2009

Course Outcomes:**Blooms Taxonomy**

CO1: Understand the Physical and chemical Characteristics of wastewater and their measurement

Understand(K2)

CO2: Understand the various pollutant treatment techniques

Understand(K2)

CO3: Understand the concepts using biological treatment methods

Apply(K3)

CO4: Analyze the reactors used for various treatment techniques

Apply(K3)

CO5: Understand the membrane based electrochemical process for pollutant treatment

Apply(K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	1	2	2	2	2	2	2	2	2	2	2	1	1
CO2	2	2	1	2	2	2	2	2	2	2	2	2	2	2	1
CO3	2	2	2	2	3	2	2	2	2	2	2	2	2	2	1
CO4	2	2	2	2	3	2	2	2	2	2	2	2	2	2	1
CO5	2	3	2	2	3	2	2	2	2	2	2	2	2	2	1
CO Avg.	2	2.25	1.6	2	2.6	2	2	2	2	2	2	2	2	1.8	1

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHE021	SOLID WASTE MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: To make the students conversant with the types, sources, generation, storage, collection,transport, processing and disposal of municipal solid waste					
Unit I	SOURCES AND CHARACTERISTICS				9
Sources and types of municipal solid wastes- Public health and environmental impacts of improper disposal of solid wastes- sampling and characterization of wastes - factors affecting waste generation rate and characteristics - Elements of integrated solid waste management — Requirements and salient features of Solid waste management rules (2016) — Role of public and NGO’s- Public Private participation – Elements of Municipal Solid Waste Management Plan					
Unit II	SOURCE REDUCTION, WASTE STORAGE AND RECYCLING				9
Waste Management Hierarchy - Reduction, Reuse and Recycling - source reduction of waste –On-site storage methods – Effect of storage, materials used for containers – segregation of solidwastes – Public health and economic aspects of open storage – case studies under Indian conditions – Recycling of Plastics and Construction/Demolition wastes					
Unit III	COLLECTION AND TRANSFER OF WASTES				9
Methods of Residential and commercial waste collection – Collection vehicles – Manpower – Collection routes – Analysis of waste collection systems; Transfer stations –location, operation and maintenance; options under Indian conditions – Field problems- solving					
Unit IV	PROCESSING OF WASTES				9
Objectives of waste processing — Physical Processing techniques and Equipment; Resource recovery from solid waste composting and bio meth nation; Thermal processing options — case studies under Indian conditions					
Unit V	WASTE DISPOSAL				9
Land disposal of solid waste- Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor – DumpsiteRehabilitation					
Total periods: 45					
Text Books:					
1.William A. Worrell, P. AarneVesilind (2012) Solid Waste Engineering, Cengage Learning,2012.					
2.John Pitchel (2014), Waste Management Practices-Municipal, Hazardous and industrial —CRC Press, Taylor and Francis, New York.					
3.Tchobanoglous, G., Theisen, H. M., and Eliassen, R. “Solid Wastes: EngineeringPrinciples and Management					

Issues". McGraw Hill, New York, 1993.

4.Vesilind, P.A. and Rimer, A.E., "Unit Operations in Resource Recovery Engineering", Prentice Hall, Inc., 1981

References:

1.Government of India, "Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, New Delhi, 2000.

2.Manser A.G.R. and Keeling A.A., "Practical Handbook of Processing and Recycling of Municipal solid Wastes", Lewis Publishers, CRC Press, 1996.

Course Outcomes:													Blooms Taxonomy		
CO1: State solid waste characteristics and its sources.													Understand(K2)		
CO2: Identify and analyze different methods of treatment of solid waste													Apply(K3)		
CO3: Illustrate Industrial practices in solid waste management.													Understand(K2)		
CO4: Discuss the significance of recycling reuse and reclamation of solid wastes													Apply(K3)		
CO5: Assess the relationships between environmental guidelines, human activities and quality of impacted soil, water and air.													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	1	2	2	2	2	1	2	2	1	2
CO2	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2
CO3	2	2	2	2	2	1	2	2	2	2	2	2	2	1	2
CO4	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2
CO5	2	1	2	2	2	2	2	2	2	2	2	2	2	1	2
CO Avg.	2	2	2	1.4	2	2	2	2	1.8	2	2	1	2	2	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHE022	ENVIRONMENTAL IMPACT ASSESSMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects					
Unit I	INTRODUCTION				9
Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework					
Unit II	ENVIRONMENTAL ASSESSMENT				9
Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices — Networks — Checklist Methods - Mathematical models for Impact prediction					
Unit III	ENVIRONMENTAL MANAGEMENT PLAN				9
Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance					
Unit IV	SOCIO ECONOMIC ASSESSMENT				9
Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis					
Unit V	MONITORING STUDIES AND APPLICATIONS				9
Environmental monitoring - guidelines - policies - planning of monitoring programmes; Environmental Management Plan- Post project audit ; Case studies of EIA of developmental projects in Food, Fertilizer and Petrochemical industry					
Total periods: 45					
Text Books:					
1.Canter, L. W., Environmental Impact Assessment, McGraw Hill, New York, 1996.					
2.Petts, J., Handbook of Environmental Impact Assessment Vol. I and II, Blackwell Science,London, 2009.					
3.Lawrence, D.P., Environmental Impact Assessment — Practical solutions to recurrent problems, Wiley-Interscience, New Jersey, 2003.					
4.Anjaneyulu, Y., and Manickam, V., Environmental Impact Assessment, Methodologies, 2nd Edition, BS Publications, 2007					
References:					
1. Becker H. A., Frank Vanclay, “The International handbook of social impact assessment” conceptual and					

methodological advances, Edward Elgar Publishing, 2003.

2. Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme, 2002

3. Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 1998

4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010

5. Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991

6. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996

7. Morris, P., and Therivel, R., Methods of Environmental Impact Assessment, 3rd Edition, Taylor & Francis, 2009

Course Outcomes:													Blooms Taxonomy		
CO1: Understand the concept of environmental Impact assessment													Understand(K2)		
CO2: Know various components and assessment techniques of EIA.													Apply(K3)		
CO3: Understand Environmental management plan													Apply(K3)		
CO4: Understand socio economic assessment plans													Understand(K2)		
CO5: gain knowledge about EIA monitoring studies through various industrial exposure													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	2	2	2	2	2	2	2	2	2	2
CO2	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO3	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO4	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO5	2	1	2	2	1	2	2	2	2	2	2	2	2	2	2
CO Avg.	2	1	1.8	2	1	2	2	2	2	2	2	2	2	2	2
1 - Low, 2 - Medium, 3 - High, ‘-’ No correlation															

23CHE023	PROCESS SAFETY MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL.					
Unit I	PROCESS SAFETY INFORMATION				9
Safety vs Process Safety, Importance of Process Safety, Elements of Process safety - Overview ; Process Safety Information (PSI) — Importance of Process Safety Information , Types of PSI, Collection of PSI, familiarization					

of formats for capturing PSI, Challenges

Unit II	SAFETY PROGRAMMES AND PROCEDURES	9
Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling-Implementation of safety procedures – periodic inspection and replacement; Standard Operating Procedure – Overview and its importance, how to write effective operating procedure, Types of Procedures, Standard operating conditions and consequence of deviation; Emergency planning		
Unit III	ACCIDENT ANALYSIS	9
Accidents – identification and prevention, promotion of industrial safety. Process Safety Incident reporting and Investigation – Element overview, reporting and its importance; Process safety incident classification, Root cause analysis, making recommendations ; Past accident analysis- Fixborough-Mexico- Chernobyl nuclear disaster-Bhopal gas analysis- process safety indicators		
Unit IV	PROCESS HAZARD ANALYSIS	9
Hazard identification- safety audits, checklist, what if analysis, vulnerability models- event tree analysis- fault tree analysis. Asset Integrity Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation — Key Aspects. Cyclic PHA /Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes		
Unit V	SAFETY MANAGEMENT	9
Employee Participation — Overview, Benefits of Employee participation, Various modes of engaging workforce in PSM, Challenges; Management of Change – Types of Changes, Managing Changes in PSM Perspective, Framework, evaluating changes-Institutionalizing and integrating safety into the PSM fabric, 5 tier approach, selection, training, Performance monitoring; Case studies – Process safety management in industry – present and futuristic approach		
Total periods: 45		
Text Books:		
1.Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar,Prantice Hall, NJ, 1990.		
2.Fawatt, H.H. and Wood, W.S., “Safety and Accident Prevention in Chemical Operation“,Wiley Interscience, 1965.		
3.Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.		
4.Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis,Dyadem Press, 2004		
References:		
1.Handley, W., “Industrial Safety Hand Book “, 2nd Edn., McGraw-Hill Book Company, 1969.		
2.Heinrich, H.W. Dan Peterson, P.E. and Rood, N., “Industrial Accident Prevention“,McGrawHill Book Co., 1980.		
3.Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall,London, 1994		

Course Outcomes:													Blooms Taxonomy		
CO1 - Understand the chemical process safety, safety codes													Understand(K2)		
CO2 – safe handling of chemicals and plant inspection													Understand(K2)		
CO3 – learn the different analysis to overcome the accidents in process industry													Understand(K2)		
CO4 – understand the hazard analysis in process industry													Apply (K3)		
CO5 – knowledge on safety management in different process industry													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	2	2	2	2	2	1	2	2	2	1
CO2	2	-	2	2	-	2	2	2	2	2	1	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	3	2	2	2	2	2	2	2	2	2	2
CO5	2	2	3	2	3	2	2	2	2	2	2	2	2	2	2
CO Avg.	2	2	2.3	2	2.7	2	2	2	2	2	1.6	2	2	2	1.8
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE024	RISK AND HAZOP ANALYSIS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites Nil.					
Unit I	RISK ANALYSIS				9
Risk analysis introduction, quantitative risk assessment, rapid risk analysis –comprehensive riskanalysis – identification, evaluation and control of risk					
Unit II	RISK ASSESSMENT				9
Risk assessment – introduction and available methodologies, Risk assessment steps- Quantitative risk analysis-event tree, fault tree, consequence analysis and layer of protection analysis- Bow tie analysis					
Unit III	EMERGENCY PLANNING				9
Overall risk analysis--emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies- marketing terminal, gas processing complex ; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball					
Unit IV	HAZARD				9
Hazard - Hazard identification — methods: Process Hazard Analysis - Introduction to PHA, Overview of PHA Techniques, Selection of PHA techniques Implementation of recommendation – Key Aspects. Cyclic PHA					

/Revalidation; Review of PHA methodology (Prerequisites, Team Composition and their attributes)

Unit V**HAZOP****9**

Introduction to HAZOP-Significance of HAZOP -HAZOP procedure –HAZOP Analysis -Computer usage in HAZOP- softwares employed - Limitations of HAZOP – case studies

Total periods: 45**Text Books:**

1.Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar,Prantice Hall, NJ, 1990.

2.Fawatt, H.H. and Wood, W.S., “Safety and Accident Prevention in Chemical Operation“, WileyInterscience, 1965.

3.Marcel, V.C., Major Chemical Hazard- Ellis Harwood Ltd., Chi Chester, UK, 1987.

4.Hyatt, N., Guidelines for process hazards analysis, hazards identification & risk analysis,Dyadem Press, 2004

References:

1.Handley, W., “Industrial Safety Hand Book “, 2nd Edition. McGraw-Hill Book Company, 1969.

2.Heinrich, H.W. Dan Peterson, P.E. and Rood, N., “Industrial Accident Prevention“, McGraw-HillBook Co., 1980.

3.Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall,London, 1994

Course Outcomes:**Blooms Taxonomy**

CO1: Understand the knowledge of types of risks arising in working environment

Apply (K3)

CO3: Design Risk management systems and planning

Understand(K2)

CO2: Perform Risk Assurance and Assessment

Apply (K3)

CO4: Analyze the effect of process hazard

Understand(K2)

CO5: hazop and its consequences and to create hazard free working premises

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	-	2	2	2	2	1	1	1	2	-	1
CO2	2	1	2	2	2	2	2	2	2	1	2	1	2	-	1
CO3	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
CO4	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
CO5	2	2	3	3	2	2	2	2	2	1	2	2	2	2	1
CO Avg.	2	1.7	2.8	2.7	2.0	2	2	2	2	1	1.8	1.6	2	2	1

1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation

VERTICALS - V
COMPUTATIONAL CHEMICAL ENGINEERING

23CHE025	COMPUTATIONAL TECHNIQUES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL.					
Unit I	NUMERICAL METHODS FOR SYSTEM OF LINEAR ALGEBRAICEQUATIONS				9
Gauss elimination, LU decomposition, matrix inversion, Tri-diagonal matrix algorithm, Gauss-Seidel method, Chemical Engineering problems involving solution of linear algebraic equations					
Unit II	NUMERICAL METHODS FOR NON LINEAR ALGEBRAIC EQUATIONS				9
Introduction, Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, System of Non-linear Equations, Chemical Engineering problems involving solution of non-linear equations					
Unit III	INTERPOLATION AND NUMERICAL INTEGRATION				9
Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression, Numerical integration: Trapezoidal rule, Simpson’s rule, integration with unequal segments, Chemical engineering problems involving numerical differentiation and integration					
Unit IV	NUMERICAL METHODS FOR ODES				9
Euler method – explicit and implicit, Runge-Kutta method – 2 nd and 4 th order, Boundary value problems – shooting method, Chemical engineering problems involving single and system ofODEs					
Unit V	NUMERICAL METHODS FOR PDES				9
Introduction to Partial Differential Equations: Characterization of PDEs, parabolic, elliptic and first order hyperbolic equations, explicit and implicit methods, Chemical engineering problems involving the three types of PDEs					
Total periods: 45					
Text Books:					
1.Chapra. S. C. & Canale, R. P., "Numerical Methods for Engineers", Eighth Edition, McGraw Hill,2021.					
2.Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.					
3.Ahuja, P., “Introduction to Numerical methods in Chemical Engineering” 2 nd Edition, PHllearning Private Ltd, 2019.					
References:					
1. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.					
Course Outcomes:					Blooms Taxonomy

CO1 - Understand the numerical methods for linear algebraic equations.													Apply (K3)		
CO2 – Identify numerical methods for non linear algebraic equations													Apply (K3)		
CO3 - Identify different methods for interpolation and numerical integration													Understand(K2)		
CO4 – knowledge on the numerical methods for ordinary differential equations													Apply (K3)		
CO5 – understand the basic methods for partial differential equations													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	1	-	-	1	2	2	2	2	2	1
CO2	2	2	1	2	1	1	-	-	1	2	2	2	2	2	-
CO3	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
CO4	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
CO5	2	2	1	2	1	1	1	-	1	2	2	2	2	2	1
CO Avg.	2	2	1.0	2	1.0	1	1	-	1	2	2	2	2	2	1
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE026	OPTIMIZATION OF CHEMICAL PROCESSES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL.					
Unit I	PROBLEM FORMULATION & CLASSIFCATION				9
Introduction; formulation of objective functions; fitting models to data; classification of functions; necessary and sufficient conditions for optimum; unimodal, multimodal functions; analytical methods					
Unit II	LINEAR PROGRAMMING				9
Review on basic concepts of LP formulations; Simplex methods; Big-M method, two phase method and Duality in linear programming					
Unit III	NON-LINEAR PROGRAMMING				9
The Lagrange multiplier method, Integer, quadratic, geometric and dynamic programming					
Unit IV	NUMERICAL METHODS				9
Unimodal functions; Newton, quasi Newton, secant methods; region elimination methods, polynomial approximation; quadratic and cubic interpolation techniques for optimum. Multimodal functions; direct methods; Powell's technique; indirect methods; gradient and conjugate gradientmethods; secant method					
Unit V	APPLICATIONS				9
Heat transfer and energy conservation; separation processes; fluid flow systems; reactor design and operation; large					

scale systems

Total periods: 45**Text Books:**

1. Edgar T.F., Himmelblau D.M., Lasdon, L.S., Optimization of Chemical Processes, Second Edition, McGraw-Hill, New York, 2001.

2. Rao, S. S., Engineering Optimization: Theory and Practice, Fifth Edition, Wiley, New York, 2019

References:

1. Reklaitis G.V., Ravindran A., Ragsdell, K.M., Engineering Optimization, Wiley, New York, 1980.

Course Outcomes:**Blooms Taxonomy****CO1:** be familiar on the basic problem formulation and optimization.

Understand (K2)

CO2: Understand mathematical characteristics of Linear programming

Apply (K3)

CO3: Learn computational solution techniques for nonlinear unconstrained optimization.

Understand (K2)

CO4: Understand various techniques used in constrained optimization

Apply (K3)

CO5: Apply the optimal and dynamic optimization.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	1	1	-	1	1	1	2	2	2	2
CO2	1	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO3	1	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO4	2	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO5	2	2	2	2	2	1	1	-	1	2	2	2	2	2	2
CO Avg.	1.4	2	2.0	2	2.0	1	1	-	1	1.8	1.8	2	2	2	2

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23CHE027	PROCESS MODELING AND SIMULATION	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL.					
Unit I	INTRODUCTION AND FIRST PRINCIPLES				9
Definition, Uses of Mathematical Models - Principles of formulation, Classification of Process Models, Fundamental laws: Total Continuity equation- Macroscopic and Microscopic Examples, Component Continuity Equation — Macroscopic and Microscopic Examples, Energy equation, Equations of motion, Transport equations, Equations of State, Equilibrium and Chemical Kinetics. Simple Examples					
Unit II	LUMPED SYSTEMS				9

Simple Hydraulic Tank, Variable flow hydraulic tank, Enclosed tank, Adiabatic compression in gas space, Mixing vessel, Mixing with reaction, Reversible reaction, Steam jacketed vessel, Continuous flow boiling system																
Unit III		STAGED OPERATIONS AND DISTRIBUTED SYSTEMS												9		
Staged Operations: Counter current extraction, Distillation columns - Binary distillation. Distributed systems: Counter current Heat exchanger, Membrane separation process, tubular reactor and evaporators																
Unit IV		FITTING MODEL TO DATA												9		
Fitting Linear Model, Multi-Linear Models, Matrix representation of Multi Linear Model, Fitting Quadratic Model, Cubic Model and Polynomial model using Regression, Power Law models. Performance Criteria to check quality of model, Co-efficient of Determination (R ²)																
Unit V		SIMULATION OF BASIC MODELS												9		
MATLAB/Simulink - Introduction, Basic components, Operational Blocks, Examples - Gravity flow tank, Three CSTR's in series, Numerical solution of model using RK4, Euler's explicit and implicit techniques, Introduction to ODE 45 solver, Dynamic simulation of simple tank, variable flow tank, enclosed tank with isothermal compression, mixing vessel, mixing vessel with reaction using ODE 45solver.																
Total periods: 45																
Text Books:																
1. Bequette, B. W., Process Dynamics: Modeling, Analysis, and Simulation. Prentice-Hall,2002																
2. Babu, B V., Process Plant Simulation, Oxford University Press, 2004																
3. Jana, A. K., Chemical Process Modeling and Computer Simulation, Second Edition, PrenticeHall India Pvt. Ltd, 2011																
References:																
1. Luyben, W.L.: Process Modeling, Simulation and Control for Chemical Engineers,McGraw Hill, International Student Edition, Second Edition, 1996																
2. Ramirez, W. D., Computational Methods for Process Simulation, Second Edition, ElsevierScience, 1997																
Course Outcomes:													Blooms Taxonomy			
CO1: Understand the fundamentals of modeling and their applications to transport/energy equations, chemical and phase equilibria kinetics													Understand (K2)			
CO2: Associate the model with constitutive relations such as phenomenological laws, rate equations, equations of state, property estimation methods													Apply (3)			
CO3: Create the mathematical models for different unit operations equipments													Understand (K2)			
CO4: Analyze the principles of steady state/unsteady state lumped systems and steady state/unsteady state distributed systems													Understand (K2)			
CO5: Apply relevant solution methods for the mathematical models with relevant initial and/or boundary conditions													Understand (K2)			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	

CO1	2	2	2	2	1	1	1	1	2	1	1	2	2	2	1
CO2	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO3	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO4	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO5	2	2	2	2	2	1	1	1	2	1	1	2	2	2	1
CO Avg.	2	2	2.0	2	1.8	1	1	1	2	1	1	2	2	2	1

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CHE028	PINCH ANALYSIS AND HEAT EXCHANGER NETWORK DESIGN	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
• Nil.					
Unit I	INTRODUCTION				9
Pinch analysis, process synthesis, pinch point, composite curves, energy targeting: problem table algorithm, shifted composite curve, capital cost, total cost targeting, process modification					
Unit II	TARGETING				9
Heat exchanger networks, energy targeting, area targeting, unit targeting, shell targeting, cost targeting, super targeting, and continuous targeting					
Unit III	PINCH ANALYSIS				9
Identification of streams, temperature, enthalpy diagram, minimum temperature difference, construction of composite curves, energy cost target, optimum target, design of heat exchanger network					
Unit IV	PINCH DESIGN AND OPTIMIZATION				9
Networks for maximum energy recovery, Pinch design method, flexibility criteria of the pinch, optimization of heat exchanger network, optimality for a minimum area network, Sensitivity analysis					
Unit V	ENERGY AND RESOURCE ANALYSIS OF VARIOUS PROCESSES				9
Batch process, flexible process, distillation process, evaporation process, reaction process, process using mass separating agent, heat pipes and heat pumps					
Total periods: 45					
Text Books:					
1.Kemp, I. C., Pinch Analysis and Process Integration, Second edition, Elsevier, 2006.					
2.Shenoy, V. U., Heat Exchanger network synthesis, Gulf Publishing, 1995					
References:					
1. Douglas, J. M., Conceptual Design of Chemical Process, McGraw Hill, 1988					

Course Outcomes:													Blooms Taxonomy		
CO1. Understand the pinch concept and process thermodynamics													Apply (3)		
CO2: Identify minimum energy targets													Understand (K2)		
CO3: Understand the knowledge of diagrams and energy cost target													Apply (3)		
CO4. Identify different choices and constraint during heat exchange networking													Understand (K2)		
CO5. Apply strategies for retrofitting existing process plant, integration of energy demands of multiple processes													Apply (3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	1	2	2	2	2	1	2	2	1	2
CO2	2	1	2	2	2	1	2	2	2	2	1	2	2	2	2
CO3	2	1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO4	2	1	3	2	2	1	2	2	2	2	2	2	2	2	2
CO5	2	2	3	2	2	1	2	2	2	2	2	2	2	1	2
CO Avg.	2	1.2	2.4	2	2.0	1	2	2	2	2	1.6	2	2	1.6	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHE029	CHEMICAL PROCESS FLOW SHEETING	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites Nil.					
Unit I	FLWSHEETING				9
Introduction, symbols, flowsheet presentation with examples, manual flowsheet calculation, flowsheeting approaches					
Unit II	DECOMPOSITION OF NETWORKS				9
Partitioning and tearing a flowsheet, tearing algorithms based on signal flow graph, algorithms based on reduced graph, comparing various tearing algorithms					
Unit III	SEQUENTIAL MODULAR APPROACH TO FLOW SHEETING				9
Principle of method, convergence of flowsheet using different methods - Newton’s method, direct substitution, Wegstein’s method, dominant Eigenvalue method, quasi Newton method, criteria for acceleration					
Unit IV	FLWSHEETING BY EQUATION SOLVING METHODS				9
Precedence ordering, disjoining, tearing a system of equations, SWS algorithm, maintaining sparsity, solution of system of equations using Newton’s method					

Unit V	CASE STUDIES												9		
Simulation of process flowsheets involving mass recycle, energy recycle, tear stream and design specification, demonstration of open source flowsheeting software															
Total periods: 45															
Text Books:															
1. Babu, B V., Process Plant Simulation, Oxford University Press, 2004															
Course Outcomes:													Blooms Taxonomy		
CO1 – understand the basic concept in preparation of flowsheet													Apply (3)		
CO2 – knowledge on preparing networks													Understand (K2)		
CO3 – understand different approach in flowsheeting													Apply (3)		
CO4 – to learn the flowsheet preparation by equation solving methods													Understand (K2)		
CO5 – Evaluate the case studies using flowsheeting software													Apply (3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	-	-	1	-	1	1	1	2	1	2	2	2	2
CO2	2	-	-	-	2	1	1	1	1	2	1	2	2	2	2
CO3	2	1	2	1	2	1	1	1	1	2	2	2	2	2	2
CO4	2	2	2	1	2	1	1	1	1	2	2	2	2	2	2
CO5	2	2	2	2	2	1	1	1	1	2	2	2	2	2	2
CO Avg.	2	1.7	2.0	1.3	1.8	1	1	1	1	2	1.6	2	2	2	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHE030	COMPUTATIONAL FLUID DYNAMICS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
• Nil.					
Unit I	GOVERNING EQUATIONS				9
Governing equations of fluid flow and heat transfer - Navier-Stokes equations for a Newtonian fluid,Classification of physical behaviour, Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations					
Unit II	TURBULENCE AND ITS MODELLING				9
Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, free turbulent flows, flat plate boundary layer and pipe flow, Turbulence models, mixing length model, The k-omega model, Reynolds stress equation model, algebraic stress equation model					

Unit III	FINITE VOLUME METHOD FOR DIFFUSION PROBLEMS												9		
Introduction to finite volume method, one-dimensional steady state diffusion, two-dimensional diffusion, discretised equations for diffusion problems															
Unit IV	FINITE VOLUME METHOD FOR CONVECTION-DIFFUSION PROBLEMS												9		
Steady one-dimensional convection and diffusion, the central differencing scheme, properties of discretisation schemes - conservativeness, boundedness, transportiveness, Assessment of the central differencing scheme for convection-diffusion problems, The upwind differencing scheme, hybrid differencing scheme, power-law scheme, higher order differencing schemes, quadratic upwind differencing scheme															
Unit V	FINITE VOLUME METHOD FOR UNSTEADY FLOWS												9		
One-dimensional unsteady heat conduction, transient convection-diffusion equation, solution procedure for unsteady flow calculations. Implementation of inlet, outlet and wall boundary conditions, constant pressure boundary condition															
Total periods: 45															
Text Books:															
1.Versteeg H. K. and Malalasekera, W., An introduction to computational fluid dynamics: the finite volume method, Second edition, Pearson, 2008.															
2.Anderson, J. D. Computational fluid dynamics: The Basics with Applications, McGraw-Hill,1995.															
References:															
1. Ranade, V. V., Computational flow modeling for Chemical Reactor Engineering, Academic Press, 2002															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand the basics of CFD and governing equations for conservation of mass momentum and energy													Apply (3)		
CO2: Understand mathematical characteristics of partial differential equations													Understand (K2)		
CO3: learn computational solution techniques for time integration of ordinary differential equations													Apply (3)		
CO4 gain knowledge in various discretization techniques used in CFD													Understand (K2)		
CO5: Understand flow field computation techniques for steady and unsteady flows													Apply (3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO2	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO3	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO4	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO5	2	2	2	2	2	2	1	1	2	2	1	2	2	2	1
CO Avg.	2	2.0	2.0	2.0	2.0	2	1	1	2	2	1	2	2	2	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

VERTICAL - VI
EMERGING TECHNOLOGIES

23CHE031	POLYMER TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	0
Prerequisites					
• NILS					
Unit I					9
Definitions and concepts of terms used in polymer engineering, Classification of polymers; Polymer structures, functionality; polymerization reactions – mechanism of polymerization; stereospecific polymerization, copolymerization					
Unit II					9
Polymerization reactors, polymerization processes, characterization of polymers, analysis of polymerization reactions, polymer degradation					
Unit III					9
Molecular weight and molecular weight distribution in polymers, properties of polymers – physical, chemical, mechanical and electrical properties of polymers, elementary idea on polymer rheology, polymer blends					
Unit IV					9
Polymer processing: modeling – compression & transfer, injection & jet; casting; extrusion, calendaring, lamination, spinning & finishing					
Unit V					9
Processing methods, effect of additives used, plasticizers, colourants, heat stabilizers, antioxidants, ultraviolet absorbers, antistatic agents, flame retardants, blowing agents, fillers etc. Molding techniques for plastics, injection molding, compression molding, calendaring, blow molding, extrusion, thermoforming, spinning methods for fibres, compounding methods for elastomers, general study of elastomer processing methods. rule					
Total periods: 45					
Text Books:					
1. . Text Book of Polymer Science, F. W. Billmeyer, John Wiley, New York 2. Polymer Science & Technology, P.Ghosh, TMC					
2. York 2. Polymer Science & Technology, P.Ghosh, TMC					
References:					
1. The elements of Polymer Science & Engineering, Alfred Rudin, Academic Press, 2nd Edition					
2. Introduction to Polymers, R. J. Young, Chapman & Hall, London					
Course Outcomes:					Blooms Taxonomy
CO1: Understand the basic classifications of polymers, types and kinetics of					Apply (3)

polymerization.															
CO2: Explain the uses and preparations of various polymers.													Understand (K2)		
CO3: Analyze various polymerization techniques.													Understand (K2)		
CO4: Explain the polymer flow properties.													Apply (3)		
CO5: Illustrate the different techniques used to determine the molecular weight of polymers													Apply (3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	2	2	1	2	2	2	1	1	2	2	1
CO2	2	2	1	1	2	2	1	2	2	2	1	1	2	2	1
CO3	2	2	1	1	2	2	1	2	2	2	1	1	2	2	1
CO4	2	2	1	1	2	2	1	2	2	2	1	1	2	2	1
CO5	2	2	1	1	2	2	1	2	2	2	1	1	2	2	1
CO Avg.	2	2.0	1.0	1.0	2.0	2	1	2	2	2	1	1	2	2	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHE032	PROCESS AUTOMATION	Category: PEC			
		L	T	P	C
		3	0	0	0
Prerequisites NIL.					
Unit I					9
Overview of Process Automation: Definition of Process Automation, Benefits of Process Automation, Common Use Cases. Understanding Business Processes: Definition of Business Processes, Types of Business Processes, Process Mapping. Identifying Processes for Automation: Criteria for Process Automation, Process Selection Techniques					
Unit II					9
Process Automation Strategy: Automation Roadmap, Process Reengineering, Process Standardization. Robotic Process Automation (RPA): Definition of RPA, RPA Applications, RPA Tools and Platforms. Business Process Management (BPM): Definition of BPM, BPM Tools and Platforms, BPM vs RPA					
Unit III					9
Artificial Intelligence (AI) and Machine Learning (ML): Definition of AI and ML, AI and ML Applications in Process Automation, AI and ML Tools and Platforms. Integration and Data Management: Integration Platforms, Data Management Tools, Data Analysis and Reporting Tools					

Unit IV													9		
Automation Projects Project Planning and Management: Project Planning Process, Project Management Techniques. Implementation Process: Process Documentation, Testing and Quality Assurance, Change Management															
Unit V													9		
Performance Monitoring and Optimization: Key Performance Indicators (KPIs), Performance Analysis Techniques, Continuous Improvement Strategies. Ethical and Legal Considerations: Ethics of Process Automation, Legal Implications of Process Automation. Case Studies and Best Practices: Case Studies of Successful Digital Automation Implementation, Best Practices in Digital Automation															
Total periods: 45															
References:															
1. H. M. ter Hofstede, W. M. P. Aalst, M. Adams, N. Russell (eds), Modern Business Process Automation: YAWL and its Support Environment, Springer, 1998.															
2. Cichocki, A(S). Helal, M. Rusinkiewicz, D. Woelk, Workflow and Process Automation: Concepts and Technolog, Springer Science, 1998.															
3. H. Mahey, Robotic Process Automation with Automation Anywhere: Techniques to fuel business productivity and intelligent automation using RPA, Packt Publishing, 2020.															
4. Naqvi, J. M. Munoz, Handbook of Artificial Intelligence and Robotic Process Automation Policy and Government Applications, Anthem Press, 2020															
Course Outcomes:												Blooms Taxonomy			
CO 1: Understand the benefits of automation in process selection techniques												Understand (K2)			
CO2: Analyze and differentiate between key process automation tools and platforms												Analyze (K4)			
CO3: Apply data management techniques and integrate automation systems												Apply (K3)			
CO4: Develop a process automation strategy												Understand (K2)			
CO5: Plan and manage process automation projects												Understand (K2)			
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2
CO2	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2
CO3	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2
CO4	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2
CO5	2	2	1	1	2	2	1	2	2	1	1	2	2	1	2
CO Avg.	2	2.0	1.0	1.0	2.0	2	1	2	2	1	1	2	2	1	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHE033	NANOTECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	0
Prerequisites NIL.					
Unit I					9
Introduction to Nanoscience Emergence of Nanoscience with special reference to Feynman and Drexler, Role of particle size, Spatial and temporal scale, Exciton, Concept of confinement, strong and weak confinement with suitable examples, Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot. Density of states of 1D,2D & 3D structure, surface effect					
Unit II					9
Types of Nanomaterials Nanoclusters, Solid solutions, Thin film, Nanocomposites (Metal Oxide and Polymer based), Core Shell Nanostructure, Buckyballs, Carbon nano tubes and, Zeolites minerals, Dendrimers, Micelles, Liposomes, Block Copolymers, Porous Materials, ,Metal Nanocrystals Semiconductor nanomaterials					
Unit III					9
Classification of materials: Metal, Semiconductor, Insulator, Band structures, Brillouin zones, Mobility, resistivity, relaxation time, and recombination centers, Hall effect Quantum Hall effect. Quantum Tunneling , Coulomb Blockade, single electron transistor . Origin of magnetic Moment in materials, Revisit to Different kind of magnetism in nature: Dia, para, ferro magnetic, Domain structure, antiferro, feri & superparamagnetism, nanomagnetic materials: Fe, Fe3O4, Ferrites, Ferro-fluids					
Unit IV					9
Photo-conductivity, Photovoltaic effect, optical absorption & transmission, photoluminescence, fluorescence, phosphorescence, electroluminescence, LED, Concept of phonon, thermal conductivity, specific heat, exothermic & endothermic heat, Thermoelectric effect, Thermoelectric material(TEM) properties					
Unit V					9
Stress- Strain curve, True Stress True strain, Hardness, compressive & tensile strengths, Fracture toughness Fatigue, Creep and other elastic properties of materials, Deformation behavior of Nanomaterials					
Total periods: 45					
Text & Reference Books:					
1.Processing & properties of structural naonmaterials by Leon L. Shaw (editor)					
2.Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al. Wiley VCH Verlag Gmbh & Co, Weinheim					
3.Nanostructure and Nanomaterials: Synthesis , Properties and Application by G. Cao, Imperial College Press, 2004					
Course Outcomes:					Blooms Taxonomy
CO 1: Understand the Fundamentals of Nanoscience and Nanotechnology					Understand (K2)

CO2: Identify and Classify Different Types of Nanomaterials													Understand (K2)		
CO3: Apply the Concepts of Material Classification to Nanomaterials													Apply (K3)		
CO4: Understand the Properties of Nanomaterials Related to Optical and Electrical Phenomena													Understand (K2)		
CO5: Analyze the Mechanical and Deformation Properties of Nanomaterials													Analyze (K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2
CO2	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2
CO3	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2
CO4	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2
CO5	2	2	2	2	2	2	2	2	1	1	2	2	1	2	2
CO Avg.	2	2.0	2.0	2.0	2.0	2	2	2	1	1	2	2	1	2	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHE034	MATERIAL SELECTION	Category: PEC			
		L	T	P	C
		3	0	0	0
Prerequisites					
• NIL.					
Unit I					9
Introduction – classification of engineering materials – selection of materials for engineering purposes -selection of materials and shape -classification metal and alloys, polymers, ceramics and glasses, composites, natural materials,- non metallic materials- smart materials – physical, metrical properties of metals					
Unit II					9
Mechanical properties – fatigue strength – fracture Toughness – Thermal Properties – Magnetic Properties – Fabrication Properties -electrical , optical properties – Environmental Properties , Corrosion properties -shape and size – Material Cost and Availability- failure analysis					
Unit III					9
Interaction of Materials Selection, Design, and Manufacturing Processes – Production Processes and Equipment for Metals – Metal Forming, Shaping, and Casting – Plastic Parts Processing -Composites Fabrication Processes – Advanced Ceramics Processing – surface treatment -Resource -The Price and Availability of Materials					

Unit IV													9		
Interaction of Materials Selection, Design, and Manufacturing Processes – Production Processes and Equipment for Metals – Metal Forming, Shaping, and Casting – Plastic Parts Processing -Composites Fabrication Processes – Advanced Ceramics Processing – surface treatment -Resource -The Price and Availability of Materials															
Unit V													9		
Selection of Materials for Biomedical Applications – Medical Products – Materials in Electronic Packaging – Advanced Materials in Sports Equipment – Materials Selection for Wear Resistance -Advanced Materials in Telecommunications – Using Composites – Manufacture and Assembly with Plastics, fiber and Diamond Films															
Total periods: 45															
Text Books:															
1.Ashby, M. F. Materials selection in mechanical design, 3rd edition. Elsevier, 2005.															
2.Ashby, M. F. and Johnson, K. Materials and design – the art and science of material selection in product design. Elsevier, 2002															
References:															
1.Charles, J. A., Crane, F. A. A. and Furness, J. A. G. Selection and use of engineering materials, 3rd edition. Butterworth-Heinemann, 1997															
2.Handbook of Materials Selection. Edited by Myer Kutz2002 John Wiley and Sons, Inc., NewYork															
Course Outcomes:												Blooms Taxonomy			
CO1: Understand different types of availability materials												Understand (K2)			
CO2: Easy and effective way to select required materials												Understand (K2)			
CO3: Ability to identify the material properties												Apply (K3)			
CO4: Ability to gain knowledge on materials used for equipment design												Understand (K2)			
CO5: Apply the new materials practically												Understand (K2)			
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	1	1	2	1	2	2	2	2	2
CO2	2	2	2	1	2	2	1	1	2	1	2	2	2	2	2
CO3	2	2	1	2	2	2	1	1	1	2	2	1	2	1	2
CO4	3	2	1	1	2	2	1	1	1	1	2	1	2	1	2
CO5	2	2	1	1	2	2	1	1	1	1	2	1	2	1	2
CO Avg.	2.4	2.0	1.4	1.2	2.0	2	1	1	1.4	1.2	2	1.4	2	1.4	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHE035	INDUSTRY 4.0 CONCEPTS												Category: PEC			
													L	T	P	C
													3	0	0	0
Prerequisites																
• NIL.																
Unit I															9	
Introduction to Industry 4.0 Introduction, Idea of Industry 4.0, Various Industrial Revolutions, Origin concept of Industry 4.0, Industry 4.0 Production system, How is India preparing for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory																
Unit II															9	
Trends in Industry 4.0 Introduction, Main Concepts and Components of Industry 4.0, State of Art Technologies, Proposed Framework for Industry 4.0, Trends of Industrial Big Data and Smart Business Transformation																
Unit III															9	
Roadmap for Industry 4.0 Introduction, Proposed Framework for Technology Roadmap: Strategy Phase, Development Phase, Smart Manufacturing, Types of Smart Devices, Smart Logistics, Smart Cities, Predictive Analytics																
Unit IV															9	
Advances in the Era of Industry 4.0 Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Things, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly, IIoT- Industrial IoT																
Unit V															9	
The Role of Industry 4.0 and Future Aspects Introduction, Challenges & Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.																
Total periods: 45																
Reference book:																
(MATERIAL IS READILY AVAILABLE ON INTERNET)																
Course Outcomes:													Blooms Taxonomy			
CO 1: Understand the concept and evolution of Industry 4.0													Understand (K2)			
CO2: Explore the key components and trends of Industry 4.0													Analyze (K4)			
CO3: Develop a technology roadmap for Industry 4.0 adoption													Apply (K3)			
CO4: Investigate advances in automation and robotics in Industry 4.0													Understand (K2)			
CO5: Assess the challenges and future aspects of Industry 4.0													Understand (K2)			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	2	2	1	2	1	2	1	2	1	2	1	3	1	-	
CO2	2	2	2	1	2	1	2	1	2	1	2	1	2	1	-	

CO3	2	2	1	2	2	2	2	2	2	2	2	2	2	2	-
CO4	3	2	1	1	2	1	2	1	2	1	2	1	3	1	-
CO5	2	2	1	1	2	1	2	1	2	1	2	1	2	1	-
CO Avg.	2.4	2.0	1.4	1.2	2.0	1.2	2	1.2	2	1.2	2	1.2	2.4	1.2	-

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CHE036	MINERAL PROCESSING TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	0

Prerequisites

- NIL.

Unit I	9

Definition, Scope and necessity of Mineral Processing, Historical developments and Economics. Physical Properties of Ores and their importance in Mineral Processing. Sampling: Definition, purpose, types of sampling and measurements of accuracy of sampling. Definition of terms – Concentrate, Tailing, Middling, Recovery and Ratio of concentration. Unit operations. Simple problems on estimation of recovery and ratio of concentration. Efficiency and Selectivity index

Unit II	9

Brief introduction of fundamentals of Mineral Processing techniques – Gravity methods, Physicochemical methods and chemical processing. Analysis of separation processes- Thermodynamics, Kinetics, Determination of separability curves, Separation efficiency

Unit III	9

Laboratory Sizing: Definition of particle size, measurement of particle size, Sizing by screening and sub- sieve sizing. Definition of sieve, screen, mesh. Advantages of wet and dry sieving. Graphical representation of size analysis data, size distribution functions and their applications. Industrial screens and their efficiency. Liberation: Definition, importance and application of ore microscopy in liberation studies and its analysis. Methods of liberation and behavior of locked particles.

Unit IV	9

Classification : Principles, Mechanism of classification for sizing, Types ,Performance ,Operation and efficiency of sizing classifiers, problems on circulating load, classifier efficiency and performance curves. Hydrocyclones : Principles, Operation & efficiency of cyclones, types and their industrial application

Unit V	9

Comminution: Definition and basic laws of Comminution, Simple problems on energy estimations. Crushing: Purposes, Mechanism of crushing, types of crushers and their salient features and maintenance of crushers. Grinding: Tumbling mills, Importance of cascading and cataracting, estimation of critical speed of tumbling mills.

Types of tumbling mills, grinding practice, open and closed circuit grinding operations and related problems

Total periods: 45**References:**

1. K.V.G.K Gokhale & T.C.Rao : Ore Deposits of India
2. A.M.Gaudin : Principles of Mineral Dressing
3. B.A.Wills : Mineral Processing Technology
4. S.K.Jain : Ore Processing
5. E.J.Pryor : Mineral Processing
6. A.F.Taggart : Text Book of Ore Dressing
7. A.F.Taggart : Hand Book of Mineral Dressing
8. Kelly & Spottiswood : Introduction to Mineral Processing
9. Robert.H.Richards, Charles Lock & R.Schumann : A Text Book of Ore Dressing
10. Pradeep & Rakesh Kumar : Selected Topics in Mineral Processing

Course Outcomes:**Blooms Taxonomy****CO 1:** Understand comminution processes and apply them in crushing and grinding operations

Understand (K2)

CO2: Evaluate classification and separation equipment efficiency

Understand (K2)

CO3: Analyze particle size and liberation characteristics in mineral processing

Apply (K3)

CO4: Apply basic mineral processing techniques to separation processes

Understand (K2)

CO5: Understand the fundamentals and scope of mineral processing

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	2	1	2	1	2	1	2	2	1	2
CO2	2	2	1	2	1	2	1	2	1	2	1	2	2	1	2
CO3	2	1	2	2	2	2	2	2	2	2	2	2	1	2	2
CO4	2	1	1	2	1	2	1	2	1	2	1	2	1	1	2
CO5	2	1	1	2	1	2	1	2	1	2	1	2	1	1	2
CO Avg.	2	1.4	1.2	2.0	1.2	2	1.2	2	1.2	2	1.2	2	1.4	1.2	2

1 - Low, 2 - Medium, 3 - High , '-' No correlation

OPEN ELECTIVE I AND II

23CSO001	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites					
Course Objectives: The main objectives of this course are to: - Understand the importance, principles, and search methods of AI, - Provide knowledge on predicate logic and Prolog. - Introduce machine learning fundamentals - Study of supervised learning algorithms. - Study about unsupervised learning algorithms.					
Unit I	INTELLIGENT AGENT AND UNINFORMED SEARCH				6
Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform-cost search - Depth First Search - Depth Limited Search					
Unit II	PROBLEM SOLVING WITH SEARCH TECHNIQUES				6
Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning - Constraint Satisfaction Problems (CSP) - Examples - Map Coloring - Job Scheduling - Backtracking Search for CSP					
Unit III	LEARNING				6
Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation, Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression					
Unit IV	SUPERVISED LEARNING				6
Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM)					
Unit V	UNSUPERVISED LEARNING				6
Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering					

algorithms – k-means algorithm

LIST OF EXPERIMENTS

1	Programs for Problem solving with Search - Implement breadth first search - Implement depth first search - Analysis of breadth first and depth first search in terms of time and space - Implement and compare Greedy and A* algorithms.
2	Supervised learning - Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs - Write a program to demonstrate the working of the decision tree based algorithm. - Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets. - Write a program to implement the naïve Bayesian classifier.
3	Unsupervised learning - Implementing neural network using self-organizing maps - Implementing k-Means algorithm to cluster a set of data. - Implementing hierarchical clustering algorithm.

Lecture : 30**Practical : 30****Total periods:60****Text Books:**

1. S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd ed,

References:

- 1.Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997.
- 2.I. Bratko, “Prolog: Programming for Artificial Intelligence”, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
- 3.C. Muller & Sarah Alpaydin, Ethem. Introduction to machine learning. MIT press, 2020.

Course Outcomes:**Blooms Taxonomy**

CO1: Understand the foundations of AI and the structure of Intelligent Agents	Understand (K2)
CO2: Use appropriate search algorithms for any AI problem	Apply (K3)
CO3: Study of learning methods	Understand (K2)
CO4: Solving problem using Supervised learning	Apply (K3)
CO5: Solving problem using Unsupervised learning.	Apply (K3)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	–	–	–	1	2	–	2	3	2	–	2
CO2	3	3	3	2	2	–	–	–	1	2	–	2	3	3	3
CO3	2	2	1	2	1	–	–	–	1	2	–	2	2	2	2
CO4	3	3	3	3	2	–	–	–	1	2	–	2	3	3	3
CO5	3	2	3	3	2	–	–	–	1	2	–	2	3	3	3
CO Avg.	2.6	2.2	2.2	2.2	1.75	-	-	1	1.2	2	2	2.2	2.6	2.75	2.6
1 - Low, 2 - Medium, 3 - High, '–' No correlation															

23CSO002	IOT CONCEPTS AND APPLICATIONS	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites					
Course Objectives: - To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT - To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms. - To introduce the technologies behind Internet of Things(IoT). - To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform. - To apply the concept of Internet of Things in real world scenario.					
Unit I	INTRODUCTION TO INTERNET OF THINGS				5
Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT					
Unit II	COMPONENTS IN INTERNET OF THINGS				5
Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)					
Unit III	PROTOCOLS AND TECHNOLOGIES BEHIND IOT				6
IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics,					

Cloud Computing, Embedded Systems.

Unit IV	OPEN PLATFORMS AND PROGRAMMING	7
IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.		
Unit V	IOT APPLICATIONS	7
Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture		
LIST OF EXPERIMENTS		
1	Introduction to Arduino platform and programming	
2	Interfacing Arduino to Zigbee module	
3	Interfacing Arduino to GSM module	
4	Interfacing Arduino to Bluetooth Module	
5	Introduction to Raspberry PI platform and python programming	
6	Interfacing sensors to Raspberry PI	
7	Communicate between Arduino and Raspberry PI using any wireless medium	
8	Setup a cloud platform to log the data	
9	Log Data using Raspberry PI and upload to the cloud platform	
10	Design an IOT based system	
Lecture : 30 Practical : 30 Total periods:60		
Text Books:		
1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, CISCO Press, 2017		
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015		
References:		
1. Perry Lea, “Internet of things for architects”, Packt, 2018		
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012		
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.		
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.		
5. ArshdeepBahga, Vijay Madiseti, “Internet of Things – A hands-on approach”, Universities Press, 2015		

6. <https://www.arduino.cc/>
[https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet.](https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet)

Course Outcomes:													Blooms Taxonomy		
CO 1: Explain the concept of IoT.													Understand (K2)		
CO2: Understand the communication models and various protocols for IoT.													Understand (K2)		
CO3: Design portable IoT using Arduino/Raspberry Pi /open platform													Analyze(K4)		
CO4: Apply data analytics and use cloud offerings related to IoT.													Apply (K3)		
CO5: Analyze applications of IoT in real time scenario.													Analyze(K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	1	–	–	2	–	2	2	2	1	3
CO2	3	3	2	2	2	–	–	–	–	2	–	2	3	2	3
CO3	2	2	3	3	3	–	–	–	1	2	–	2	3	3	2
CO4	2	2	2	3	3	–	–	–	1	2	–	3	3	3	2
CO5	2	3	2	2	2	2	2	1	1	2	–	3	3	3	2
CO Avg.	2.4	2.2	2	2.2	2.2	1.5	2	1	1.25	2	2	2.4	2.8	2.4	2.4
1 - Low, 2 - Medium, 3 - High , ‘–’ No correlation															

23CSO003	DATA SCIENCE FUNDAMENTALS	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites					
•					
Course Objectives:					
• Familiarize students with the data science process. • Understand the data manipulation functions in Numpy and Pandas. • Explore different types of machine learning approaches. • Understand and practice visualization techniques using tools. • Learn to handle large volumes of data with case studies.					
Unit I	INTRODUCTION				6
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – data preparation - Exploratory Data analysis – build the model – presenting findings and building applications - Data Mining - Data Warehousing – Basic statistical descriptions of Data.					

Unit II	DATA MANIPULATION	9
Python Shell - Jupyter Notebook - IPython Magic Commands - NumPy Arrays-Universal Functions – Aggregations – Computation on Arrays – Fancy Indexing – Sorting arrays – Structured data – Data manipulation with Pandas – Data Indexing and Selection – Handling missing data – Hierarchical indexing – Combining datasets – Aggregation and Grouping – String operations – Working with time series – High performance		
Unit III	MACHINE LEARNING	5
The modeling process - Types of machine learning - Supervised learning - Unsupervised learning - Semi-supervised learning- Classification, regression - Clustering – Outliers and Outlier Analysis		
Unit IV	DATA VISUALIZATION	5
Importing Matplotlib – Simple line plots – Simple scatter plots – visualizing errors – density and contour plots – Histograms – legends – colors – subplots – text and annotation – customization – three dimensional plotting - Geographic Data with Basemap - Visualization with Seaborn		
Unit V	HANDLING LARGE DATA	5
Problems - techniques for handling large volumes of data - programming tips for dealing with large data sets- Case studies: Predicting malicious URLs, Building a recommender system - Tools and techniques needed - Research question - Data preparation - Model building – Presentation and automation.		
LIST OF EXPERIMENTS		
1	Download, install and explore the features of Python for data analytics.	
2	Working with Numpy arrays	
3	Working with Pandas data frames	
4	Basic plots using Matplotlib	
5	Statistical and Probability measures a) Frequency distributions b) Mean, Mode, Standard Deviation c) Variability d) Normal curves e) Correlation and scatter plots f) Correlation coefficient g) Regression	
6	Use the standard benchmark data set for performing the following: a)Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis.	
7	Apply supervised learning algorithms and unsupervised learning algorithms on any data set.	
8	Apply and explore various plotting functions on any data set.	
Lecture : 30 Practical : 30 Total periods: 60		

Text Books:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, "Introducing Data Science", Manning Publications, 2016.

2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly, 2016.

References:

1. Robert S. Witte and John S. Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017.

2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.

Course Outcomes:**Blooms Taxonomy**

CO 1: Gain knowledge on data science process.

Understand (K2)

CO2: Perform data manipulation functions using Numpy and Pandas.

Understand (K2)

CO3: Understand different types of machine learning approaches.

Understand (K2)

CO4: Perform data visualization using tools.

Apply (K3)

CO5: Handle large volumes of data in practical scenarios.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	–	–	–	–	2	–	2	2	2	1
CO2	3	3	2	2	3	–	–	–	–	2	–	2	3	3	1
CO3	3	3	2	2	3	–	–	–	–	2	–	2	3	3	1
CO4	2	2	3	3	3	–	–	–	1	2	–	2	3	3	2
CO5	2	3	3	3	3	–	–	–	1	2	–	3	3	3	2
CO Avg.	2.6	2.8	2.2	2.2	2.6	-	-	-	1	2	-	2.2	2.8	2.8	1.4

1 - Low, 2 - Medium, 3 - High, '–' No correlation

23CSO004	AUGMENTED AND VIRTUAL REALITY	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites					
Course Objectives: - To impart the fundamental aspects and principles of AR/VR technologies. - To know the internals of the hardware and software components involved in the development of AR/VR enabled applications. - To learn about the graphical processing units and their architectures. - To gain knowledge about AR/VR application development. - To know the technologies involved in the development of AR/VR based applications.					
Unit I	INTRODUCTION				7
Introduction to Virtual Reality and Augmented Reality – Definition – Introduction to Trajectories and Hybrid Space- Three I’s of Virtual Reality – Virtual Reality Vs 3D Computer Graphics – Benefits of Virtual Reality – Components of VR System – Introduction to AR-AR Technologies-Input Devices – 3D Position Trackers – Types of Trackers – Navigation and Manipulation Interfaces – Gesture Interfaces – Types of Gesture Input Devices – Output Devices – Graphics Display – Human Visual System – Personal Graphics Displays – Large Volume Displays – Sound Displays – Human Auditory System.					
Unit II	VR MODELING				6
Modeling – Geometric Modeling – Virtual Object Shape – Object Visual Appearance – Kinematics Modeling – Transformation Matrices – Object Position – Transformation Invariants –Object Hierarchies – Viewing the 3D World – Physical Modeling – Collision Detection – Surface Deformation – Force Computation – Force Smoothing and Mapping – Behavior Modeling – Model Management.					
Unit III	VR PROGRAMMING				6
VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D					
Unit IV	APPLICATIONS				6
Human Factors in VR – Methodology and Terminology – VR Health and Safety Issues – VR and Society-Medical Applications of VR – Education, Arts and Entertainment – Military VR Applications – Emerging Applications of VR – VR Applications in Manufacturing – Applications of VR in Robotics – Information Visualization – VR in Business – VR in Entertainment – VR in Education.					
Unit V	AUGMENTED REALITY				5
Introduction to Augmented Reality-Computer vision for AR-Interaction-Modelling and Annotation- Navigation-					

Wearable devices

LIST OF EXPERIMENTS

1	Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2	Use the primitive objects and apply various projection types by handling camera.
3	Download objects from asset store and apply various lighting and shading effects.
4	Model three dimensional objects using various modelling techniques and apply textures over them.
5	Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6	Add audio and text special effects to the developed application.
7	Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8	Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
9	Develop AR enabled simple applications like human anatomy visualization, DNA/RNA structure visualization and surgery simulation.
10	Develop simple MR enabled gaming applications.

Lecture : 30**Practical : 30****Total periods: 60****Text Books:**

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016
3. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
4. William R. Sherman, Alan B. Craig: Understanding Virtual Reality – Interface, Application, Design", Morgan Kaufmann, 2003

References:

1. **Steven M. LaValle**, *Virtual Reality*, Cambridge University Press, 2017.
2. **William R. Sherman & Alan B. Craig**, *Understanding Virtual Reality: Interface, Application, and Design*, 2nd Edition, Morgan Kaufmann, 2019.
3. **Doug Bowman, Ernst Kruijff, Joseph J. LaViola, Ivan Poupyrev**, *3D User Interfaces: Theory and Practice*, Addison-Wesley, 2005.

Course Outcomes:**Blooms Taxonomy**

CO 1: Understand the basic concepts of AR and VR	Understand (K2)
CO2: Understand the tools and technologies related to AR/VR	Understand (K2)
CO3: Working principle of AR/VR related Sensor devices	Understand (K2)
CO4: Design of various models using modeling techniques	Apply (K3)

CO5: Develop AR/VR applications in different domains.													Apply (K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
CO2	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
CO3	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
CO4	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
CO5	3	3	3	3	3	-	-	-	3	3	3	3	3	3	3
CO Avg.	2.6	2.8	2.2	2.2	2.6	-	-	-	1	2	-	2.2	2.8	2.8	1.4
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

OPEN ELECTIVE III

23HSO001	ENGLISH FOR COMPETITIVE EXAMINATIONS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
- Course Objectives: - To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS). - To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests. - To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing. - To improve students’ confidence to express their ideas and opinions in formal contexts - To create awareness of accuracy and precision in communication					
UNIT I	Vocabulary and Verbal Skills				9
Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.					
UNIT II	Grammar and Sentence Structure				9
Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles –					

Clauses – Speech patterns.																
UNIT III		Reading Comprehension and Critical Reading												9		
Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.																
UNIT IV		Writing Skills and Composition												9		
Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.																
Unit V		Listening and Speaking Skills												9		
Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.																
Total periods:45																
Text Books:																
1. R.P.Bhatnagar - General English for Competitive Examinations. Macmillan India Limited, 2009.																
References:																
1.Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.																
2.The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.																
3.R Rajagopalan- General English for Competitive Examinations, McGraw Hill Education (India) Private Limited, 2008.																
Course Outcomes:													Blooms Taxonomy			
CO 1: Expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required													Understand(K2)			
CO2: Identify errors with precision and write with clarity and coherence													Analyze(K4)			
CO3: Understand the importance of task fulfilment and the usage of task-appropriate vocabulary													Understand(K2)			
CO4: Communicate effectively in group discussions, presentations and interviews													Understand(K2)			
CO5: Write topic based essays with precision and accuracy													Understand(K2)			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	1	3	3	1	3	3	3	3	1	3	1	3	-	-	-	

CO2	2	3	3	2	3	3	3	3	1	3	3	3	-	-	-
CO3	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
CO4	2	2	2	2	2	2	2	2	3	3	3	3	-	-	-
CO5	2	2	2	2	2	2	2	2	2	3	2	3	-	-	-
CO Avg.	2	2.6	2.6	2	2.6	2.6	2.6	2.6	2	3	2.4	3	2.8	2.8	1.4
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23MGO001	NGOS AND SUSTAINABLE DEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - to understand the importance of sustainable development - to acquire a reasonable knowledge on the legal frameworks pertaining to pollution control and environmental management - to comprehend the role of NGOs in attaining sustainable development					
UNIT I	ENVIRONMENTAL CONCERNS				9
Introduction to sustainable development goals, Global responsibility of environmental concern, Importance of environmental preservation, Environmental threats, Pollution and its types, Effects of Pollution, Pollution control, Treatment of wastes					
UNIT II	ROLE OF NGOS				9
Role of NGO’s in national development, NGO’s and participatory management, Challenges and limitations of NGO’s, Community Development programmes, Role of NGO’s in Community Development programmes, Participation of NGO’s in environment management, Corporate Social responsibility, NGO’s and corporate social responsibility					
UNIT III	SUSTAINABLE DEVELOPMENT				9
Issues and Challenges of Sustainable Development, Bioenergy, Sustainable Livelihoods and Rural Poor in Sustainable Development, Protecting ecosystem services for sustainable development, Non-renewable sources of energy and its effect, Renewable sources of energy for sustainability, Nuclear resources and Legal Regulation of Hazardous Substances, Sustainable Development: Programme and Policies, Sustainability assessment and Indicators					
UNIT IV	NGO’S FOR SUSTAINABILITY				9
Civil Society Initiatives in Environment Management, Civil Society Initiatives for Sustainable Development, Global Initiatives in Protecting Global Environment, World Summit on Sustainable Development (Johannesburg Summit 2002), Ecological economics, Environmental sustainability, Social inclusion, Health for all, education for all, Food					

security and Water security, NGOs and Sustainable Development strategies

UNIT V	LEGAL FRAMEWORKS	9

Need for a Legal framework and its enforcement, Legal measures to control pollution, Environmental Legislations in India, Mechanism to implement Environmental Laws in India, Legal Protection of Forests Act 1927, Legal Protection of Wild Life, Role of NGO's in implementing environmental laws, Challenges in the implementation of environmental legislation

Total periods: 45

Text Books:

1. Kulsange, S and Kamble, R. (2019). *Environmental NGOs: Sustainability Stewardship*. Lap Lambert Academic Publishing, India. ISBN: 978-6200442444.

2 .Dodds, F. (2007). *NGO Diplomacy: The Influence of Nongovernmental Organizations in International Environmental Negotiations*. MIT Press, Cambridge. ISBN: 978-0262524766.

3 .Ghosh, S. (Ed.). (2019). *Indian Environmental Law: Key Concepts and Principles*. Orient BlackSwan, India. ISBN: 978-9352875795.

References:

1. Kulsange, S and Kamble, R. (2019). *Environmental NGO's: Sustainability Stewardship*, Lap Lambert Academic Publishing, India, ISBN-13: 978-6200442444.

2.Dodds, F. (2007). *NGO diplomacy: The influence of nongovernmental organizations in international environmental negotiations*. Mit Press, Cambridge, ISBN-13: 978-0262524766.

3. Ghosh, S. (Ed.). (2019). *Indian environmental law: Key concepts and principles*. Orient BlackSwan, India, ISBN-13: 978-9352875795.

4. Alan Fowler and Chiku Malunga (2010) *NGO Management: The Earthscan Companion*, Routledge, ISBN-13 : 978-1849711197.

Course Outcomes:

Blooms Taxonomy

CO1: Have a thorough grounding on the issues and challenges being faced in attaining sustainable development

Analyze(K4)

CO2: Have a knowledge on the role of NGOs towards sustainable developemnt

Understand(K2)

CO3: Present strategies for NGOs in attaining sustainable development

Apply(K3)

CO4: Recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment

Understand(K2)

CO5: Understand the environmental legislations.

Understand(K2)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	–	2	2	2	–	–	2	–	2	3	2	–
CO2	3	2	2	2	2	–	2	–	–	2	–	2	3	2	–
CO3	2	2	3	3	3	–	2	–	–	2	–	2	3	3	2
CO4	2	2	2	2	2	3	3	2	–	2	–	2	3	2	–
CO5	3	2	2	2	2	–	2	–	–	2	–	2	3	2	–
CO Avg.	2.6	2.2	2.2	2.25	2.2	2.5	2.2	2	-	2	-	2	3	2.2	2
1 - Low, 2 - Medium, 3 - High , ‘–’ No correlation															

23MGO002	DEMOCRACY AND GOOD GOVERNANCE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To understand the role and functioning of regulatory and lobbying institutions - To explore contemporary political economy and development models in India - o analyze the dynamics of civil society and its impact on governance.					
Unit I					9
Regulatory Institutions – SEBI, TRAI, Competition Commission of India					
Unit II					9
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.					
Unit III					9
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.					
Unit IV					9
Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E- governance					
Unit V					9
Dynamics of Civil Society: New Social Movements, Role of NGO’s, Understanding the political significance of Media and Popular Culture.					
Total periods:45					
Text Books:					
1. tul Kohli (ed.), <i>The Success of India’s Democracy</i> , Cambridge University Press, 2001.					

2. Corbridge, Stuart and John Harris, *Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy*, Oxford University Press, 2000.

3. J. Dreze and A. Sen, *India: Economic Development and Social Opportunity*, Clarendon, 1995

References:

1. Atul Kohli (ed.): *The Success of India's Democracy*, Cambridge University Press, 2001.

2. Corbridge, Stuart and John Harris: *Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy*, Oxford University Press, 2000.

3. J. Dreze and A. Sen, *India: Economic Development and Social Opportunity*, Clarendon, 1995.

4. Saima Saeed: *Screening the Public Sphere: Media and Democracy in India*, 2013

5. Himat Singh: *Green Revolution Reconsidered: The Rural World of Punjab*, OUP, 2001.

6. Jagdish Bhagwati: *India in Transition: Freeing The Economy*, 1993.

7. Smitu Kothari: *Social Movements and the Redefinition of Democracy*, Boulder, Westview, 1993.

Course Outcomes:	Blooms Taxonomy
CO 1: Understand the role of regulatory institutions like SEBI, TRAI, Competition Commission	Understand (K2)
CO2: Examine the role of lobbying institutions such as trade unions, chambers, farmers' associations	Analyze (K4)
CO3: Understand contemporary political economy and policy debates on development	Understand (K2)
CO4: Analyze trends in liberalization, e-governance, and sectoral reforms	Analyze (K4)
CO5: Understand the dynamics of civil society, media, NGOs, and social movements	Understand (K2)

CO - PO & PSO Mapping:

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	-	-	-	-	-	-	-	-	2	-	-
CO2	2	2	3	2	2	-	2	-	-	-	-	-	2	-	-
CO3	2	2	2	2	2	-	-	-	-	-	-	-	2	-	-
CO4	2	2	2	2	2	-	-	-	-	-	-	-	2	-	-
CO5	2	2	3	2	2	-	2	-	-	-	-	-	2	-	-
CO Avg.	2	2	2.4	2	2	-	2	-	-	-	-	-	2	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23EE0001	RENEWABLE ENERGY TECHNOLOGIES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To know the Indian and global energy scenario - To learn the various solar energy technologies and its applications. - To educate the various wind energy technologies. - To explore the various bio-energy technologies. - To study the ocean and geothermal technologies.					
Unit I	ENERGY SCENARIO				9
Indian energy scenario in various sectors — domestic, industrial, commercial, agriculture, transportation and others — Present conventional energy status — Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans					
Unit II	SOLAR ENERGY				9
Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems — Solar PV applications.					
Unit III	WIND ENERGY				9
Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance — Hybrid systems — Environmental issues - Applications					
Unit IV	BIO-ENERGY				9
Bio resources — Biomass direct combustion — thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration — Carbonisation — Pyrolysis - Biogas plants — Digesters –Biodiesel production — Ethanol production - Applications					
Unit V	OCEAN AND GEOTHERMAL ENERGY				9
Small hydro - Tidal energy — Wave energy — Open and closed OTEC Cycles — Limitations — Geothermal energy — Geothermal energy sources - Types of geothermal power plants — Applications - Environmental impact.					
Total periods: 45					
Text Books:					
1. Fundamentals and Applications of Renewable Energy Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636.					

2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

References:

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012
2. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014
3. Sukhatme.S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015

Course Outcomes:													Blooms Taxonomy		
CO1: Discuss the Indian and global energy scenario													Analyze(K4)		
CO2: Describe the various solar energy technologies and its applications.													Analyze(K4)		
CO3: Explain the various wind energy technologies													Understand(K2)		
CO4: Explore the various bio-energy technologies													Understand(K2)		
CO5: Discuss the ocean and geothermal technologies.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
CO2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
CO3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
CO4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
CO5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
CO Avg.	2.4	2.2	2.4	2.2	2	2.6	2.4	2.2	2.6	3	2.6	3	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO001	APPLIED DESIGN THINKING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Introduce tools & techniques of design thinking for innovative product - development Illustrate customer-centric product innovation using on simple - use cases Demonstrate development of Minimum usable Prototypes - Outline principles of solution concepts & their evaluation - Describe system thinking principles as applied to complex systems					
UNIT I	DESIGN THINKING PRINCIPLES				9
Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies					
UNIT II	ENDUSER-CENTRIC INNOVATION				9
Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and field visit					
UNIT III	APPLIED DESIGN THINKING TOOLS				9
Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design					
UNIT IV	CONCEPT GENERATION				9
Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts					
UNIT V	SYSTEM THINKING				9
System Thinking, Understanding Systems, Examples and Understandings, Complex Systems					
Total periods: 45					
Text Books:					
1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley.					
2.Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value					

3. Proposition Design: How to Create Products and Services Customers Want, Wiley

4. Donella H. Meadows, (2015), "Thinking in Systems -A Primer", Sustainability Institute.

5. Tim Brown, (2012) "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Business.

References:

1. <https://www.ideo.com/pages/design-thinking#process>

2. <https://blog.forgefor ward.in/valuation-risk-versus-validation-risk-in-product-innovations-49f253ca8624>

3. <https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356>

4. <https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e>

5. <https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd>

6. <https://blog.forgefor ward.in/star-tup-failure-is-like-true-lie-7812cdfe9b85>

Course Outcomes:

Blooms Taxonomy

CO 1: Apply design thinking principles to human-centered innovation

Apply (K3)

CO2: Conduct end-user research and create user personas and stories

Apply (K3)

CO3: Design and test Minimum Usable Prototypes (MUPs)

Apply (K3)

CO4: Generate and evaluate solution concepts using systematic approaches

Analyze (K4)

CO5: Apply system thinking to understand complex problems and solutions.

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	1	-	-	-	1	2	2	-	-	2	-	-
CO2	2	3	3	2	1	-	-	-	1	2	2	-	3	-	-
CO3	3	2	3	2	1	2	2	2	2	3	2	-	3	-	-
CO4	3	2	3	3	2	2	2	2	2	3	2	-	3	-	-
CO5	2	2	2	3	2	2	2	2	2	2	2	-	2	-	-
CO Avg.	2.4	2.4	2.6	2.2	1.5	2	2	1.75	1.8	2.4	2	-	2.6	-	-

1 - Low, 2 - Medium, 3 - High, '-' - No correlation

23MEO002	REVERSE ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - The main learning objective of this course is to prepare students for: - Applying the fundamental concepts and principles of reverse engineering in product design and development. - Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development. - Applying the concept and principles of material identification and process verification in reverse engineering of product design and development. - Analysing the various legal aspect and applications of reverse engineering in product design and development. - Understand about 3D scanning hardware & software operations and procedure to generate 3D model					
Unit I	INTRODUCTION & GEOMETRIC FORM				9
Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement – Prototyping.					
Unit II	MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION				9
Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength – Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.					
Unit III	DATA PROCESSING				9
Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis – Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility.					
Unit IV	3D SCANNING AND MODELLING				9
Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.					
Unit V	INDUSTRIAL APPLICATIONS				9
Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry. Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent – Copyrights –Trade Secret – Third-Party Materials.					

Total periods: 45**Text Books:**

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014

2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011

References:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022

2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001

3. Kathryn, A. Ingle, "Reverse Engineering", McGraw-Hill, 1994.

4. Linda Wills, "Reverse Engineering", Kluwer Academic Publishers, 1996

5. Vinesh Raj and Kiran Fernandes, "Reverse Engineering: An Industrial Perspective", Springer- Verlag London Limited 2008.

Course Outcomes:**Blooms Taxonomy**

CO1: Apply the fundamental concepts and principles of reverse engineering in product design and development.

Apply(K3)

CO2: Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.

Apply(K3)

CO3: Apply the concept and principles of material identification and process verification in reverse engineering of product design and development

Apply(K3)

CO4: Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development

Apply(K3)

CO5: Analyze the various legal aspect. Applications of reverse engineering in product design and development.

Analyze(K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	2	2	2	2	-	3	2	-	2	1	-
CO2	3	2	3	2	1	2	-	2	2	2	2	-	3	2	3
CO3	3	2	3	2	1	2	-	2	2	2	2	-	3	2	3
CO4	3	2	3	2	1	2	-	2	2	2	2	-	3	2	3
CO5	2	2	2	1	1	-	-	2	2	2	2	-	2	2	2
CO Avg.	2.6	1.8	2.75	1.75	1.2	2	2	2	2	2.2	2	-	2.6	1.8	2.75

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23MEO003	SUSTAINABLE MANUFACTURING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives:					
- To be acquainted with sustainability in manufacturing and its evaluation. - To provide knowledge in environment and social sustainability. - To provide the student with the knowledge of strategy to achieve sustainability. - To familiarize with trends in sustainable operations. - To create awareness in current sustainable practices in manufacturing industry.					
Unit I	ECONOMIC SUSTAINABILITY				9
Industrial Revolution-Economic sustainability: globalization and international issues Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability					
Unit II	SOCIAL AND ENVIRONMENTAL SUSTAINABILITY				9
Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability.					
Unit III	SOCIAL AND ENVIRONMENTAL SUSTAINABILITY				9
Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers - Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model.					
Unit IV	MANUFACTURING STRATEGY FOR SUSTAINABILITY				9
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.					
Unit V	TRENDS IN SUSTAINABLE OPERATIONS				9
Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.					
Total periods:45					

Text Books:

1. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.

2. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.

References:

1. Jovane F, Emper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer, 2009, United States, ISBN 978-3-540-77011-

2. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.

3. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

Course Outcomes:**Blooms Taxonomy**

CO 1: Discuss the importance of economic sustainability

Understand(K2)

CO2: Describe the importance of sustainable practices

Understand(K2)

CO3: Identify drivers and barriers for the given conditions.

Analyze(K4)

CO4: Formulate strategy in sustainable manufacturing

Understand(K2)

CO5: Plan for sustainable operation of industry with environmental, cost consciousness.

Apply(K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2		-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO Avg.	3	-	2.6	-	-	-	2	2.3	-	1	1	2	1.6	2	1.4

1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation

23EEO002	ELECTRIC AND HYBRID VEHICLES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: The objective of this course is to prepare the students to know about the general aspects of Electric and Hybrid Vehicles (EHV), including architectures, modelling, sizing, and sub system design and hybrid vehicle control.					
Unit I	DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES				9
Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.					
Unit II	ENERGY SOURCES				9
Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.					
Unit III	MOTORS AND DRIVES				9
Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.					
Unit IV	POWER CONVERTERS AND CONTROLLERS				9
Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes					
Unit V	HYBRID AND ELECTRIC VEHICLES				9
Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.					
Total periods:45					
Text Books:					
1.Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003					
2.Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRCPress,2005.					
References:					
1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003					
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005					

3. Ron HodKinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the operation and architecture of electric and hybrid vehicles													Understand(K2)		
CO2: Identify various energy source options like battery and fuel cell													Analyze(K4)		
CO3: Select suitable electric motor for applications in hybrid and electric vehicles.													Analyze(K4)		
CO4: Explain the role of power electronics in hybrid and electric vehicles													Understand(K2)		
CO5: Analyse the energy and design requirement for hybrid and electric vehicles.													Analyze(K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
CO2	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
CO3	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
CO4	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
CO5	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
CO Avg.	1	1	2	1	-	3	2	-	-	-	-	2	-	1	3
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23ECO002	SPACE ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Use the standard atmosphere tables and equations. - Find lift and drag coefficient data from NACA plots. - Apply the concept of static stability to flight vehicles. - Describe the concepts of stress, strain, Young’s modulus, Poisson’s ratio, yield strength. - Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.					
Unit I	STANDARD ATMOSPHERE				9
History of aviation – standard atmosphere - pressure, temperature and density altitude.					
Unit II	AERODYNAMICS				9
Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag					

coefficients using NACA data.

UNIT III	PERFORMANCE AND PROPULSION	9

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -thrust/power available and thrust/power required.

UNIT IV	AIRCRAFT STABILITY AND STRUCTURAL THEORY	9

Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke's Law- brittle and ductile materials - moment of inertia - section modulus.

UNIT V	SPACE APPLICATIONS	9

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

Total periods:45

Text Books:

1. John D. Anderson, Introduction to Flight, 8 th Ed., McGraw-Hill Education, New York, 2015.
2. E Rathakrishnan, "Introduction to Aerospace Engineering: Basic Principles of Flight", John Wiley, NJ, 2021.
3. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics, 1997.

References:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

Course Outcomes:	Blooms Taxonomy
CO 1: Illustrate the history of aviation & developments over the years	Understand(K2)
CO2: Ability to identify the types & classifications of components and control systems	Analyze(K4)
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere	Understand(K2)
CO4: Identify the types of fuselage and constructions.	Analyze(K4)
CO5: Distinguish the types of Engines and explain the principles of Rocket	Understand(K2)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	3	2	-	-	2	-	2	2	-	-	2	2	-
CO3	2	1	2	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	3	2	-	-	2	-	2	2	-	-	2	2	-
CO5	2	1	2	-	-	-	-	-	2	1	-	-	2	1	-
CO Avg.	2.4	1.5	2.2	2	-	-	2	-	2	1.6	-	-	1.6	1.6	-

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23MGO004	INDUSTRIAL MANAGEMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To introduce fundamental concepts of industrial management - To understand the approaches to the study of Management - To learn about Decision Making, Organizing and leadership - To analyze the Managerial Role and functions - To know about the Supply Chain Management					
UNIT I	INTRODUCTION				9
Technology Management - Definition - Functions - Evolution of Modern Management - Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization -Individual Ownership - Partnership - Joint Stock Companies - Co-operative Enterprises - Public Sector Undertakings, Corporate Frame Work- Share Holders - Board of Directors - Committees - Chief Executive Line and Functional Managers,- Financial-Legal-Trade Union					
UNIT II	FUNCTIONS OF MANAGEMENT				9
Planning - Nature and Purpose - Objectives - Strategies – Policies and Planning Premises - Decision Making - Organizing - Nature and Process - Premises - Departmentalization - Line and staff - Decentralization -Organizational culture, Staffing - selection and training .Placement - Performance appraisal - Career Strategy – Organizational Development. Leading - Managing human factor - Leadership .Communication, Controlling - Process of Controlling - Controlling techniques, productivity and operations management - Preventive control, Industrial Safety.					
UNIT III	ORGANIZATIONAL BEHAVIOUR				9
Definition - Organization - Managerial Role and functions -Organizational approaches, Individual behaviour - causes - Environmental Effect - Behaviour and Performance, Perception - Organizational Implications. Personality - Contributing factors - Dimension – Need Theories - Process Theories - Job Satisfaction, Learning and Behaviour- Learning Curves, Work Design and approaches.					
Unit IV	GROUPDYNAMICS				9
Group Behaviour - Groups - Contributing factors - Group Norms, Communication - Process - Barriers to communication - Effective communication, leadership - formal and informal characteristics – Managerial Grid - Leadership styles - Group Decision Making - Leadership Role in Group Decision, Group Conflicts - Types -Causes - Conflict Resolution -Inter group relations and conflict, Organization centralization and decentralization - Formal and informal - Organizational Structures Organizational Change and Development -Change Process – Resistance to Change - Culture and Ethics					

Unit V	MODERN CONCEPTS												9		
Management by Objectives (MBO) - Management by Exception (MBE),Strategic Management - Planning for Future direction - SWOT Analysis -Evolving development strategies, information technology in management Decisions support system-Management Games Business Process Re- engineering(BPR) –Enterprises Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (AM) - Global Perspective - Principles and Steps Advantages and disadvantage															
Total periods:45															
Text Books:															
1.Tephen P. Robbins & Mary Coulter – <i>Management</i> , 14th Edition, Pearson, 2021.															
2. Harold Koontz & Heinz Weihrich – <i>Essentials of Management</i> , McGraw-Hill Education, 2010.															
3. Robert Kreitner & Mamata Mohapatra – <i>Management</i> , Cengage Learning, 2012.															
References:															
1. James A.F. Stoner, R. Edward Freeman & Daniel R. Gilbert – <i>Management</i> , Pearson, 2008.															
2. Peter Drucker – <i>Management: Tasks, Responsibilities, Practices</i> , Harper Business, 2007.															
3. Richard L. Daft – <i>Management</i> , 12th Edition, Cengage Learning, 2015.															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand the basic concepts of industrial management													Understand(K2)		
CO2: Identify the group conflicts and its causes.													Apply(K3)		
CO3: Perform swot analysis													Analyze(K4)		
CO4 : Analyze the learning curves													Analyze(K4)		
CO5 : Understand the placement and performance appraisal													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
CO2	-	3	2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	2	3	2	3	-	-	-	-	-	-	-	-	1	2	3
CO4	2	2	3	3	-	-	-	-	-	-	-	-		3	3
CO5	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO Avg.	2	2.2	2.3	3	-	-	-	-	-	-	-	-	1.6	2	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MGO003	QUALITY ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Developing a clear knowledge in the basics of various quality concepts. - Facilitating the students in understanding the application of control charts and its techniques. - Developing the special control procedures for service and process oriented industries. - Analyzing and understanding the process capability study. - Developing the acceptance sampling procedures for incoming raw material.					
UNIT I	INTRODUCTION				9
Quality Dimensions–Quality definitions–Inspection–Quality control–Quality Assurance–Quality planning–Quality costs–Economics of quality– Quality loss function					
UNIT II	CONTROL CHARTS				9
Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- $\bar{X}$, R and S charts, attribute control charts - p, np, c and u- Construction and application					
UNIT III	SPECIAL CONTROL PROCEDURES				9
Warning and modified control limits, control chart for individual measurements, multi-vari chart, $\bar{X}$ chart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.					
UNIT IV	STATISTICAL PROCESS CONTROL				9
Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.					
UNIT V	ACCEPTANCE SAMPLING				9
The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS 2500 standards.					
Total periods:45					
Text Books:					
1. Douglas C. Montgomery – Introduction to Statistical Quality Control, 8th Edition, Wiley, 2020.					
2. Juran, J.M., & Godfrey, A.B. – Juran’s Quality Handbook, 6th Edition, McGraw-Hill, 2016.					
References:					
1. Montgomery, D.C. – Design and Analysis of Experiments, 9th Edition, Wiley, 2017.					
2. Grant, E.L., & Leavenworth, R.S. – Statistical Quality Control, 8th Edition, McGraw-Hill, 2000.					
Course Outcomes:					Blooms Taxonomy
CO1: Control the quality of processes using control charts for variables in manufacturing					Apply(K3)

industries.															
CO2: Control the occurrence of defective product and the defects in manufacturing companies.													Apply(K3)		
CO3: Control the occurrence of defects in services.													Apply(K3)		
CO4: Analyzing and understanding the process capability study.													Analyze(K4)		
CO5: Developing the acceptance sampling procedures for incoming raw material.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	3	-	3	-	-	1	2	-	-	2	1	-	-
CO2	-	3	3	-	3	3	-	-	3	-	-	3	-	2	-
CO3	3	3	3	-	3	-	-	-	3	-	-	3	1	-	-
CO4	3		2	-	3	-	-	-	-	-	1	-	1	-	-
CO5	-	2		-	3	-	-	-	3	-	-	3	-	-	1
CO Avg.	2.6	2.7	2.7	-	3	3	-	1	2.7	-	1	2.7	1	2	1
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHO001	FIRE SAFETY ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					
Course Objectives:					
- To enable the students to acquire knowledge of Fire and Safety Studies - To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance - To learn about fire area, fire stopped areas and different types of fire-resistant doors - To learn about the method of fire protection of structural members and their repair due to fire damage. - To develop safety professionals for both technical and management through systematic and quality-based study programmers’					
Unit I	INHERENT SAFETY CONCEPTS				9
Compartment fire-factors controlling fire severity, ventilation controlled and fuel controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.					

Unit II	PLANT LOCATIONS	9
Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements- standard heating condition, Indian standard test method, performance criteria.		
Unit III	WORKING CONDITIONS	9
Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas-in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors; method of suspension of fire doors; Air-tight sealing of doors.		
Unit IV	FIRE SEVERITY AND REPAIR TECHNIQUES	9
Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC.. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures		
Unit V	WORKING AT HEIGHTS	9
Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems-Accident Case Studies.		
Total periods:45		
Text Books:		
1. Roytman, M. Y, "Principles of fire safety standards for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi, 1975		
2. John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK, 2009.		
References:		
1. Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A, 1979.		
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A. 1983.		
3. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi, 2010. 4. Hazop&Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition , 1999		
4. Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009.		
Course Outcomes:		Blooms Taxonomy
CO1: Understand the effect of fire on materials used for construction		Understand(K2)
CO2: Understand the method of test for non-combustibility and fire resistance; and		Understand(K2)

will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.															
CO3: To understand the design concept of fire walls, fire screens, local barriers and fire doors and able to select them appropriately to prevent fire spread.													Understand(K2)		
CO4: To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.													Understand(K2)		
CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	-	1	-	-	1	-	-	-	-	-	-	-	-	-
CO2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	1	-	2	-	-	-	3	-	-	1	-	-	-	-	-
CO4	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
CO5	2	-	1	-	-	1	1	1	-	1	-	1	-	-	-
CO Avg.	1.6	-	1.75	-	-	1	1.6	1	-	1	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO001	INTRODUCTION TO NON-DESTRUCTIVE TESTING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Understanding the basic importance of NDT in quality assurance. - Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards. - Equipping themselves to locate a flaw in various materials, products. - Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards. - Acquiring the knowledge on the selection of the suitable NDT technique for a given application					
Unit I	INTRODUCTION TO NDT & VISUAL TESTING				9
Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect					

methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting		
Unit II	LIQUID PENETRANT & MAGNETIC PARTICLE TESTING	9
Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation. Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications		
Unit III	EDDY CURRENT TESTING & THERMOGRAPHY	9
Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation. Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.		
Unit IV	ULTRASONIC TESTING & AET	9
Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.		
Unit V	RADIOGRAPHY TESTING	9
Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrometers, safety in radiography.		
Total periods:45		
Text Books:		
Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.		
J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.		
Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.		
References:		
ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.		
Barry Hull and Vernon John, "Nondestructive Testing", Macmillan, 1989.		

Chuck Hellier, "Handbook of Nondestructive Evaluation", Mc Graw Hill, 2012.

Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.

Course Outcomes:													Blooms Taxonomy		
CO1: Realize the importance of NDT in various engineering fields.													Apply(K3)		
CO2: Basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.													Understand(K2)		
CO3: Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.													Understand(K2)		
CO4: Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.													Understand(K2)		
CO5: Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	-	-	2	2	-	-	-	2	1	2	-
CO2	3	1	2	2	-	-	2	2	-	-	-	2	2	2	1
CO3	3	2	1	2	-	-	2	2	-	-	-	2	2	2	-
CO4	3	1	2	2	-	-	2	2	-	-	-	2	2	2	2
CO5	3	2	2	2	-	-	2	2	-	-	-	2	2	2	1
CO Avg.	2.8	1.6	1.8	2.2	-	-	2	2	-	-	-	2	1.8	2	1.3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO004	MECHATRONICS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Selecting sensors to develop mechatronics systems. - Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs. - Designing appropriate interfacing circuits to connect I/O devices with microprocessor. - Applying PLC as a controller in mechatronics system. - Designing and develop the apt mechatronics system for an application.					
Unit I	INTRODUCTION AND SENSORS				9
Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT –					

Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.

Unit II	8085 MICROPROCESSORS	9

Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.

Unit III	PROGRAMMABLE PERIPHERAL INTERFACE	9

Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.

Unit IV	PROGRAMMABLE LOGIC CONTROLLER	9

Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.

Unit V	ACTUATORS AND MECHATRONICS SYSTEM DESIGN	9

Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.

Total periods:45

Text Books:

1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.

References:

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histan, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

Course Outcomes:	Blooms Taxonomy
CO1: Select sensors to develop mechatronics systems.	Apply(K3)
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.	Understand(K2)
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.	Apply(K3)

CO 4: Apply PLC as a controller in mechatronics system.													Understand(K2)		
CO 5: Design and develop the apt mechatronics system for an application.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
CO2	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
CO3	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
CO4	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
CO5	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
CO Avg.	3	2	1	3	-	2	-	-	-	-	-	2	3	2	3
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23MEO005	FOUNDATION OF ROBOTICS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives:					
- To study the kinematics, drive systems and programming of robots. - To study the basics of robot laws and transmission systems. - To familiarize students with the concepts and techniques of robot manipulator, its kinematics. - To familiarize students with the various Programming and Machine Vision application in robots. - To build confidence among students to evaluate, choose and incorporate robots in engineering systems.					
Unit I	FUNDAMENTALS OF ROBOT				9
Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.					
Unit II	ROBOT KINEMATICS				9
Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.					

Unit III	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9
Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper		
Unit IV	SENSORS IN ROBOTICS	9
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.		
Unit V	PROGRAMMING AND APPLICATIONS OF ROBOT	9
Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.		
Total periods:45		
Text Books:		
1. Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006.		
2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2 ND edition 2012.		
References:		
1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co. 2007.		
2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.		
3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.		
4. John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.		
5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.		
Course Outcomes:		Blooms Taxonomy
CO1: Interpret the features of robots and technology involved in the control.		Analyze(K4)
CO2: Apply the basic engineering knowledge and laws for the design of robotics.		Apply(K3)
CO3: Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.		Understand(K2)
CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.		Understand(K2)
CO5: Demonstrate the image processing and image analysis techniques by machine vision system.		Understand(K2)

CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	-	-	3
CO2	3	2	1	1	-	-	-	-	-	-	-	1	-	-	3
CO3	3	2	1	1	-	-	-	-	-	-	-	1	-	-	3
CO4	3	2	1	1	-	-	-	-	-	-	-	1	-	-	3
CO5	3	2	1	1	-	-	-	-	-	-	-	1	-	-	3
CO avg.	3	2.0	1.0	1.0	-	-	-	-	-	-	-	1	-	-	3
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23MEO006	FUNDAMENTALS OF AERONAUTICAL ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives:					
- To acquire the knowledge on the Historical evaluation of Airplanes - To learn the different component systems and functions - To know the concepts of basic properties and principles behind the flight - To learn the basics of different structures & construction - To learn the various types of power plants used in aircrafts					
Unit I	HISTORY OF FLIGHT				8
Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years					
Unit II	AIRCRAFT CONFIGURATIONS AND ITS CONTROLS				10
Different types of flight vehicles, classifications-Components of an airplane and their functions- Conventional control, powered control- Basic instruments for flying-Typical systems for control actuation					
Unit III	BASICS OF AERODYNAMICS				9
Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton’s Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Maneuvers					
Unit IV	BASICS OF AIRCRAFT STRUCTURES				9
General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke’s law- stress-strain diagrams- elastic constants-Factor of Safety.					
Unit V	BASICS OF PROPULSION				9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production- Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

Total periods:45

Text Books:

1.Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015

2.Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021

3.Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

References:

1.SADHU SINGH, “INTERNAL COMBUSTION ENGINES AND GAS TURBINE”-, SSKataraia & sons, 2015

2.KERMODE , “FLIGHT WITHOUT FORMULAE”, -, Pitman; 4th Revised edition 1989

Course Outcomes:													Blooms Taxonomy		
CO1: Illustrate the history of aircraft & developments over the years													Analyze(K4)		
CO2: Ability to identify the types & classifications of components and control systems													Analyze(K4)		
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere													Understand(K2)		
CO4: Identify the types of fuselage and constructions.													Understand(K2)		
CO5: Distinguish the types of Engines and explain the principles of Rocket													Analyze(K4)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-
CO2	2	2	2	1	2	-	-	-	-	-	-	-	2	-	-
CO3	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
CO4	2	2	2	2	1	-	-	-	-	-	-	-	2	-	-
CO5	3	2	2	2	2	-	-	-	-	-	-	-	3	-	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CEO002	REMOTE SENSING CONCEPTS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					

Course Objectives:

- To introduce the concepts of remote sensing processes and its components.
- To expose the various remote sensing platforms and sensors and to introduce the elements of data interpretation

Unit I	REMOTE SENSING AND ELECTROMAGNETIC RADIATION	9
Definition – components of RS – History of Remote Sensing – Merits and demerits of data collation between conventional and remote sensing methods - Electromagnetic Spectrum – Radiation principles - Wave theory, Planck's law, Wien's Displacement Law, Stefan's Boltzmann law, Kirchoff's law – Radiation sources: active & passive - Radiation Quantities		
Unit II	EMR INTERACTION WITH ATMOSPHERE AND EARTH MATERIAL	9
Standard atmospheric profile – main atmospheric regions and its characteristics – interaction of radiation with atmosphere – Scattering, absorption and refraction – Atmospheric windows - Energy balance equation – Specular and diffuse reflectors – Spectral reflectance & emittance – Spectroradiometer – Spectral Signature concepts – Typical spectral reflectance curves for vegetation, soil and water – solid surface scattering in microwave region.		
Unit III	ORBITS AND PLATFORMS	9
Motions of planets and satellites – Newton's law of gravitation - Gravitational field and potential - Escape velocity - Kepler's law of planetary motion - Orbit elements and types – Orbital perturbations and maneuvers – Types of remote sensing platforms - Ground based, Airborne platforms and Space borne platforms – Classification of satellites – Sun synchronous and Geosynchronous satellites – Lagrange Orbit.		
Unit IV	SENSING TECHNIQUES	9
Classification of remote sensors – Resolution concept : spatial, spectral, radiometric and temporal resolutions - Scanners - Along and across track scanners – Optical-infrared sensors – Thermal sensors – microwave sensors – Calibration of sensors - High Resolution Sensors - LIDAR , UAV – Orbital and sensor characteristics of live Indian earth observation satellites		
Unit V	DATA PRODUCTS AND INTERPRETATION	9
Photographic and digital products – Types, levels and open source satellite data products – selection and procurement of data– Visual interpretation: basic elements and interpretation keys - Digital interpretation – Concepts of Image rectification, Image enhancement and Image classification		

Total periods:45**Text Books:**

- 1.Thomas M.Lillesand, Ralph W. Kiefer and Jonathan W. Chipman, Remote Sensing and Image interpretation, John Wiley and Sons, Inc, New York,2015.
- 2.George Joseph and C Jeganathan, Fundamentals of Remote Sensing,Third Edition Universities Press (India) Private limited, Hyderabad, 2018

References:

- 1.Janza, F.Z., Blue H.M. and Johnson,J.E. Manual of Remote Sensing. Vol.1, American Society of

Photogrametry, Virginia, USA, 2002.

2.Verbyla, David, Satellite Remote Sensing of Natural Resources. CRC Press, 1995

3.Paul Curran P.J. Principles of Remote Sensing. Longman, RLBS, 1988.

4.Introduction to Physics and Techniques of Remote Sensing , Charles Elachi and Jacob Van Zyl, 2006 Edition II, Wiley Publication.

5.Basudeb Bhatta, Remote Sensing and GIS, Oxford University Press, 2011

Course Outcomes: On completion of the course, the student is expected to	Blooms Taxonomy
CO 1: Understand the concepts and laws related to remote sensing	Understand(K2)
CO2: Understand the interaction of electromagnetic radiation with atmosphere and earth material	Understand(K2)
CO3: Acquire knowledge about satellite orbits and different types of satellites	Understand(K2)
CO4: Understand the different types of remote sensors	Understand(K2)
CO5: Gain knowledge about the concepts of interpretation of satellite imagery	Understand(K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-
CO2	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-
CO4	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-
CO5	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CEO003	URBAN AGRICULTURE	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

-

Course Objectives:

- To introduce the students the principles of agricultural crop production and the production practices of crops in modern ways.
- To delineate the role of agricultural engineers in relation to various crop production practices

Unit I	INTRODUCTION	9
Benefits of urban agriculture- economic benefits, environmental benefits, social and cultural benefits, educational, skill-building and job training benefits, health, nutrition and food accessibility benefits.		
Unit II	VERTICAL FARMING	9
Vertical farming- types, green facade, living/green wall-modular green wall , vegetated mat wall- Structures and components for green wall system: plant selection, growing media, irrigation and plant nutrition: Design, light, benefits of vertical gardening. Roof garden and its types. Kitchen garden, hanging baskets: The house plants/ indoor plants		
Unit III	SOIL LESS CULTIVATION	9
Hydroponics, aeroponics, aquaponics: merits and limitations, costs and Challenges, backyard gardens- tactical gardens- street landscaping- forest gardening, greenhouses, urban beekeeping		
Unit IV	MODERN CONCEPTS	9
Growth of plants in vertical pipes in terraces and inside buildings, micro irrigation concepts suitable for roof top gardening, rain hose system, Green house, polyhouse and shade net system of crop production on roof tops		
Unit V	WASTE MANAGEMENT	9
Concept, scope and maintenance of waste management- recycle of organic waste, garden wastes- solid waste management-scope, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues, waste utilization		
TOTAL : 45 PERIODS		
Text Books:		
1.Martellozzo F and J S Landry. 2020. Urban Agriculture. Scitus Academics Llc.		
2.Rob Roggema. 2016. Sustainable Urban Agriculture and Food Planning. Routledge Taylor and Francis Group.		
3.Akrong M O. 2012. Urban Agriculture. LAP Lambert Academic Publishing.		
References:		
1.Agha Rokh A. 2008. Evaluation of ornamental flowers and fishes breeding in Bushehr urban wastewater using a pilot-scale aquaponic system. Water and Wastewater, 19 (65): 47–53.		
2.Agrawal M, Singh B, Rajput M, Marshall F and Bell J. N. B. 2003. Effect of air pollution on peri- urban agriculture: A case study. Environmental Pollution, 126 (3): 323–		
3. https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24 .		
4.Jac Smit and Joe Nasr. 1992. Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources. Environment and Urbanization, 4 (2):141-152.		
Course Outcomes:		Blooms Taxonomy
CO 1: Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops		Understand(K2)

CO2: Explain different methods of crop production on roof tops													Understand(K2)		
CO3: Explain nutrient and pest management for crop production on roof tops													Understand(K2)		
CO4: Illustrate crop water requirement and irrigation water management on roof tops													Analyze(K4)		
CO5: Explain the concept of waste management on roof tops.													Understand(K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-
CO2	2	1	1	1	-	-	-	-	-	-	-	-	2	-	-
CO3	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-
CO4	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-
CO5	2	1	2	1	-	-	-	-	-	-	-	-	2	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO004	DRINKING WATER SUPPLY AND TREATMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					
Course Objectives:					
• To equip the students with the principles and design of water treatment units and distribution system.					
Unit I	SOURCES OF WATER				9
Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards					
Unit II	CONVEYANCE FROM THE SOURCE				9
Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.					
Unit III	WATER TREATMENT				9
Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation — sand filters - Disinfection — Construction, Operation and Maintenance aspects.					

Unit IV	ADVANCED WATER TREATMENT												9		
Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects															
Unit V	WATER DISTRIBUTION AND SUPPLY												9		
Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection- Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.															
Total periods:45															
Text Books:															
1.Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.															
2.Punmia B.C, Arun K.Jain, Ashok K.Jain, “ Water supply Engineering” Lakshmi publication private limited, New Delhi, 2016.															
3.Rangwala "Water Supply and Sanitary Engineering", February 2022															
4.Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.															
References:															
1.Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.															
2.Babbitt.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.															
3.Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.															
4.Duggal. K.N., “Elememts of public Health Engineering”, S.Chand and Company Ltd, New Delhi, 1998.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Understanding of water quality criteria and standards, and their relation to public health													Understand(K2)		
CO2: Ability to design the water conveyance system													Understand(K2)		
CO3: Ability to knowledge in various unit operations and processes in water treatment													Understand(K2)		
CO4: ability to understand the various systems for advanced water treatment													Understand(K2)		
CO5: Insight into the structure of drinking water distribution system													Apply(K3)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	-	-	-	-	-	3	-	3	-	-	3	-	-
CO2	-	3	-	2	-	2	-	-	-	3	-	-	3	-	-
CO3	-	-	-	2	-	2	-	-	-	3	-	-	3	-	-

CO4	-	-	3	2	-	-	-	3	2	3	-	-	3	-	-
CO5	-	-	3	2	-	-	1	-	2	3	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23EEO003	ELECTRIC VEHICLE TECHNOLOGY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To provide knowledge about electric machines and special machine - To understand the basics of power converters - To know the concepts of controlling DC and AC drive systems - To understand the architecture and power train components. - To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)					
Unit I	ROTATING POWER CONVERTERS				9
Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations — Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM					
Unit II	STATIC POWER CONVERTERS				9
Working and Characteristics of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters					
Unit III	CONTROL OF DC AND AC MOTOR DRIVES				9
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives					
Unit IV	HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN COMPONENTS				9
History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) — Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes					

Unit V	MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF VEHICLES												9		
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode															
Total periods:45															
References:															
Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7 th Edition, 2020.															
Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011															
Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek “Analysis of Electric Machinery and Drive Systems”, 3 rd Edition, Wiley-IEEE Press, 2013.															
Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10 th Impression 2021															
Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2021															
Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017															
James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, Wiley, 2012															
Course Outcomes:													Blooms Taxonomy		
CO 1: : Able to understand the principles of conventional and special electrical machines													Analyze(K4)		
CO2: Acquired the concepts of power devices and power converters.													Apply(K3)		
CO3: Able to understand the control for DC and AC drive systems													Understand(K2)		
CO4: Learned the electric vehicle architecture and power train components.													Apply(K3)		
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles													Apply(K3)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			3								3	3	3
CO2	3	2	2			3			3				3	3	3
CO3	3			3		2	2						3	3	3
CO4	3	2	2		3								3	3	3
CO5	3		2								2		3	3	3
CO Avg.	3	2	2	3	3	1	2		3		2		3	3	3
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23EE0004	INTRODUCTION TO PLC PROGRAMMING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Understand basic PLC terminologies digital principles, PLC architecture and operation. - Familiarize different programming language of PLC. - Develop PLC logic for simple applications using ladder logic. - Understand the hardware and software behind PLC and SCADA. - Exposures about communication architecture of PLC/SCADA.					
Unit I	INTRODUCTION TO PLC				9
Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC- PLC Construction: What is a PLC, PLC Memories, PLC I/O, , PLC Special I/O, PLC Types					
Unit II	PLC INSTRUCTIONS				9
PLC Basic Instructions: PLC Ladder Language- Function block Programming- Ladder/Function Block functions- PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung)- Configuration of Sensors, Switches, Solid State Relays-Interlock examples- Timers, Counters, Examples					
Unit III	PLC PROGRAMMING				9
Different types of PLC program, Basic Ladder logic, logic functions, PLC module addressing, registers basics, basic relay instructions, Latching Relays, arithmetic functions, comparison functions, data handling, data move functions, timer-counter instructions, input-output instructions, sequencer instructions					
Unit IV	COMMUNICATION OF PLC AND SCADA				9
Communication Protocol – Modbus, HART, Profibus- Communication facilities SCADA: - Hardware and software, Remote terminal units, Master Station and Co mmunication architectures					
Unit V	CASE STUDIES				9
Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems					
SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/Assignment/Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)					
1	Market survey of the recent PLCs and comparison of their features.				
2	Summarize the PLC standards				
3	Familiarization of any one programming language (Ladder diagram/ Sequential Function Chart/ Function Block Diagram/ Equivalent open source software)				
4	Market survey of Communication Network Used for PLC/SCADA.				

Total periods:45 Periods**Text Books:**

1.Frank Petruzzola, Programmable Logic Controllers, Tata Mc-Graw Hill Edition

2.John W. Webb, Ronald A. Reis, Programmable Logic Controllers Principles and Applications, PHI publication

References:

1.MadhuchandMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.

2.J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication

Course Outcomes:**Blooms Taxonomy****CO 1:**Know the basic requirement of a PLC input/output devices and architecture. (L1)

Understand(K2)

CO2:Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.(L2)

Analyze(K4)

CO3: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)

Apply(K3)

CO4:Able to develop a PLC logic for a specific application on real world problem. (L5)

Analyze(K4)

CO5:Ability to Understand the Concepts of Communication used for PLC/SCADA.(L1)

Understand(K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	1	-	1	-	-	-	-	-
CO2	3	3	2	-	-	-	-	1	-	1	2	-	-	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	-	-	-	-
CO4	3	3	-	3	3	-	-	1	-	1	-	-	3	3	-
CO5	3	3	3	2	1	-	-	1	-	1	-	-	3	3	3

1 - Low, 2 - Medium, 3 - High , '-' No correlation**23CHO002****NANO TECHNOLOGY****Category: OEC****L****T****P****C****3****0****0****3****Prerequisites**

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Unit I	INTRODUCTION	9
General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.		
Unit II	SYNTHESIS OF NANOMATERIALS	9
Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering		
Unit III	NANO COMPOSITES	9
Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.		
Unit IV	NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES	9
Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method		
Unit V	APPLICATIONS OF NANO MATERIALS	9
Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.		
Total periods: 45		
Text Books:		
1.Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, “ Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press		
2.G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” Imperial College Press, 2004		
3.William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3 rd Edition, CRC Taylor and Francis group 2012		
References:		
1.R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.		
2.C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gbtl & Co		

3.Ivor Brodie and Julius J.Murray,'The physics of Micro/Nano — Fabrication',Springer International Edition,2010

Course Outcomes:													Blooms Taxonomy		
CO 1:understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.													Understand(K2)		
CO2:able to acquire knowledge about the different types of nano material synthesis													Understand(K2)		
CO3:describes about the shape, size,structure of composite nano materials and their interference													Understand(K2)		
CO4:understand the different characterization techniques for nanomaterials													Understand(K2)		
CO5:develop a deeper knowledge in the application of nanomaterials in different fields.													Analyze(K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3

23MEO007	FUNCTIONAL MATERIALS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: The course emphasis on the molecular self assembly and materials for polymer electronics					
Unit I	INTRODUCTION				9
Historical Perspectives, Lessons from the Nature, Engineering the Functions, Tuning the functions, Multiscale Modeling and Computation, Classification of Functional Materials, Functional Diversity of Materials, Hybrid Materials, Technological Relevance, Societal Impact					
Unit II	MOLECULAR SELF ASSEMBLY				9
Molecular Organization, Self-Assembly in Biology, Energetics of Self-Organization, A Few Case Studies, Synthetic Protocols and Challenges, Solvent-assisted Self-Assembly, Directed Assembly- Langmuir-Blodgett and Langmuir-Schaefer techniques, Technological Applications of SAMs.					

Unit III	BIO-INSPIRED MATERIALS	9
Bio-inspired materials, Classification, Biomimicry, Spider Silk, Lotus Leaf, Gecko feet, Synovial fluid, 'Bionics'- Bio-inspired Information Technologies, Artificial Sensory Organs, Biomineralization- En route to Nanotechnology		
Unit IV	SMART OR INTELLIGENT MATERIALS	9
Criteria for Smartness, Significance of Smart Materials, Representative Examples like Smart Gels and Polymers, Electro/Magneto Rheological Fluids, Smart Electroceramics, Technical Limitations and Challenges, Functional Nanocomposites, Polymer-carbon nanotube composites.		
Unit V	MATERIALS FOR POLYMER ELECTRONICS	9
Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.		
Total periods:45		
Text Books:		
1.Vijayamohan K. Pillai and MeeraParthasarathy, "Functional Materials: A chemist's perspective", Universities Press Hyderabad (2012)		
2. Functional Materials: A Chemist's Perspective by Vijayamohan K. Pillai & Meera Parthasarathy (Universities Press, 2012)		
3. Nanotechnology: Principles and Practices by B.S. Murthy, R.S. Ramesh, & B. Raj		
References:		
1.Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.		
2. anomaterials: Synthesis, Properties, and Applications by K. S. Rajasekaran & K. R. Srivastava		
Course Outcomes:		
CO 1: Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.	Blooms Taxonomy Analyze(K4)	
CO2: Explain molecular self-assembly processes in nature and synthetic systems.	Understand(K2)	
CO3: Analyze bio-inspired materials and their technological applications	Analyze (K4)	
CO4: Evaluate smart/intelligent materials for specific engineering applications	Evaluate(K5)	
CO5: Apply functional materials in polymer electronics, including OLEDs, FETs, and data storage devices.	Apply (K3)	

CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	1	2	1	1	1	-	-	-	3	-	-	-
CO2	3	2	2	1	1	2	1	1	1	-	-	-	-	-	-
CO3	3	3	2	1	1	2	1	2	1	-	-	-	-	-	-
CO4	3	3	2	1	1	3	1	3	2	-	-	-	-	-	-
CO5	3	2	3	1	1	3	1	3	2	-	-	-	-	-	-

23BMO001	BIOMEDICAL INSTRUMENTATION	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

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Course Objectives:

- The course emphasis on the molecular safe assembly and materials for polymer electronics

Unit I	ELECTRODE CONFIGURATIONS	9

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode-skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes

Unit II	Biosignal Characteristics	9

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12 lead system. EEG – EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG – Electrode configuration -unipolar and bipolar mode.

Unit III	Bioamplifiers	9

Need for bio-amplifier – Differential bio-amplifier – Single ended amplifier – Band pass filtering, isolation amplifiers – transformer and optical isolation – isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference

Unit IV	Measurement Of Bio Signals	9

Temperature, respiration rate and pulse rate measurements. Blood Pressure – indirect methods: auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers – systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements.

Unit V	Biochemical Measurements												9		
Biochemical sensors – pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.															
Total periods:45															
Text Books:															
1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, 2nd edition, Prentice hall of India, New Delhi, 2015															
2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015															
3. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003															
References:															
1. John Enderle, Susan Blanchard, Joseph Bronzino, “Introduction to Biomedical Engineering”, second edition, Academic Press, 2005															
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson Education, 2004															
Course Outcomes:													Blooms Taxonomy		
CO 1: Students will be able to differentiate among various functional properties and select appropriate material for certain functional applications, analyze the nature and potential of functional material.													Analyze(K4)		
CO2: Explain molecular self-assembly processes in nature and synthetic systems.													Understand(K2)		
CO3: Analyze bio-inspired materials and their technological applications													Analyze (K4)		
CO4: Evaluate smart/intelligent materials for specific engineering applications													Evaluate(K5)		
CO5: Apply functional materials in polymer electronics, including FETs, ISFET													Apply (K3)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	1	2	1	1	1	-	-	-	3	-	-	-
CO2	3	2	2	1	1	2	1	1	1	-	-	-	-	-	-
CO3	3	3	2	1	1	2	1	2	1	-	-	-	-	-	-
CO4	3	3	2	1	1	3	1	3	2	-	-	-	-	-	-

CO5	3	2	3	1	1	3	1	3	2	-	-	-	-	-	-

23BTO001	TRADITIONAL INDIAN FOODS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

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Course Objectives:

- To help students acquire a sound knowledge on diversities of foods, food habits and patterns in India with focus on traditional foods

Unit I	HISTORICAL AND CULTURAL PERSPECTIVES	9

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts

Unit II	TRADITIONAL METHODS OF FOOD PROCESSING	9

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

Unit III	TRADITIONAL FOOD PATTERNS	9

Typical breakfast, meal and snack foods of different regions of India. Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods, pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

Unit IV	COMMERCIAL PRODUCTION OF TRADITIONAL FOODS	9

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

Unit V	HEALTH ASPECTS OF TRADITIONAL FOODS	9

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses

Total periods: 45

Text Books:

1.Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.

2.Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001

References:

1. **Sen, Colleen Taylor**, *Food Culture in India*, Greenwood Press, 2005.

2. **Davidar, Ruth N.**, *Indian Food Science: A Health and Nutrition Guide to Traditional Recipes*, East West Books, 2001.

Course Outcomes:

Blooms Taxonomy

CO 1:To understand the historical and traditional perspective of foods and food habits

Understand(K2)

CO2: To understand the wide diversity and common features of traditional Indian foods and meal patterns

Understand(K2)

CO3: Understand traditional food processing methods and their comparison to modern methods.

Understand(K2)

CO4: Learn about the commercial production of traditional foods and beverages.

Analyze(K4)

CO5: Understand the health aspects and nutritional comparison of traditional foods vs. fast foods.

Understand(K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	2	1	2	1	1	0	0	3	3	2
CO2	3	3	2	1	3	3	2	1	2	1	1	0	3	3	3
CO3	3	2	3	2	3	3	2	1	1	1	1	0	3	3	3
CO4	3	3	3	3	3	2	3	2	2	2	1	0	3	3	3
CO5	3	3	2	2	3	3	2	2	1	1	0	0	3	3	3

23BTO002	INTRODUCTION TO FOOD PROCESSING	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

-

Course Objectives:

- The course aims to introduce the students to the area of Food Processing.
- This is necessary for effective understanding of a detailed study of food processing and technology subjects.
- This course will enable students to appreciate the importance of food processing with respect to the producer, manufacturer and consumer.

UNIT I	PROCESSING OF FOOD AND ITS IMPORTANCE	9

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing — cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

UNIT II	METHODS OF FOOD HANDLING AND STORAGE	9

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.

UNIT III	LARGE-SCALE FOOD PROCESSING	12

Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying — Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.

UNIT IV	FOOD WASTES IN VARIOUS PROCESSES	6

Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.

UNIT V	FOOD HYGIENE	9

Food related hazards — Biological hazards — physical hazards — microbiological considerations in foods. Food adulteration — definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.

Total periods:45

Text Books:

1.Karnal, Marcus and D.B. Lund “Physical Principles of Food Preservation”. Rutledge, 2003.

2. VanGarde, S.J. and Woodburn. M “Food Preservation and Safety Principles and Practice”.Surbhi Publications, 2001.

3.Sivasankar, B. “Food Processing & Preservation”, Prentice Hall of India, 2002.

4.Khetarpaul, Neelam, “Food Processing and Preservation”, Daya Publications, 2005.

References:

1. **Karnal, Marcus and D.B. Lund**, *Physical Principles of Food Preservation*, Routledge, 2003.

2. **VanGarde, S.J. and Woodburn, M.**, *Food Preservation and Safety Principles and Practice*, Surbhi Publications, 2001.

Course Outcomes:	Blooms Taxonomy
CO1: Understand the significance of food processing and raw materials for processing.	Understand(K2)
CO2: Learn methods for handling, storing, and preserving food materials.	Analyze(K4)
CO3: Gain knowledge of large-scale food processing techniques and methods.	Analyze(K4)
CO4: Understand food waste management, including disposal and pest control	Understand(K2)
CO5: : Understand food hygiene, safety standards, and contamination prevention.	Understand(K2)

CO - PO & PSO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	2	1	1	1	-	-	-	3	-	-
CO2	3	3	2	2	-	-	-	1	1	1	1	-	3	-	-
CO3	3	3	3	3	3	3	2	1	2	1	-	-	3	-	-
CO4	2	2	2	2	2	2	2	2	1	1	-	-	3	-	-
CO5	3	3	2	3	3	3	2	2	1	1	-	-	3	-	-

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23BTO003	IPR FOR PHARMA INDUSTRY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					

Course Objectives:

- To provide the basic fundamental knowledge of different forms of Intellectual Property Rights in national and international level.
- To provide the significance of the Intellectual Property Rights about the patents, copyrights, industrial design, plant and geographical indications.
- This paper is to study significance of the amended patent act on pharma industry.

UNIT I	INTRODUCTION- INTELLECTUAL PROPERTY RIGHTS	9
Introduction, Types of Intellectual Property Rights -patents, plant varieties protection, geographical indicators, copyright, trademark, trade secrets.		
UNIT II	PATENTS	9
Patents-Objective, Introduction, Requirement for patenting- Novelty, Inventive step (Non- obviousness) and industrial application (utility), Non-patentable inventions, rights of patent owner, assignment of patent rights, patent specification (provisional and complete), parts of complete specification, claims, procedure for obtaining patents, compulsory license.		
UNIT III	PLANT VARIETY-TRADITIONAL KNOWLEDGE –GEOGRAPHICAL INDICATIONS	9
Plant variety- Justification, criteria for protection of plant variety and protection in India. Traditional knowledge- Concept of traditional knowledge, protection of traditional knowledge under Intellectual Property frame works in national level and Traditional knowledge digital library (TKDL). Geographical Indications — Justification for protection, National and International position.		
UNIT IV	ENFORCEMENT AND PRACTICAL ASPECTS OF IPR	9
Introduction – civil remedies – injunction, damage, account of profit – criminal remedies – patent, trademark. Practical aspects – Introduction, benefits of licensing, licensing of basic types of IPR, licensing clauses of IPR. Case studies of patent infringement, compulsory licensing, simple patent license agreements.		
UNIT V	INTERNATIONAL BACKGROUND OF INTELLECTUAL PROPERTY	9
International Background of Intellectual Property- Paris Convention, Berne convention, World Trade Organization (WTO), World Intellectual Property Organization (WIPO), Trade Related Aspects of Intellectual Property Rights (TRIPS) and Patent Co-operation Treaty (PCT).		
Total periods:45		
Text Books:		
1.N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, “Intellectual Property Rights” Edu creation Publishing, New Delhi, 2017.		
2.The Patents Act, 1970 (Bare Act with Short Notes) (New Delhi: Universal Law Publishing Company Pvt. Ltd. 2012.		
3.B.S. Rao, P.V. Appaji, “Intellectual Property Rights in Pharmaceutical Industry: Theory and Practice”, 2015.		
References:		

1. Patents for Chemicals, Pharmaceuticals, & Biotechnology-Fundamentals of Global Law, Practice and Strategy. Philip W. Grubb, Oxford University Press, 2004.

2. Basic Principles of patent law — Basics principles and acquisition of IPR. Ramakrishna T. CIPRA, NLSIU, Bangalore, 2005

3. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.

Course Outcomes: The student will be able to

Blooms Taxonomy

CO1: Understand and differentiate the categories of intellectual property rights.

Understand(K2)

CO2: Describe about patents and procedure for obtaining patents.

Understand(K2)

CO3: Distinguish plant variety, traditional knowledge and geographical indications under IPR.

Understand(K2)

CO4: Provide the information about the different enforcements and practical aspects involved in protection of IPR.

Apply(K3)

CO5: Understand the interrelationships between different Intellectual Property Rights on International Society.

Understand(K2)

CO - PO & PSO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3		2	-	-	-	-	2	2	-	-	-	-	-
CO2	-	3	3	-	-	-	2	2	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	2	2	-	-	-	1	-	-	-
CO4	-	-	-	-	2	-	3	3	-	2	2		-	-	-
CO5	-	3	-	-	-	-	3		-	2	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CHO003	BASICS OF TEXTILE FINISHING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: To enable the students to understand the basics and different types of finishes required for textile materials and machines used for finishing.					

UNIT I	RESIN FINISHING												9		
Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.															
UNIT II	FLAME PROOF & WATERPROOF												9		
Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.															
UNIT III	SOIL RELEASE AND ANTISTATIC FINISHES												9		
Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.															
UNIT IV	MECHANICAL FINISHES												9		
Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.															
UNIT V	STIFFENING AND SOFTENING												9		
Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET.Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.															
Total periods:45															
Text Books:															
1.V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai															
2.Perkins, W.S., “Textile colouration and finishing”, Carolina Academic Press., U.K, ISBN: 0890898855.2004.															
References:															
1.Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62															
2.Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3															
3.W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.															
Course Outcomes:													Blooms Taxonomy		
CO1: Basics of Resin Finishing Process.													Understand(K2)		
CO2: Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes.													Understand(K2)		
CO3: Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.													Understand(K2)		
CO4: Concept of Mechanical finishing.													Understand(K2)		
CO5: Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO1	PSO2	PSO3

	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	2	2	1	1	1	1	1	1	-	-	-	2	3	-	-
CO2	3	2	2	1	1	1	1	1	1	-	-	0	2	-	-
CO3	3	2	2	1	1	1	1	1	1	-	-	0	2	-	-
CO4	3	2	3	2	1	2	2	1	1	-	-	0	3	-	-
CO5	3	3	2	1	1	3	2	2	1	-	-	0	3	-	-
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHO004	INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: To enable the students to learn about basics of industrial engineering and different tools of industrial engineering and its application in apparel industry					
Unit I	INTRODUCTION				9
Scope of industrial engineering in apparel Industry, role of industrial engineers. Productivity: Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.					
Unit II	WORK STUDY				9
Definition, Purpose, Basic procedure and techniques of work-study.Work environment — Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment Material Handling — Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.					
Unit III	METHOD STUDY				9
Definition, Objectives, Procedure, Process charts and symbols. Various charts — Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale — multiple activity chart. Diagrams indicating movement — flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart MOTION STUDY: Principle of motion economy, Two handed process chart, micro motion analysis — therbligs, SIMO chart.					
Unit IV	WORK MEASUREMENT				9

Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study-equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating — relaxation and other allowances. Calculation of SAM for different garments, GSD.

Unit V	WORK STUDY APPLICATION												9		
Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.															
Total periods:45															
Text Books:															
1.George Kanwaty, “Introduction to Work Study “, ILO, Geneva, 1996, ISBN: 9221071081 ISBN-13: 9789221071082															
2.Enrick N. L., “Time study manual for Textile industry”, Wiley Eastern (P) Ltd., 1989, ISBN: 0898740444 ISBN-13: 9780898740448															
3.Khanna O. P., and Sarup A., “Industrial Engineering and Management”, Dhanpat Rai Publications, New Delhi, 2010, ISBN: 818992835X / ISBN: 978-8189928353															
References:															
1.Norberd Lloyd Enrick., “Industrial Engineering Manual for Textile Industry”, Wiley Eastern															
2.(P) Ltd., New Delhi, 1988, ISBN: 0882756311 ISBN-13: 9780882756318															
3.Chuter A. J., “Introduction to Clothing Production Management”, Wiley-Black well Science,															
4.U.S. A., 1995, ISBN: 0632039396 ISBN-13: 9780632039395															
Course Outcomes:													Blooms Taxonomy		
CO1: Fundamental concepts of industrial Engineering and productivity													Understand(K2)		
CO2: Method study													Understand(K2)		
CO3: Motion analysis													Analyze(K4)		
CO4: Work measurement and SAM													Understand(K2)		
CO5: Ergonomics and its application to garment industry.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO2	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-

1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation

23CHO004	BASICS OF TEXTILE MANUFACTURE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: To enable the students to learn about the basics of fibre forming, yarn production, fabric formation, coloration of fabrics and garment manufacturing					
UNIT I	NATURAL FIBRES				9
Introduction: Definition of staple fibre, filament; Classification of natural and man-made fibres, essential and desirable properties of fibres. Production and cultivation of Natural Fibers: Cultivation of cotton, production of silk (sericulture), wool and jute — physical and chemical structure of these fibres..					
UNIT II	REGENERATED AND SYNTHETIC FIBRES				9
Production sequence of regenerated and modified cellulosic fibres: viscose rayon, Acetate Rayon, high wet modulus and high tenacity fibres; synthetic fibres — chemical structure, fibre forming polymers, production principles.					
UNIT III	BASICS OF SPINNING				9
Spinning — principle of yarn formation, sequence of machines for yarn production with short staple fibres and blends, principles of opening and cleaning machines; yarn numbering - calculations					
UNIT IV	BASICS OF WEAVING				9
Woven fabric — warp, weft, weaving, path of warp; looms — classification, handloom and its parts, powerloom, automatic looms, shuttleless looms, special type of looms; preparatory machines for weaving process and their objectives; basic weaving mechanism - primary, secondary and auxiliary mechanisms,					
UNIT V	BASICS OF KNITTING AND NONWOVEN				9
Knitting — classification, principle, types of fabrics; nonwoven process –classification, principle, types of fabrics.					
Total periods:45					
Text Books:					
1.Mishra S. P. , “A Text Book of Fibre Science and Technology”, New Age Publishers, 2000, ISBN: 8122412505					
2.Marks R., and Robinson. T.C., “Principles of Weaving”, The Textile Institute, Manchester, 1989, ISBN: 0 900739 258.					

3.Spencer D.J., “Knitting Technology”, III Ed., Textile Institute, Manchester, 2001, ISBN: 185573 333 1.

References:

1.Hornberer M., Eberle H., Kilgus R., Ring W. and Hermeling H., “Clothing Technology: From Fibre to Fabric”, Europa LehrmittelVerlag, 2008, ISBN: 3808562250 / ISBN: 978- 3808562253.

2.Wynne A., “Motivate Series-Textiles”, Maxmillan Publications, London, 1997.

3.Carr H. and Latham B., “The Technology of Clothing Manufacture” Backwell Science, U.K., 1994, ISBN: 0632037482 / ISBN:13: 9780632037483.Klein W., “The Rieter Manual of

4.Spining, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.

5.Klein W., “The Rieter Manual of Spinning, Vol.2”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-2-2 / ISBN 13 978-3-9523173-2-7.

6.Klein W., “The Rieter Manual of Spinning, Vol.1-3”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-3-0 / ISBN 13 978-3-9523173-3-4.

7.Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.

8.Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95.

Course Outcomes:

Blooms Taxonomy

CO1: Classification of fibres and production of natural fibres

Understand(K2)

CO2: Regenerated and synthetic fibres

Understand(K2)

CO3: Yarn spinning

Understand(K2)

CO4: Weaving

Understand(K2)

CO5: Knitting and nonwoven

Understand(K2)

CO - PO & PSO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO2	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO3	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO4	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-
CO5	-	-	-	-	-	-	-	2	1	-	1	1	-	1	-

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CHO006	INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: The course is aimed to Gain knowledge about petroleum refining process and production of petrochemical products.					
UNIT I	ORIGIN, FORMATION AND REFINING OF CRUDE OIL				9
Origin, Formation and Evaluation of Crude Oil. Testing of Petroleum Products. Refining of Petroleum - Atmospheric and Vacuum Distillation.					
UNIT II	CRACKING				9
Cracking, Thermal Cracking, Vis-breaking, Catalytic Cracking (FCC), Hydro Cracking, Coking and Air Blowing of Bitumen					
UNIT III	REFORMING AND HYDROTREATING				9
Catalytic Reforming of Petroleum Feed Stocks. Lube oil processing- Solvent Treatment Processes, Dewaxing, Clay Treatment and Hydrofining. Treatment Techniques: Removal of Sulphur Compounds in all Petroleum Fractions to improve performance.					
UNIT IV	INTRODUCTION TO PETROCHEMICALS				9
Petrochemicals - Cracking of Naphtha and Feed stock gas for the production of Ethylene, Propylene, Isobutylene and Butadiene. Production of Acetylene from Methane, and Extraction of Aromatics.					
UNIT V	PRODUCTION OF PETROCHEMICALS				9
Production of Petrochemicals like Dimethyl Terephthalate(DMT), Ethylene Glycol, Synthetic glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol, Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and production of Carbon Black.					
Total periods:45					
Text Books:					
1.Nelson, W. L., “Petroleum Refinery Engineering”, 4th Edition., McGraw Hill, New York,1985.					
2.Wiseman. P., "Petrochemicals", UMIST Series in Science and Technology, John Wiley & Sons,1986.					
References:					
1.Bhaskara Rao, B. K., “Modern Petroleum Refining Processes”, 2nd Edition, Oxford and IBH Publishing Company, New Delhi, 1990.					
2.Bhaskara Rao, B. K. “A Text on Petrochemicals”, 1st Edition, Khanna Publishers					

Course Outcomes: On the completion of the course students are expected to													Blooms Taxonomy		
CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.													Understand(K2)		
CO2: Understand the insights of primary treatment processes to produce the precursors.													Understand(K2)		
CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.													Understand(K2)		
CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.													Analyze(K4)		
CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	2	1	1	1	0	0	3	3	2
CO2	3	2	2	2	2	2	2	1	1	0	0	0	3	3	2
CO3	3	2	3	2	2	2	2	1	1	1	0	0	3	3	2
CO4	3	3	2	3	3	2	2	2	1	1	1	1	3	3	3
CO5	3	2	2	2	2	1	1	1	1	0	1	0	3	2	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23EEO005	ENERGY CONSERVATION AND MANAGEMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: At the end of the course, the student is expected to - understand and analyse the energy data of industries - carryout energy accounting and balancing - conduct energy audit and suggest methodologies for energy savings and - utilise the available resources in optimal ways					
UNIT I	INTRODUCTION				9

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II	ELECTRICAL SYSTEMS	9

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III	THERMAL SYSTEMS	9

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV	ENERGY CONSERVATION IN MAJOR UTILITIES	9

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems –Cooling Towers – D.G. sets

UNIT V	ECONOMICS	9

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

Total periods:45

Text Books:

1,Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com. a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

References:

1.Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.

2.Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.

3.Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982

4.Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982.

5.Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987

Course Outcomes:	Blooms Taxonomy
CO1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment.	Understand(K2)
CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion.	Understand(K2)
CO3: Skills on combustion thermodynamics and kinetics.	Understand(K2)
CO4: Studied different heat treatment furnace.	Understand(K2)
CO5: Practical and theoretical knowledge burner design.	Apply(K3)

CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	2	1	1	1	-	-	3	-	-
CO2	3	2	2	2	2	2	2	1	1	1	-	-	3	-	-
CO3	3	3	3	2	2	2	2	1	1	1	-	-	3	-	-
CO4	3	2	3	2	2	2	2	1	1	1	-	-	3	-	-
CO5	3	3	3	2	3	3	3	1	1	1	-	-	3	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHO007	BASICS OF PLASTICS PROCESSING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on - To gain practical knowledge on the polymer selection and its processing - Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting) - To understand suitable additives for plastics compounding - To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques					
UNIT I	INTRODUCTION TO PLASTICS PROCESSING				9
Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.					
UNIT II	EXTRUSION				9
Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooning. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw					

extruder and its applications. Applications of extrusion and new developments.

UNIT III	INJECTION MOLDING	9

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures- Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

UNIT IV	COMPRESSION AND TRANSFER MOLDING	9

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms-Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties-Curing time-Mould temperature and Pressure requirements. Preforms and preheating- Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding

UNIT V	BLOW MOLDING, THERMOFORMING AND CASTING	9

Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.

Total periods:45

Text Books:

1. **S. S. Schwart, S. H. Goodman**, *Plastics Materials and Processes*, Van Nostrand Reinhold Company Inc. (1982).
2. **F. Hensen (Ed.)**, *Plastic Extrusion Technology*, Hanser Gardner (1997).
3. **W. S. Allen and P. N. Baker**, *Handbook of Plastic Technology, Volume-1: Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]*, CBS Publishers and Distributors (2004).

References:

- 1.S. S. Schwart, S. H. Goodman, *Plastics Materials and Processes*, Van Nostrad Reinhold Company Inc. (1982).
- 2.F. Hensen (Ed.), *Plastic Extrusion Technology*, Hanser Gardner (1997).
- 3.W. S. Allen and P. N. Baker, *Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding]*, CBS Publishers and Distributors (2004).
- 4.M. Chanda, S. K. Roy, *Plastic Technology handbook*, 4th Edn., CRC Press (2007).

- 5.I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).
- 6.D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).
- 7.M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).
- 8.B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).
- 9.D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).

Course Outcomes:	Blooms Taxonomy

CO1: Ability to find out the correlation between various processing techniques with product properties.	Understand(K2)

CO2: Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.	Understand(K2)

CO3: Acquire knowledge on additives for plastic compounding and methods employed for the same	Understand(K2)

CO4: Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.	Understand(K2)

CO5: Select an appropriate processing technique for the production of a plastic product	Understand(K2)

CO - PO & PSO Mapping															

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	2	1	1	1	-	-	3	3	-
CO2	3	3	3	3	3	2	2	1	1	1	-	-	3	3	-
CO3	2	2	3	2	2	2	1	1	1	1	-	-	3	3	-
CO4	3	2	3	3	3	3	2	2	1	1	-	-	3	3	-
CO5	3	3	3	3	3	3	2	1	1	1	-	-	3	3	-

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23ECO003	SIGNALS AND SYSTEMS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To understand the basic properties of signal & systems - To know the methods of characterization of LTI systems in time domain - To analyze continuous time signals and system in the Fourier and Laplace domain					

- To analyze discrete time signals and system in the Fourier and Z transform domain

UNIT I	CLASSIFICATION OF SIGNALS AND SYSTEMS	9
Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals — Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- — Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.		
UNIT II	ANALYSIS OF CONTINUOUS TIME SIGNALS	9
Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties		
UNIT III	LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS	9
Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.		
UNIT IV	ANALYSIS OF DISCRETE TIME SIGNALS	9
Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties		
UNIT V	LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS	9
Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.		
Total periods:		
Text Books:		
1.Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(Units I - V)		
2.Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002.		
References:		
1.B. P. Lathi, “Principles of Linear Systems and Signals”, 2 nd Edition, Oxford, 2009.		
2.M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw-Hill Education, 2018.		
3.John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007.		
Course Outcomes: At the end of the course, the student will be able to		Blooms Taxonomy
CO1: determine if a given system is linear/causal/stable		Understand(K2)
CO2: determine the frequency components present in a deterministic signal		Understand(K2)
CO3: characterize continuous LTI systems in the time domain and frequency domain		Understand(K2)
CO4: characterize discrete LTI systems in the time domain and frequency domain		Understand(K2)

CO5: compute the output of an LTI system in the time and frequency domains													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	-	3	-	3	2	-	-	-	-	-	3	-	-	1
CO2	3	-	3	-	-	2	-	-	-	-	-	3	-	3	-
CO3	3	3	-	-	3	2	-	-	-	-	-	3	2	-	-
CO4	3	3	-	-	3	2	-	-	-	-	-	3	-	3	1
CO5	3	3	-	3	3	2	-	-	-	-	-	3	-	3	1
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23ECO004	FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					
Course Objectives:					
- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits - To analyze the frequency response of small signal amplifiers - To design and analyze single stage and multistage amplifier circuits - To study about feedback amplifiers and oscillators principles - To understand the analysis and design of multi vibrators					
UNIT I	SEMICONDUCTOR DEVICES				9
PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator					
UNIT II	AMPLIFIERS				9
Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model — Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower — Gain and frequency response- High frequency analysis.					
UNIT III	MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER				9
Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.					
UNIT IV	FEEDBACK AMPLIFIERS AND OSCILLATORS				9

Advantages of negative feedback — Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback—Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

UNIT V**POWER AMPLIFIERS AND DC/DC CONVERTERS****9**

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors — Buck, Boost, Buck-Boost analysis and design.

Total periods:**Text Books:**

1.David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5 th Edition, 2010.

2.Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.

3.Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.

References:

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.

2.D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989

3.Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

Course Outcomes: At the end of the course the students will be able to

Blooms Taxonomy

CO1: Explain the structure and working operation of basic electronic devices.

Understand(K2)

CO2: Design and analyze amplifiers.

Apply(K3)

CO3: Analyze frequency response of BJT and MOSFET amplifiers

Understand(K2)

CO4: Design and analyze feedback amplifiers and oscillator principles.

Analyze(K4)

CO5: Design and analyze power amplifiers and supply circuits.

Analyze(K4)

CO - PO & PSO Mapping

Analyze(K4)

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	1	-	-	-	-	-	1	2	1	1
CO2	3	2	2	3	2	2	-	-	-	-	-	1	2	1	1
CO3	3	3	3	2	1	2	-	-	-	-	-	1	2	1	1
CO4	3	3	2	3	2	2	-	-	-	-	-	1	2	1	1
CO5	3	2	3	2	2	1	-	-	-	-	-	1	2	1	1

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23MEO008	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To understand the global trends and development methodologies of various types of products and services - To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems - To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification - To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics - To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer					
Unit I	BASICS OF PRODUCT DEVELOPMENT				9
Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.					
Unit II	REQUIREMENTS AND SYSTEM DESIGN				9
Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.					
Unit III	DESIGN AND TESTING				9
Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation					
Unit IV	SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT				9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal

Unit V	BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY	9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

Total periods: 45 PERIODS

Text Books:

1. Book specially prepared by NASSCOM as per the MoU.

2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.

References:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.

2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.

3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.

4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

Course Outcomes:	Blooms Taxonomy
CO 1: Define, formulate, and analyze a problem	Understand(K2)
CO2: Solve specific problems independently or as part of a team	Apply(K3)
CO3: Gain knowledge of the Innovation & Product Development process in the Business Context	Analyze(K4)
CO4: Work independently as well as in teams	Understand(K2)
CO5: Manage a project from start to finish.	Understand(K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1	-	-	-	-	-	1	-	1	-	-	-
CO2	3	2	3	1	-	-	-	-	-	1	-	1	-	-	-
CO3	3	2	3	1	1	-	-	1	1	1	-	1	-	-	-
CO4	3	2	3	1	1	-	-	1	1	1	-	1	-	-	-

CO5	3	2	3	1	1	-	-	1	1	1	-	1	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23BMO002	ASSISTIVE TECHNOLOGY	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

-

Course Objectives:

- To know the hardware requirement various assistive devices
- To understand the prosthetic and orthotic devices
- To know the developments in assistive technology

Unit I	CARDIAC ASSIST DEVICES	9

Cardiac functions and parameters, principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, cardiac pacemaker.

Unit II	HEMODIALYSERS	9

Physiology of kidney, Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

Unit III	HEARING AIDS	9

Anatomy of ear, Common tests — audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids — principles, drawbacks in the conventional unit, DSP based hearing aids

Unit IV	PROSTHETIC AND ORTHODIC DEVICES	9

Hand and arm replacement — different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices

Unit V	RECENT TRENDS	9

Transcutaneous electrical nerve stimulator, bio-feedback, assistive devices in drug delivery

Total periods: 45 PERIODS

Text Books:

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006

2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010

3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC

Press, 1st edition, 2010.

References:

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola, Elsevier 2019 ISBN 978 -0-323-662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1.

Course Outcomes:

Blooms Taxonomy

CO 1: Interpret the various mechanical techniques that will help in assisting the heart functions.

Understand(K2)

CO2: Describe the underlying principles of hemodialyzer machine.

Understand(K2)

CO3: Indicate the methodologies to assess the hearing loss.

Understand(K2)

CO4: Evaluate the types of assistive devices for mobilization.

Understand(K2)

CO5: Explain about TENS and biofeedback system.

Understand(K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO5	3	1	1	1	1	-	-	-	-	-	-	-	-	-	-

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23MAO001	OPERATIONS RESEARCH	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

-

Course Objectives:

- determine the optimum solution for Linear programming problems.
- study the Transportation and assignment models and various techniques
- to solve them.
- acquire the knowledge of optimality, formulation and computation of integer

programming problems.

- acquire the knowledge of optimality, formulation and computation of dynamic programming problems.
- determine the optimum solution for non-linear programming problems.

Unit I	LINEAR PROGRAMMING	9
Formulation of linear programming models – Graphical solution – Simplex method - Big M Method – Two phase simplex method - Duality - Dual simplex method.		
Unit II	TRANSPORTATION AND ASSIGNMENT PROBLEMS	9
Matrix form of Transportation problems – Loops in T.P – Initial basic feasible solution – Transportation algorithm – Assignment problem – Unbalanced assignment problems .		
Unit III	INTEGER PROGRAMMING	9
Introduction – All and mixed I.P.P – Gomory's method – Cutting plane algorithm – Branch and bound algorithm – Zero – one programming.		
Unit IV	DYNAMIC PROGRAMMING PROBLEMS	9
Recursive nature of computation – Forward and backward recursion – Resource Allocation model – Cargo – loading model – Work – force size model - Investment model – Solution of L.P.P by dynamic programming .		
Unit V	NON - LINEAR PROGRAMMING PROBLEMS	9
Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn – Tucker Conditions – Quadratic programming.		
Total periods: 45 PERIODS		
Text Books:		
1. Kanti Swarup, P.K.Gupta and Man Mohan, " Operations Research ", Sultan Chand & Sons, New Delhi, Fifth Edition , 1990.		
2. Taha. H.A, " Operations Research — An Introduction , Pearson Education, Ninth Edition , New Delhi, 2012.		
References:		
1. J.K.Sharma , " Operations Research - Theory and Applications " Mac Millan India Ltd , Second Edition , New Delhi , 2003.		
2. Richard Bronson & Govindasami Naadimuthu , " Operations Research " (Schaum's Outlines — TMH Edition) Tata McGraw Hill, Second Edition, New Delhi, 2004.		
3. Pradeep Prabhakar Pai , " Operations Research and Practice", Oxford University Press, New Delhi , 2012.		
4. J.P.Singh and N.P.Singh , " Operations Research , Ane Books Pvt.Ltd, New Delhi , 2014.		
5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.		
Course Outcomes:		Blooms Taxonomy

CO 1: Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.													Understand(K2)		
CO2: analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.													Understand(K2)		
CO3: solve the integer programming problems using various methods													Analyze(K4)		
CO4: conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.													Apply(K3)		
CO5: determine the optimum solution for non linear programming problems.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	2	2	0	0	0	0	2	0	0	2	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MAO002	ALGEBRA AND NUMBER THEORY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To introduce the basic notions of groups, rings, fields which will then be used to solve related problems. - To examine the key questions in the Theory of Numbers. - To give an integrated approach to number theory and abstract algebra, and provide a firm basis for further reading and study in the subject.					
Unit I	GROUPS AND RINGS				9

Groups: Definition - Properties - Homomorphism - Isomorphism - Cyclic groups - Cosets - Lagrange's theorem.

Rings: Definition - Sub rings - Integral domain - Field - Integer modulo n - Ring homomorphism

Unit II	FINITE FIELDS AND POLYNOMIALS	9
Rings - Polynomial rings - Irreducible polynomials over finite fields - Factorization of polynomials over finite fields.		
Unit III	DIVISIBILITY THEORY AND CANONICAL DECOMPOSITIONS	9
Division algorithm- Base- b representations – Number patterns – Prime and composite numbers – GCD – Euclidean algorithm – Fundamental theorem of arithmetic – LCM.		
Unit IV	DIOPHANTINE EQUATIONS AND CONGRUENCES	9
Linear Diophantine equations – Congruence's – Linear Congruence's - Applications : Divisibility tests - Modular exponentiation - Chinese remainder theorem – 2×2 linear systems.		
Unit V	CLASSICAL THEOREMS AND MULTIPLICATIVE FUNCTIONS	9
Wilson's theorem – Fermat's Little theorem – Euler's theorem – Euler's Phi functions – Tau and Sigma functions.		
Total periods:45 PERIODS		

Text Books:

1. Grimaldi, R.P and Ramana, B.V., "Discrete and Combinatorial Mathematics", Pearson Education, 5th Edition, New Delhi, 2007.

2. Thomas Koshy, "Elementary Number Theory with Applications", Elsevier Publications, New Delhi, 2002.

References:

1. San Ling and Chaoping Xing, "Coding Theory — A first Course", Cambridge Publications, Cambridge, 2004

2. Niven.I, Zuckerman.H.S., and Montgomery, H.L., "An Introduction to Theory of Numbers", John Wiley and Sons, Singapore, 2004.

3. Lidl.R., and Pitz. G, "Applied Abstract Algebra", Springer Verlag, New Delhi, 2nd Edition, 2006.

Course Outcomes:	Blooms Taxonomy
CO 1: Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts	Understand(K2)
CO2: Demonstrate accurate and efficient use of advanced algebraic techniques.	Analyze(K4)
CO3: The students should be able to demonstrate their mastery by solving non-trivial problems related to the concepts, and by proving simple theorems about the, statements	Understand(K2)

proven by the text															
CO4: Apply Diophantine Equations and Modular Arithmetic													Apply(K3)		
CO5: Master Classical Theorems and Functions in Number Theory.													Understand(K2)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
CO2	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
CO3	3	3	2	1	3	1	3	1	1	1	2	3	-	-	-
CO4	3	3	2	2	3	2	2	1	1	1	2	3	-	-	-
CO5	2	2	1	-	3	1	2	1	1	1	3	3	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MAO003	LINEAR ALGEBRA	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Course Objectives: - To test the consistency and solve system of linear equations. - To find the basis and dimension of vector space. - To obtain the matrix of linear transformation and its eigenvalues and eigenvectors. - To find orthonormal basis of inner product space and find least square approximation. - To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.					
Unit I	MATRICES AND SYSTEM OF LINEAR EQUATIONS				9
Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.					
Unit II	VECTOR SPACES				9
Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.					
Unit III	LINEAR TRANSFORMATION				9
Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.					

Unit IV	INNER PRODUCT SPACES												9		
Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process - Least square approximation.															
Unit V	EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION												9		
Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.															
Total periods: 45															
Text Books:															
1. Faires J.D. and Burden R., Numerical Methods, Brooks/Cole (Thomson Publications), New Delhi, 2002.															
2. Friedberg A.H, Insel A.J. and Spence L, Linear Algebra, Pearson Education, 5 th Edition,2019.															
References:															
1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8 th Edition, 2009.															
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7 th Edition, 2007.															
3. Kumaresan S, Linear Algebra - A geometric approach, Prentice Hall of India, New Delhi Reprint, 2010.															
4. Richard Branson, Matrix Operations, Schaum's outline series, 1989.															
5. Strang G, Linear Algebra and its applications, Thomson (Brooks / Cole) New Delhi, 4 th Edition, 2005.															
6. Sundarapandian V, Numerical Linear Algebra, Prentice Hall of India, New Delhi, 2014.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Test the consistency and solve system of linear equations.													Understand(K2)		
CO2: Find the basis and dimension of vector space.													Understand(K2)		
CO3: Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.													Understand(K2)		
CO4: Find orthonormal basis of inner product space and find least square approximation.													Understand(K2)		
CO5: Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.													Analyze(K4)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

OPEN ELECTIVE – IV

23HSO002	PROJECT REPORT WRITING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic English grammar knowledge • Fundamental writing skills (paragraph writing, coherence, cohesion) • Understanding of general communication skills					
Course Objectives: • Understand the essentials of project writing. • Perceive the difference between general writing and technical writing • Assimilate the fundamental features of report writing. • Understand the essential differences that exist between general and technical writing. • Learn the structure of a technical and project report.					
Unit I					9
Writing Skills – Essential Grammar and Vocabulary – Passive Voice, Reported Speech, Concord, Signpost words, Cohesive Devices – Paragraph writing - Technical Writing vs. General Writing.					
Unit II					9
Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.					
Unit III					9
Structure of the Project Report: (Part 1) Framing a Title – Content – Acknowledgement – Funding Details -Abstract – Introduction – Aim of the Study – Background - Writing the research question - Need of the Study/Project Significance, Relevance – Determining the feasibility – Theoretical Framework.					
Unit IV					9
Structure of the Project Report: (Part 2) – Literature Review, Research Design, Methods of Data Collection - Tools and Procedures - Data Analysis - Interpretation - Findings –Limitations -Recommendations – Conclusion – Bibliography.					
Unit V					9
Proof reading a report – Avoiding Typographical Errors – Bibliography in required Format – Font – Spacing – Checking Tables and Illustrations – Presenting a Report Orally – Techniques.					
Total Periods :45 PERIODS					
Text Books:					
1. Gerson, S. J., & Gerson, S. M. Technical Communication: Process and Product, 7th Edition, Prentice Hall, 2012.					
2. Riordan, Daniel. Technical Report Writing Today, Cengage Learning, 1998.					

References:

1. Gerson and Gerson - Technical Communication: Process and Product, 7th Edition, Prentice Hall(2012)
 2. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)
 3. Daniel Riordan - Technical Report Writing Today (1998)
- Darla-Jean Weatherford - Technical Writing for Engineering Professionals (2016) Penwell Publishers.

Course Outcomes:**Blooms Taxonomy****CO 1:** Write effective project reports.

Understand

CO2: Use statistical tools with confidence.

Apply

CO3: Explain the purpose and intension of the proposed project coherently and with clarity.

Understand

CO4: Create writing texts to suit achieve the intended purpose.

Create

CO5: Master the art of writing winning proposals and projects.

Apply

CO-PO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	1	1	3	2	2	3	3	3	3	-	-	-
CO2	2	2	2	1	1	1	2	1	2	3	2	3	-	-	-
CO3	2	2	3	3	2	3	2	2	2	3	2	3	-	-	-
CO4	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-
CO5	3	3	3	3	3	3	3	3	3	3	3	3	-	-	-

1- Low, 2- Medium, 3- High, '-' -No correlation

23CEO007	BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic understanding of water resources and environmental studies.

Course Objectives:

- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

Unit I	OVERVIEW OF IWRM	9
Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.		
Unit II	WATER USE SECTORS: IMPACTS AND SOLUTION	9

Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

Unit III	WATER ECONOMICS	9
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.		
Unit IV	RECENT TREANDS IN WATER MANAGEMENT	9
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.		
Unit V	IMPLEMENTATION OF IWRM	9
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.		

Total Periods :45 PERIODS

Text Books:

1. Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2. Mollinga P. et al. "Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

References:

1. Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2. IWRM Guidelines at River Basin Level (UNESCO, 2008).
3. Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET.
http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrn/Tutorial_text.pdf
4. Pramod R. Bhawe, 2011, Water Resources Systems, Narosa Publishers.
5. The 17 Goals, United Nations, <https://sdgs.un.org/goals>.

Course Outcomes:													Blooms Taxonomy		
CO 1: Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.													Apply		
CO2: Discuss on the different water uses; how it is impacted and ways to tackle these impacts.													Understand		
CO3: Explain the economic asOECts of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.													Understand		
CO4: Illustrate the recent trends in water management.													Apply		
CO5: Understand the implementation hitches and the institutional frameworks.													Understand		
CO-PO Mapping															
Particular	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO1	PSO2	PSO3

	1	2	3	4	5	6	7	8	9	10	11	12			
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

1- Low, 2- Medium, 3- High, '-' -No correlation

23MAO004	ADVANCED NUMERICAL METHODS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Understanding of calculus and linear algebra.
- Knowledge of ordinary and partial differential equations.
- Familiarity with basic numerical methods and programming concepts.

Course Objectives:

- To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

Unit I	ALGEBRAIC EQUATIONS AND EIGENVALUE PROBLEM	9

System of nonlinear equations : Fixed point iteration method - Newton's method; System of linear equations: Thomas algorithm for tri diagonal system - SOR iteration methods ; Eigen value problems: Given's method - Householder's method.

Unit II	INTERPOLATION	9

Central difference: Stirling and Bessel's interpolation formulae ; Piecewise spline interpolation: Piecewise linear, piecewise quadratic and cubic spline ; Least square approximation for continuous data (upto 3rd degree).

Unit III	NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS	9

Explicit Adams - Bashforth Techniques - Implicit Adams - Moulton Techniques, Predictor -Corrector Techniques - Finite difference methods for solving two - point linear boundary value problems - Orthogonal Collocation method.

Unit IV	FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS	9

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes - Leibmann's iterative methods - Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes .

Unit V	FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS	9

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's

and Neumann conditions – First order hyperbolic equations - Method of characteristics - Different explicit and implicit methods; Wave equation : Explicit scheme – Stability of above schemes.

Total Periods :45 PERIODS

Text Books:

1. Grewal, B.S., "Numerical Methods in Engineering & Science ", Khanna Publications, Delhi, 2013.
2. Gupta, S.K., "Numerical Methods for Engineers", (Third Edition), New Age Publishers, 2015.
3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., "Computational Methods for Partial Differential Equations", New Age Publishers, 1994.

References:

1. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
2. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9 th Edition, Cengage Learning, New Delhi, 2016.
3. Gupta S.K., "Numerical Methods for Engineers", 4th Edition, New Age Publishers, 2019.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Morton, K.W. and Mayers D.F., "Numerical solution of Partial Differential equations", Cambridge University press, Cambridge, 2002.

Course Outcomes:

Blooms Taxonomy

CO 1: Demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems

Understand

CO2: Understand the interpolation theory

Understand

CO3: Understand the concepts of numerical methods for ordinary differential equations

Understand

CO4: Demonstrate the understandings of common numerical methods for elliptic equations

Understand

CO5: Understand the concepts of numerical methods for time dependent partial differential equations

Understand

CO-PO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	2	2	1	1	1	1	3	-	-	-
CO2	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO3	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO4	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-
CO5	3	3	3	3	3	2	2	1	1	1	1	3	-	-	-

1- Low, 2- Medium, 3- High, '-' -No correlation

23MAO005	RANDOM PROCESSES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Probability and Statistics – Understanding of probability theory, random variables, and basic distributions. - Linear Algebra – Knowledge of matrices, vectors, and operations on them. - Signals and Systems / Calculus – Familiarity with linear systems, differential equations, and basic signal analysis.					
Course Objectives: - To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon. - To understand the basic concepts of random processes which are widely used in communication networks. - To acquaint with specialized random processes which are apt for modelling the real time scenario. - To understand the concept of correlation and spectral densities. - To understand the significance of linear systems with random inputs.					
Unit I	RANDOM VARIABLES				9
Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution- Covariance and Correlation – Transformation of a random variable.					
Unit II	RANDOM PROCESSES				9
Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.					
Unit III	SPECIAL RANDOM PROCESSES				9
Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.					
Unit IV	CORRELATION AND SPECTRAL DENSITIES				9
Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.					
Unit V	LINEAR SYSTEMS WITH RANDOM INPUTS				9
Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.					
Total Periods :45 PERIODS					
Text Books:					
1. Ibe, O.C., "Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.					
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.					
References:					

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.

Course Outcomes:**Blooms Taxonomy**

CO 1: Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.

Understand

CO2: Apply the concept random processes in engineering disciplines.

Apply

CO3: Understand and apply the concept of correlation and spectral densities.

Understand

CO4: Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.

Analyze

CO5: Analyze the response of random inputs to linear time invariant systems.

Analyze

CO-PO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO2	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO3	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO4	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-
CO5	3	3	0	0	0	0	0	0	3	0	0	2	-	-	-

1- Low, 2- Medium, 3- High, '-' -No correlation

23MAO006	QUEUEING AND RELIABILITY MODELLING	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Probability theory – basic understanding of probability, random variables, and distributions.
- Random processes – familiarity with stationary processes, Poisson processes, and Markov chains.
- Basic mathematics – calculus and linear algebra to handle system modeling and reliability calculations.

Course Objectives:

- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To understand the concept of queueing models and apply in engineering.
- To provide the required mathematical support in real life problems and develop probabilistic models which can be used in several areas of science and engineering.
- To study the system reliability and hazard function for series and parallel systems.
- To implement Markovian Techniques for availability and maintainability which opens up new avenues for research.

Unit I	RANDOM PROCESSES	9
Classification – Stationary process – Markov process - Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations – Limiting distributions.		
Unit II	MARKOVIAN QUEUEING MODELS	9
Markovian queues – Birth and death processes – Single and multiple server queueing models – Little's formula - Queues with finite waiting rooms.		
Unit III	ADVANCED QUEUEING MODELS	9
M/G/1 queue – Pollaczek Khinchin formula - M/D/1 and M/EK/1 as special cases – Series queues – Open Jackson networks.		
Unit IV	SYSTEM RELIABILITY	9
Reliability and hazard functions- Exponential, Normal, Weibull and Gamma failure distribution – Time - dependent hazard models – Reliability of Series and Parallel Systems.		
Unit V	MAINTAINABILITY AND AVAILABILITY	9
Maintainability and Availability functions – Frequency of failures – Two Unit parallel system with repair – k out of m systems.		
Total Periods :45 PERIODS		
Text Books:		
1. Shortle J.F, Gross D, Thompson J.M,Harris C.M., “Fundamentals of Queueing Theory”, John Wiley and Sons, New York,2018		
2. Balagurusamy E., “Reliability Engineering”, Tata McGraw Hill Publishing Company Ltd., New Delhi,2010.		
References:		
1. Medhi J, ”Stochastic models of Queueing Theory”, Academic Press, Elsevier, Amsterdam, 2003.		
2. Taha, H.A., "Operations Research", 9th Edition, Pearson India Education Services, Delhi, 2016.		
3. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer Science Applications", 2nd Edition, John Wiley and Sons, 2002.		
4. Govil A.K., “Reliability Engineering”, Tata-McGraw Hill Publishing Company Ltd., New Delhi,1983.		

Course Outcomes:													Blooms Taxonomy		
CO 1: Enable the students to apply the concept of random processes in engineering disciplines.													Apply		
CO2: Students acquire skills in analyzing various queueing models.													Analyze		
CO3: Students can understand and characterize phenomenon which evolve with resOEct to time in a probabilistic manner.													Understand		
CO4: Students can analyze reliability of the systems for various probability distributions.													Analyze		
CO5: Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach.													Apply		
CO-PO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	0	0	0	0	0	0	2	0	0	2	-	-	-
CO2	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO3	3	3	0	2	0	0	0	0	2	0	0	2	-	-	-
CO4	3	3	2	0	0	0	0	0	2	0	0	2	-	-	-
CO5	3	3	3	2	0	0	0	0	2	0	0	2	-	-	-
1- Low, 2- Medium, 3- High, ‘ - ‘-No correlation															

23MGO004	PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of business and management principles • Fundamentals of production processes and operations • Basic mathematics for planning and optimization					
Course Objectives: • To know the basic concept and function of Production and Operation Management for entrepreneurship. • To understand the Production process and planning. • To understand the Production and Operations Management Control for business owners.					
Unit I	INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT				9
Functions of Production Management - Relationship between production and other functions – Production management and operations management, Characteristics of modern production and operation management, organisation of production function, recent trends in production /operations management - production as an organisational function, decision making in production Operations research					

Unit II	PRODUCTION & OPERATION SYSTEMS	9
Production Systems- principles – Models - CAD and CAM- Automation in Production - Functions and significance- Capacity and Facility Planning: Importance of capacity planning- Capacity measurement – Capacity Requirement Planning (CRP) process for manufacturing and service industry		
Unit III	PRODUCTION & OPERATIONS PLANNING	9
Facility Planning – Location of facilities – Location flexibility – Facility design process and techniques – Location break even analysis-Production Process Planning: Characteristic of production process systems – Steps for production process- Production Planning Control Functions – Planning phase- Action phase- Control phase - Aggregate production planning		
Unit IV	PRODUCTION & OPERATIONS MANAGEMENT PROCESS	9
Process selection with PLC phases- Process simulation tools- Work Study – Significance – Methods, evolution of normal/ standard time – Job design and rating - Value Analysis - Plant Layout: meaning – characters — Plant location techniques - Types- MRP and Layout Design - Optimisation and Theory of Constraints (TOC)– Critical Chain Project Management (CCPM)- REL (Relationship) Chart – Assembly line balancing- – Plant design optimisation - Forecasting methods.		
Unit V	CONTROLLING PRODUCTION & OPERATIONS MANAGEMENT	9
Material requirement planning (MRP)- Concept- Process and control - Inventory control systems and techniques – JIT and Lean manufacturing - Network techniques - Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Control Chart (X , R , p , np and C chart) - Cost of Quality, Continuous improvement (Kaizen) - Quality awards - Supply Chain Management - Total Quality Management - 6 Sigma approach and Zero Defect Manufacturing.		
Total Periods :45 PERIODS		
Text Books:		
1. K. Aswathappa & K. Shridhara Bhat, Production and Operations Management, Himalaya Publishing, 2010.		
2. R. Paneerselvam, Production and Operations Management, PHI Learning, 2010.		
References:		
1. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, Pearson, 2007.		
2. Amitabh Raturi, Production and Inventory Management, , 2008.		
3. Adam Jr. Ebert, Production and Operations Management, PHI Publication, 1992.		
4. Muhlemann, Okland and Lockyer, Production and Operation Management, Macmillan India,1992.		
5. Chary S.N, Production and Operations Management, TMH Publications, 2010.		
6. Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.		
Course Outcomes:		Blooms Taxonomy
CO 1: To understand the basics and functions of Production and Operation Management for business owners		Understand
CO2: To learn about the Production & Operation Systems.		Understand

CO3: To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.													Apply		
CO4: To known about the Production & Operations Management Processes in organisations.													Understand		
CO5: To comprehend the techniques of controlling, Production and Operations in industries.													Analyze		
CO-PO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	1	2	1	1	1	-	-	-
CO2	3	2	2	1	1	1	1	1	2	1	1	1	-	-	-
CO3	3	3	2	2	2	1	1	1	2	2	1	1	-	-	-
CO4	3	2	2	2	2	1	1	1	2	2	1	1	-	-	-
CO5	3	3	3	2	2	1	1	1	2	2	1	1	-	-	-
1- Low, 2- Medium, 3- High, ‘-’ -No correlation															

23MGO005	MULTIVARIATE DATA ANALYSIS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of Statistics • Fundamentals of Probability • Understanding of Data Collection and Sampling Techniques					
Course Objectives: • To know various multivariate data analysis techniques for business research					
Unit I	INTRODUCTION				9
Uni-variate, Bi-variate and Multi-variate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation					
Unit II	PREPARING FOR MULTIVARIATE ANALYSIS				9
Conceptualization of research model with variables, collection of data --Approaches for dealing with missing data Testing the assumptions of multivariate analysis					
Unit III	MULTIPLE LINEAR REGRESSION ANALYSIS, FACTOR ANALYSIS				9
Multiple Linear Regression Analysis – Inferences from the estimated regression function – Validation of the model. - Approaches to factor analysis – interpretation of results.					
Unit IV	LATENT VARIABLE TECHNIQUES				9

Confirmatory Factor Analysis, Structural equation modelling, Mediation models, Moderation models, Longitudinal studies.

Unit V**ADVANCED MULTIVARIATE TECHNIQUES****9**

Multiple Discriminant Analysis, Logistic Regression, Cluster Analysis, Conjoint Analysis, multidimensional scaling

Total periods:45 PERIODS

Textbook

1. Joseph F. Hair, William C. Black, Barry J. Babin, Rolph E. Anderson, *Multivariate Data Analysis*, 8th Edition, Pearson Education, 2019.

References:

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, *Multivariate Data Analysis*, Pearson Educa

2. 2. Barbara G. Tabachnick, Linda S.Fidell, *Using Multivariate Statistics*, 6th Edition, Pearson, 2012

3. . Richard A Johnson and Dean W.Wichern, *Applied Multivariate Statistical Analysis*, Prentice Hall,

4. . Richard A Johnson and Dean W.Wichern, *Applied Multivariate Statistical Analysis*, Prentice Hall,

Course Outcomes:**Blooms Taxonomy**

CO 1: Demonstrate a sophisticated understanding of the concepts and methods; know the exact scopes and possible limitations of each method; and show capability of using multivariate techniques to provide constructive guidance in decision making.

Understand

CO2: Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information

Analyze

CO3: Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration

Understand

CO4: Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing detail

Analyze

CO5: Make better business decisions by using advanced techniques in data analytics.

Understand

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	2	1	1
CO2	2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	1	-	-	-	3	2	2
CO4	1	1	1	2	2	-	-	1	2	2	1	1	2	2	1
CO5	2	3	2	2	1	-	-	-	1	-	-	-	1	2	2

1- Low, 2- Medium, 3- High, ‘-’ -No correlation

23MEO009	ADDITIVE MANUFACTURING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites Nil					
- COURSE OBJECTIVES: ☐ To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities. ☐ To be acquainted with vat polymerization and material extrusion processes ☐ To be familiar with powder bed fusion and binder jetting processes. ☐ To gain knowledge on applications of direct energy deposition, and material jetting processes. ☐ To impart knowledge on sheet lamination and direct write technologies.					
Unit I	INTRODUCTION				9
Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.					
Unit II	VAT POLYMERIZATION AND MATERIAL EXTRUSION				9
Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.					
Unit III	POWDER BED FUSION AND BINDER JETTING				9
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.					
Unit IV	MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION				9
Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery Materials -Benefits -Applications.					
Unit V	SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY				9
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.					
Total periods:45 PERIODS					
Textbook					
1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd					

edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0

References:

- 1 Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati, Ohio, 2011, ISBN :9783446425521.
2. Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333
3. . Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. . Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.

Course Outcomes:

Blooms Taxonomy

CO 1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities

Understand

CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.

Analyze

CO3: Elaborate the process and applications of powder bed fusion and binder jetting.

Understand

CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.

Analyze

CO5: Acquire knowledge on sheet lamination and direct write technology..

Understand

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	2	1	1
CO2	2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	1	-	-	-	3	2	2
CO4	1	1	1	2	2	-	-	1	2	2	1	1	2	2	1
CO5	2	3	2	2	1	-	-	-	1	-	-	-	1	2	2

1- Low, 2- Medium, 3- High, '-' -No correlation

23MEO010	NEW PRODUCTDEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Course Objectives: To introduce the fundamental concepts of the new product development					

- To develop material specifications, analysis and process.

Unit I	FUNDAMENTALS OF NPD	9
Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.		
Unit II	MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS	9
Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis		
Unit III	ESSENTIALS OF NPD	9
RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.		
Unit IV	CRITERIONS OF NPD	9
New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation 293 294 results, Lesson Learned & Horizontal deployment in NPD.		
Unit V	METROLOGY FOR MICRO SYSTEMS	9
Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)		

Total periods:45 PERIODS															
Text Books:															
1.Product Development – Sten Jonsson															
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger															
References:															
1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark															
2. Change by Design															
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker															
4. Winning at New Products – Robert Brands 3rd Edition															
Course Outcomes:													Blooms Taxonomy		
CO 1: Discuss fundamental concepts and customer specific requirements of the New Product development													Understand		
CO2: Discuss the Material specification standards, analysis and fabrication, manufacturing process.													Analyze		
CO3: Develop Feasibility Studies & reporting of New Product development													Understand		
CO4: Analyzing the New product qualification and Market Survey on similar products of new product development													Apply		
CO5: Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	3	-	-	-	1	1	-	-	3	3	2
CO2	2	2	3	2	2	-	-	-	1	1	-	-	3	3	3
CO3	2	2	3	2	3	-	-	-	1	1	-	-	3	3	3
CO4	1	1	2	2	3	-	-	1	2	2	1	1	2	2	2
CO5	2	1	2	2	2	-	-	-	1	1	-	-	3	3	3

23MEO011	INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES	Category: OEC			
		L	T	P	C
		2	0	2	3
Course Objectives: The course aims to - Outline Fundamental concepts in UI & UX - Introduce the principles of Design and Building an mobile app					

- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

Unit I	UI/UX	9
Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry -User engagement ethics - Design alternatives		
Unit II	APP DEVELOPMENT	9
SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application.		
Unit III	INDUSTRIAL DESIGN	9
Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing		
Unit IV	MECHANICAL RAPID PROTOTYPING	9
Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing		
Unit V	ELECTRONIC RAPID PROTOTYPING	9
Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA		
Total periods:45 PERIODS		
Textbook		
1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003).		
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.		
References:		
https://www.adobe.com/products/xd/learn/get-started.html		
https://developer.android.com/guide		
Course Outcomes:		Blooms Taxonomy
CO 1: Create quick UI/UX prototypes for customer needs.		Understand
CO2: Develop web application to test product traction / product feature		Analyze
CO3: Develop 3D models for prototyping various product ideas		Understand
CO4: :Develop 3D printing models		Analyze

CO5: Built prototypes using Tools and Techniques in a quick iterative methodology													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	-	-	-	-	2	1	1
CO2	2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	1	-	-	-	3	2	2
CO4	1	1	1	2	2	-	-	1	2	2	1	1	2	2	1
CO5	2	3	2	2	1	-	-	-	1	-	-	-	1	2	2
1- Low, 2- Medium, 3- High, ‘-’ -No correlation															

23MEO012	MICRO AND PRECISION ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic Manufacturing Processes • Fundamentals of Machine Tools • Basics of Metrology and Measurements					
Course Objectives: • Learn about the precision machine tools • Learn about the macro and micro components. • Understand handling and operating of the precision machine tools. • Learn to work with miniature models of existing machine tools/robots and other instruments. • Learn metrology for micro system					
Unit I	INTRODUCTION TO MICROSYSTEMS				9
Design, and material selection, micro-actuators: hydraulic, pneumatic, electrostatic/ magnetic etc. for medical to general purpose applications. Micro-sensors based on Thermal, mechanical, electrical properties; micro-sensors for measurement of pressure, flow, temperature, inertia, force, acceleration, torque, vibration, and monitoring of manufacturing systems.					
Unit II	FABRICATION PROCESSES FOR MICRO-SYSTEMS				9
Additive, subtractive, forming process, microsystems-Micro-pumps, micro- turbines, micro engines, micro-robot, and					

miniature biomedical devices

Unit III	INTRODUCTION TO PRECISION ENGINEERING												9		
Machine tools, holding and handling devices, positioning fixtures for fabrication/ assembly of microsystems. Precision drives: inch worm motors, ultrasonic motors, stick- slip mechanism and other piezo-based devices.															
Unit IV	PRECISION MACHINING PROCESSES												9		
Precision machining processes for macro components - Diamond turning, fixed and free abrasive processes, finishing processes															
Unit V	METROLOGY FOR MICRO SYSTEMS												9		
Metrology for micro systems - Surface integrity and its characterization															
Total periods:45 PERIODS															
Text Books:															
1. Davim, J. Paulo, ed. Microfabrication and Precision Engineering: Research and Development. Woodhead Publishing, 2017															
2. Gupta K, editor. Micro and Precision Manufacturing. Springer; 2017															
References:															
1. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer															
2. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press															
3.Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.															
4. Murthy.R.L, —Precision Engineering in Manufacturingl, New Age International, New Delhi, 2005															
Course Outcomes:													Blooms Taxonomy		
CO 1: Select suitable precision machine tools and operates													Understand		
CO2: Apply the macro and micro components for fabrication of micro systems													Analyze		
CO3: Apply suitable machining process													Understand		
CO4: Able to work with miniature models of existing machine tools/robots and other instruments.													Apply		
CO5: Apply metrology for micro system													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	1	3	-	-	-	1	1	-	-	3	3	2
CO2	2	2	3	2	2	-	-	-	1	1	-	-	3	3	3
CO3	2	2	3	2	3	-	-	-	1	1	-	-	3	3	3
CO4	1	1	2	2	3	-	-	1	2	2	1	1	2	2	2
CO5	2	1	2	2	2	-	-	-	1	1	-	-	3	3	3

23MEO013	COST MANAGEMENT OF ENGINEERING PROJECTS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of Accounting and Costing • Fundamentals of Management Principles • Understanding of Engineering Economics • Basic Mathematical and Quantitative Techniques					
Course Objectives: • Summarize the costing concepts and their role in decision making • Infer the project management concepts and their various aspects in selection • Interpret costing concepts with project execution • Develop knowledge of costing techniques in service sector and various budgetary control techniques • • Illustrate with quantitative techniques in cost management					
Unit I	INTRODUCTION TO COSTING CONCEPTS				9
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control					
Unit II	INTRODUCTION TO PROJECT MANAGEMENT				9
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contract					
Unit III	PROJECT EXECUTION AND COSTING CONCEPTS				9
Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problemPricing strategies: Pareto Analysis, Target costing, Life Cycle Costing					
Unit IV	COSTING OF SERVICE SECTOR AND BUDGETERY CONTRO				9
Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets					
Unit V	QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT				9
Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory					
Total periods:45 45 PERIODS					
Text Books:					

1. John M. Nicholas, Herman Steyn Project Management for Engineering, Business and Technology, Taylor & Francis, 2 August 2020, ISBN: 9781000092561.

2. Albert Lester, Project Management, Planning and Control, Elsevier/Butterworth-Heinemann, 2007, ISBN: 9780750669566, 075066956X.

References:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.

2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.

3. Charles T. Horngren et al Cost Accounting a Managerial Emphasis, Prentice Hall of India, New Delhi, 2011

4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003.

5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007.

Course Outcomes:	Blooms Taxonomy

CO1: Understand the costing concepts and their role in decision making.	Understand

CO2: Understand the project management concepts and their various aspects in selection.	Apply

CO3: Interpret costing concepts with project execution.	Analyze

CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.	Understand

CO5: Become familiar with quantitative techniques in cost management.	Analyze

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	1	-	-	-	1	1	-	-	2	1	3
CO2	2	2	2	3	2	-	-	-	1	2	1	1	3	2	3
CO3	2	2	2	3	2	-	-	-	1	1	1	1	3	2	2
CO4	2	2	2	2	3	-	-	1	2	2	1	1	3	3	2
CO5	2	3	2	3	3	-	-	-	1	1	-	-	3	2	2

23EE0011	BATTERIES AND MANAGEMENT SYSTEM	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic Electrical Engineering
- Fundamentals of Electrochemistry
- Knowledge of Electric Vehicle Powertrain Components
- Basics of Circuit Theory and Modeling
- Understanding of Sensors and Measurement Techniques

Course Objectives:

- The objective of this course is to make the students to understand the working and characteristics of different types of batteries and their management .

Unit I	ADVANCED BATTERIES	9
Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. <i>NCR18650B</i> specifications		
Unit II	BATTERY PACK	9
Battery Pack- design, sizing, calculations, flow chart, real and simulation Model.Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal Resistance. Cloud based and Local Smart charging		
Unit III	BATTERY MODELLING	9
Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models- Introduction. Battery Modelling software/simulation frame		
Unit IV	BATTERY STATE ESTIMATION	9
SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods- Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms		
Unit V	BMS ARCHITECTURE AND REAL TIME COMPONENTS	9
Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray CANedge1 package.ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.		
Total periods:45 45 PERIODS		
Text Books:		
1. Jiuchun Jiang and Caiping Zhang, “Fundamentals and applications of Lithium-Ion batteriesin Electric Drive Vehicles”, Wiley, 2015.		
2. Davide Andrea ,“Battery Management Systems for Large Lithium-Ion Battery Packs” ARTECH House, 2010		
REFERANCE		
1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper		
2. Panasonic <i>NCR18650B- DataShee</i>		
3. bq76PL536A-Q1- IC DataSheet		
4. CC2662R-Q1- IC DataSheet		
Course Outcomes:		Blooms Taxonomy

CO 1: Acquire knowledge of different Li-ion Batteries performance.													Understand		
CO2: Design a Battery Pack and make related calculations.													Analyze		
CO3: Demonstrate a BatteryModel or Simulation													Understand		
CO4: Estimate State-of-Charges in a Battery Pack													Analyze		
CO5: Approach different BMS architectures during real world usage													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	-	1	1	-	-	3	2	3
CO2	2	3	3	2	3	-	-	-	1	1	-	-	3	3	3
CO3	2	3	3	2	3	-	-	-	1	1	-	-	3	3	3
CO4	2	3	2	3	2	-	-	1	2	2	-	1	3	2	2
CO5	2	2	2	2	3	-	-	1	2	2	-	1	3	2	2

23EE0006	SENSORS AND ACTUATORS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic Electrical and Electronics Engineering
- Fundamentals of Measurement and Instrumentation
- Basic Circuit Theory (AC/DC circuits)
- Introductory Physics (mechanics, electromagnetism)
- Basics of Automotive Systems

Course Objectives:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.

Unit I	INTRODUCTION TO MEASUREMENTS AND SENSORS	9
Sensors: Functions- Classifications- Main technical requirement and trends Units and standards Calibration methods- Classification of errors- Error analysis- Limiting error- Probable error-Propagation of error- Odds and uncertainty- principle of transduction-Classification. Static characteristics mathematical model of transducers- Zero, First and Second order transducers-Dynamic characteristics of first and second order transducers for standard test inputs		
Unit II	VARIABLE RESISTANCE AND INDUTANCE SENSORS	9
Principle of operation- Construction details- Characteristics and applications of resistive potentiometer Strain gauges- Resistive thermometers- Thermistors- Piezoresistive sensors Inductive potentiometer Variable reluctance transducers:- EI pick up and LVDT		

Unit III	VARIABLE AND OTHER SPECIAL SENSORS	9
Variable air gap type, variable area type and variable permittivity type- capacitor microphone Piezoelectric, Magnetostrictive, Hall Effect, semiconductor sensor- digital transducers-Humidity Sensor. Rain sensor, climatic condition sensor, solar, light sensor, ant glare sensor.		
Unit IV	AUTOMOTIVE ACTUATORS	9
Electromechanical actuators- Fluid-mechanical actuators- Electrical machines- Direct-current machines- Three-phase machines- Single-phase alternating-current Machines - Duty-type ratings for electrical machines. Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor etc.		
Unit V	AUTOMATIC TEMPERATURE CONTROL ACTUATORS	9
Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for Fixed and variable displacement type air conditioning system.		
Total periods:45 PERIODS		
Text Books:		
1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N. Manik McGraw Hill Publishers, 2019.		
2. Robert Brandy, "Automotive Electronics and Computer System", Prentice Hall, 2001		
3. William Kimberley, "Bosch Automotive Handbook", 6th Edition, Robert Bosch GmbH, 2004.		
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2007, ISBN No: 978-3-658-01783-5.		
References:		
1. James D Halderman, "Automotive Electrical and Electronics", Prentice Hall, USA, 2013		
2. Tom Denton, "Automotive Electrical and Electronics Systems," Third Edition, 2004, SAE International.		
3. Patranabis.D, "Sensors and Transducers", 2nd Edition, Prentice Hall India Ltd, 2003		
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.		
Course Outcomes:		Blooms Taxonomy
CO 1: List common types of sensor and actuators used in vehicles.		Understand
CO2: Design measuring equipment's for the measurement of pressure force, temperature and flow.		Analyze
CO3: Generate new ideas in designing the sensors and actuators for automotive application		Understand
CO4: Understand the operation of the sensors, actuators and electronic control		Apply
CO5: Design temperature control actuators for vehicles.		Understand

CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	1	1	2	3	2	3
CO2	2	3	1	1	2	-	-	-	-	1	2	2	3	3	2
CO3	2	3	2	2	2	-	-	-	-	1	2	3	3	3	2
CO4	3	2	2	2	2	-	-	-	-	2	3	2	3	3	3
CO5	3	3	3	2	3	-	-	-	-	2	1	2	3	2	3

23ECO005	SPACE VEHICLES												Category: OEC			
													L	T	P	C
													3	0	0	3

Prerequisites

- Basics of Aerodynamics
- Fundamentals of Propulsion
- Engineering Mechanics
- Introduction to Aircraft / Space Systems
- Basics of Thermodynamics

Course Objectives:

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of space vehicle configuration design.
- To explain Engine system and support of space vehicle
- To interpret nose cone configuration of space vehicle

Unit I	FUNDAMENTAL ASPECTS	9
Energy and Efficiencies of power plants for space vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - role of launch environment on launch vehicle integrity		
Unit II	SELECTION OF ROCKET PROPULSION SYSTEMS	9
Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – selection of subsystems – types of staging – Interfaces – selection and criteria for stages and their role in launch vehicle configuration design.		
Unit III	ENGINE SYSTEMS, CONTROLS, AND INTEGRATION	9
Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization		
Unit IV	THRUST VECTOR CONTROL	9

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – other jet control methods - exhaust plume problems in space environment

Unit V	NOSE CONE CONFIGURATION												9		
Aerodynamic aspects on the selection of nose shape of a launch vehicle - design factors in the finalization of nose configuration with respect to payload - nose cone thermal protection system - separation of fairings - payload injection mechanism															
Total periods: 45 PERIODS															
Textbook															
1. R. K. Jain and Sunil S. Rao, <i>Industrial Safety, Health and Environment Management Systems</i> , Khanna Publishers, New Delhi, 2006															
2. Slote L., <i>Handbook of Occupational Safety and Health</i> , John Wiley & Sons, New York															
References															
1. Jeanne Mager Stellman, <i>Encyclopedia of Occupational Health and Safety (ILO)</i> , Ms. Irma Jourdan Publication															
2. Frank P. Lees, <i>Loss Prevention in Process Industries</i> , Vol. 1 & 2, Butterworth-Heinemann Ltd., London.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.													Understand		
CO2: Apply knowledge in selecting the appropriate rocket propulsion systems													Analyze		
CO3: interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.													Understand		
CO4: Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.													Analyze		
CO5: Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	-	-	-	-	1	1	2	3	2	2
CO2	3	3	3	2	2	-	-	-	-	2	2	2	3	3	3
CO3	3	3	2	2	2	-	-	-	-	2	2	2	3	3	3
CO4	2	2	3	1	2	-	-	-	-	1	1	2	3	3	3
CO5	1	3	2	1	2	-	-	-	-	2	2	2	3	3	2

23MGO006	MANAGEMENT SCIENCE	Category: OEC			
		L	T	P	C
Prerequisites					

- Basic knowledge of Economics
- Fundamentals of Engineering Management
- Basic Mathematical Skills
- Introductory knowledge of Production / Operations
- Fundamentals of Business and Communication

Course Objectives:

- To introduce fundamental concepts of management and organization to students.
- To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
- To make students familiarize with the concepts of human resources management.
- To acquaint students with the concepts of project management and cost analysis.
- To make students familiarize with the concepts of planning process and business strategies.

Unit I	INTRODUCTION TO MANAGEMENT AND ORGANISATION	9
Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's TheoryX and TheoryY-HertzbergTwoFactorTheoryofMotivation-LeadershipStyles,Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation		
Unit II	OPERATIONS AND MARKETING MANAGEMENT	9
Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production),Work Study - Basic procedure involved in Method Study and Work Measurement – Business Process Reengineering (BPR)-Statistical Quality Control:control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ,ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System,Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on ProductLifeCycle.		
Unit III	HUMAN RESOURCES MANAGEMENT	9
Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating –Capability Maturity Model (CMM)Levels.		
Unit IV	PROJECT MANAGEMENT	9
Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method(CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems		

Unit V	STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES												9		
Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Cards Contemporary Business Strategies.															
Total periods: 45 PERIODS															
Text Books:															
1. KanishkaBedi, Production and Operations Management,Oxford University Press,2007															
2. Stoner,Freeman, Gilbert, Management,6th Ed, PearsonEducation,NewDelhi,2004.															
3. ThomasN.Duening & John M.Ivancevich Management Principles and Guidelines, Biztantra, 2007.															
4. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012															
References:															
1. P.VijayKumar,N.Appa Rao and Ashnab, Chnalill, CengageLearning India,2012															
2. KoontzandWeihrich: Essentials of Management, McGrawHill, 2012.															
3. Lawrence RJauch,R.Guptaand William F. Glueck: Business Policy and Strategic Management Science,McGrawHill,2012.															
4. SamuelC.Certo:Modern Management,2012.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Plan an organizational structure for a given context in the organization to carryout production operations through Work-study													Understand		
CO2: Survey the markets,customers and competition better and price the given products appropriately													Analyze		
CO3: :Ensure quality for a given product or service													Understand		
CO4: Plan, schedule and control projects through PERTandCPM.													Apply		
CO5: :Evaluate strategy for a business or service organisation													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	2	-	-	-	2	1	1	2	2	2	2
CO2	1	2	2	2	3	-	-	-	2	2	1	2	3	2	2
CO3	2	2	3	2	3	-	-	-	1	1	1	2	3	1	3
CO4	2	3	2	3	2	-	-	-	2	1	2	2	2	3	3
CO5	1	3	2	2	2	-	-	-	3	3	2	3	3	2	2

23MEO014	PRODUCTION PLANNING AND CONTROL										Category: OEC			
											L	T	P	C

		3	0	0	3
Prerequisites • Basic Industrial Engineering • Fundamentals of Production / Operations Management • Basic Mathematics (Statistics & Optimization concepts) • Understanding of Manufacturing Processes • Basic knowledge of Inventory and Cost Concepts					
Course Objectives: • To understand the concept of production planning and control act work study, • To apply the concept of product planning, • To analyze the production scheduling, • To apply the Inventory Control concepts. • To prepare the manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP)					
Unit I	INTRODUCTION				9
Objectives and benefits of planning and control-Functions of production control-Types of production job- batch and continuous-Product development and design-Marketing aspect - Functional aspects Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration Standardization, Simplification & specialization- Break even analysis-Economics of a new design.					
Unit II	WORK STUDY				9
Method study, basic procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.					
Unit III	PRODUCT PLANNING AND PROCESS PLANNING				9
Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning- Steps in process planning-Quantity determination in batch production-Machine capacity, balancing- Analysis of process capabilities in a multi product system.					
Unit IV	PRODUCTION SCHEDULING				9
Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems - Line of balance – Flow production scheduling Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control Material requirement planning kanban – Dispatching-Progress reporting and expediting- Manufacturing lead time-Techniques for aligning completion times and due dates.					
Unit V	INVENTORY CONTROL AND RECENT TRENDS IN PP				9

Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP

Total periods: 45 PERIODS

Text Books:

1. James. B. Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.
2. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000

References:

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995
- 2 Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition John Wiley and Sons, 2000.
3. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 1990
4. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007
5. . Melynk, Denzler, " Operations management – A value driven approach" Irwin Mcgraw hill
6. Norman Gaither, G. Frazier, "Operations Management" 9th Edition, Thomson learning IE, 2007
7. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
8. Upendra Kachru, " Production and Operations Management – Text and cases" 1st Edition, Excel books 2007

Course Outcomes:	Blooms Taxonomy

CO 1: The students can able to prepare production planning and control act work study,	Understand

CO2: The students can able to prepare product planning	Analyze

CO3: The students can able to prepare production scheduling,	Understand

CO4: :The students can able to prepare Inventory Control	Analyze

CO5: They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).	Apply

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	2	2	-	-	-	2	2	1	2	2	2	2
CO2	2	2	2	2	3	-	-	-	2	2	2	2	3	2	3
CO3	2	3	2	2	3	-	-	-	1	2	2	2	3	3	2

CO4	1	2	2	3	2	-	-	-	2	3	2	2	2	2	2
CO5	2	3	3	3	3	-	-	-	3	2	3	2	3	3	3

23MGO007	OPERATIONS MANAGEMENT	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of Management Principles
- Fundamentals of Industrial Engineering
- Basic Mathematics & Statistics
- Understanding of Manufacturing Systems
- Introductory knowledge of Supply Chain & Logistics

Course Objectives:

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance

Unit I	INTRODUCTION TO OPERATIONS MANAGEMENT	9

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

Unit II	FORECASTING, CAPACITY AND FACILITY DESIGN	9

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative And Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models. Facility Layout – Principles, Types, Planning tools and techniques.

Unit III	DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS	9

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES,

Procedure .Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

Unit IV	MATERIALS MANAGEMEN	9
Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT		
Unit V	SCHEDULING AND PROJECT MANAGEMENT	9
Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson’s Algorithm – Gantt charts; personnel scheduling in services.		
Total periods: 45 PERIODS		
Text Books:		
1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12th Edition, 2010		
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.		
References:		
1. William J Stevenson, Operations Management, Tata McGraw Hill, 9 th Edition, 2009.		
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006		
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004		
4. . Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.		
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.		
6. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008		
Course Outcomes:	Blooms Taxonomy	
CO 1: The students will appreciate the role of Production and Operations management in enabling and enhancing a firm’s competitive advantages in the dynamic business environment.	Understand	
CO2: : The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems	Analyze	
CO3: The students will able to Formulate and Assess Aggregate Planning strategies and Material Requirement Plan	Understand	
CO4: The students will be able to develop analytical skills to calculate capacity	Analyze	

requirements and developing capacity alternatives															
CO5: The students will be able to apply scheduling and Lean Concepts for improving System Performance.													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	2	1	1	-	-	-	2	2	1	2	2	3	2
CO2	2	2	2	2	2	-	-	-	1	1	1	2	3	3	3
CO3	2	3	2	2	2	-	-	-	2	2	1	3	3	2	3
CO4	3	3	2	3	2	-	-	-	1	1	2	3	2	2	2
CO5	2	3	3	3	3	-	-	-	2	2	2	3	3	3	2

23BMO003	INDUSTRIAL HYGEINE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic Knowledge of Occupational Health and Safety (OHS) • Fundamental understanding of environmental science concepts • Introductory knowledge of industrial processes and workplace hazards • Awareness of basic biology and human physiology related to health impacts					
Course Objectives: • Demonstrate an understanding of how occupational hygiene standards are set and used in work health and safety. • Compare and contrast the roles of environmental and biological monitoring in work health and safety • Outline strategies for identifying, assessing and controlling risks associated with airborne gases, vapours and particulates • Discuss how personal protective equipment can be used to reduce risks associated with workplace exposures • Provide high-level advice on managing and controlling noise and noise-related hazards					
Unit I	INTRODUCTION AND SCOPE				9
Occupational Health and Environmental Safety Management - Principles practices. Comm on Occupational diseases: Occupational Health Management Services at the work place. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records					
Unit II	MONITORING FOR SAFETY, HEALTH & ENVIRONMENT				9

Occupational Health and Environment Safety Management System, ILO and EPA Standards Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures

Unit III**OCCUPATIONAL HEALTH AND ENVIRONMENTAL SAFETY EDUCATION****9**

Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limits.

Unit IV**OCCUPATIONAL SAFETY, HEALTH AND ENVIRONMENT MANAGEMENT****9**

Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. Importance of Industrial safety, role of safety department,

Unit V**INDUSTRIAL HAZARDS****9**

Radiation: Types and effects of radiation on human body, Measurement and detection of radiation intensity. Effects of radiation on human body, Measurement – disposal of radioactive waste, Control of radiation ii. Noise and Vibration: Sources, and its control, Effects of noise on the auditory system and health, Measurement of noise, Different air pollutants in industries, Effect of different gases and particulate matter, acid fumes, smoke, fog on human health, Vibration: effects.

Total periods:45 PERIODS**Text Books:**

1. R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi (2006)
2. Slote. L, Handbook of Occupational Safety and Health, John Willey and Sons, New York.

References:

1. Jeanne MagerStellman, Encyclopedia of Occupational Health and Safety (ILO) Ms. Irma Jourdan publication
2. Frank P Lees - Loss of prevention in Process Industries, Vol. 1 and 2
3. ButterworthHeinemann Ltd., London (1991). 2. Industrial Safety - National Safety Council of India
4. Frank P Lees – Loss of prevention in Process Industries, Vol. 1 and 2, Butterworth- Heinemann Ltd., London
5. R. K. Jain and Sunil S. Rao, Industrial Safety, Health and Environment Management Systems, Khanna publishers, New Delhi (2006).

Course Outcomes:**Blooms Taxonomy**

CO 1: Explain and apply human factors engineering concepts in both evaluation of existing systems and design of new systems													Understand		
CO2: Specify designs that avoid occupation related injuries													Analyze		
CO3: Define and apply the principles of work design, motion economy, and work environment design													Understand		
CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.													Analyze		
CO5: Acknowledge the impact of workplace design and environment on productivity													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	2	3	2	1	2	1	3	2	2	2
CO2	3	3	2	2	1	2	3	2	1	2	1	3	3	2	3
CO3	3	3	3	2	2	2	3	2	1	2	1	3	3	3	3
CO4	2	2	2	3	2	3	3	2	1	2	1	3	2	3	2
CO5	2	3	2	2	3	2	3	2	2	2	1	3	2	3	2

23CHO008	CHEMICAL PROCESS SAFETY	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic Chemistry and Chemical Engineering Fundamentals
- Thermodynamics and Process Engineering
- Material & Energy Balances (recommended)

Course Objectives:

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

Unit I	SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES	9

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories

Unit II	CHEMICAL REACTION HAZARDS	9
Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening,		
Unit III	SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS	9
Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices - scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels.		
Unit IV	SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS	9
Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.		
Unit V	SAFETY AND ANALYSIS	9
Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.		
Total periods: 45 PERIODS		
Text Books:		
1. David A Crowl & Joseph F Louvar, "Chemical Process safety", Pearson publication, 3rd Edition, 2014		
2. Maurice Jones .A, "Fire Protection Systems, 2nd edition, Jones & Bartlett Publishers, 2015		
References:		
1. Ralph King and Ron Hirst, "King's safety in the process industries", Arnold, London, 1998.		
2. Industrial Environment and its Evolution and Control, NIOSH Publication, 1973.		
3. National Safety Council, "Accident prevention manual for industrial operations". Chicago, 1982.		
4. Lewis, Richard. J., Sr, "Sax's dangerous properties of materials". (Ninth edition). Van Nostrand Reinhold, New York, 1996.		
5. Roy E Sanders, "Chemical Process Safety", 3rd Edition, Gulf professional publishing, 2006		

Course Outcomes:													Blooms Taxonomy		
CO1: Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants													Understand		
CO2: Develop thorough knowledge about safety in the operation of chemical plants.													Understand		
CO3: Apply the principles of safety in the storage and handling of gases													Apply		
CO4: Identify the conditions that lead to reaction hazards and adopt measures to prevent them.													Apply		
CO5: Develop thorough knowledge about													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO5	2	2	1	-	-	-	-	-	-	-	-	-	2	2	1
1- Low, 2- Medium, 3- High, ‘-’ -No correlation															

23EE0007	ELECTRICAL, ELECTRONIC AND MAGNETIC MATERIALS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basic Physics (Electricity, Magnetism, and Solid-State Physics) - Materials Science fundamentals - Semiconductor devices (recommended but not mandatory)					
Course Objectives: - Understanding the importance of various materials used in electrical, electronics and magnetic applications Acquiring knowledge on the properties of electrical, electronics and magnetic materials. - Gaining knowledge on the selection of suitable materials for the given application - Knowing the fundamental concepts in Semiconducting materials - Getting equipped with the materials used in optical and optoelectronic applications.					
Unit I	DIELECTRIC MATERIALS				9
Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials					
Unit II	MAGNETIC MATERIALS				9
Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, sOECial purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis					
Unit III	SEMICONDUCTOR MATERIALS				9
Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale Integration techniques. Concept of superconductivity; theories and examples for high temperature superconductivity; discussion on sOECific superconducting materials; comments on fabrication and engineering applications					
Unit IV	MATERIALS FOR ELECTRICAL APPLICATIONS				9
Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.					
Unit V	OPTICAL AND OPTOELECTRONIC MATERIALS				9
Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - HeNe, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockels effect.					

Total periods: 45 PERIODS**Text Books:**

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, Taylor and Francis, 2nd illustrated edition, 2017

2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

References:

1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009

2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.

3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.

4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011

5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006)

Course Outcomes:**Blooms Taxonomy**

CO1: Understand various types of dielectric materials, their properties in various conditions.

Understand

CO2: Evaluate magnetic materials and their behavior.

Analyze

CO3: Evaluate semiconductor materials and technologies.

Analyze

CO4: Select suitable materials for electrical engineering applications.

Apply

CO5: Identify right material for optical and optoelectronic applications

Apply

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO5	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1

1- Low, 2- Medium, 3- High, '-' -No correlation

23CHO009

NANOMATERIALS AND APPLICATIONS

Category: OEC

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Prerequisites

- Basic Materials Science
- Solid-State Physics
- Fundamentals of Chemistry (especially physical chemistry)

Course Objectives:

- Understanding the evolution of nanomaterials in the scientific era and make them to understand different types of nanomaterials for the future engineering applications
- Gaining knowledge on dimensionality effects on different properties of nanomaterials
- Getting acquainted with the different processing techniques employed for fabricating nanomaterials
- Having knowledge on the different characterisation techniques employed to characterise the nanomaterials
- Acquiring knowledge on different applications of nanomaterials in different disciplines of engineering.

Unit I	NANOMATERIALS	9
Introduction, Classification: 0D, 1D, 2D, 3D nanomaterials and nano-composites, their mechanical, electrical, optical, magnetic properties; Nanomaterials versus bulk materials.		
Unit II	THERMODYNAMICS & KINETICS OF NANOSTRUCTURED MATERIALS	9
Size and interface/interphase effects, interfacial thermodynamics, phase diagrams, diffusivity, grain growth, and thermal stability of nanomaterials.		
Unit III	PROCESSING	9
Bottom-up and top-down approaches for the synthesis of nanomaterials, mechanical alloying, chemical routes, severe plastic deformation, and electrical wire explosion technique.		
Unit IV	STRUCTURAL CHARACTERISTICS	9
Principles of emerging nanoscale X-ray techniques such as small angle X-ray scattering and X-ray absorption fine structure (XAFS), electron and neutron diffraction techniques and their application to nanomaterials; SPM, Nanoindentation, Grain size, phase formation, texture, stress analysis		
Unit V	APPLICATIONS	9
Applications of nanoparticles, quantum dots, nanotubes, nanowires, nanocoatings; applications in electronic, electrical and medical industries		
Total periods: 45 PERIODS		
Text Books:		
1. Bhusan, Bharat (Ed), “Springer Handbook of Nanotechnology”, 2nd edition, 2007		
2. Carl C. Koch (ed.), NANOSTRUCTURED MATERIALS, Processing, Properties and Potential Applications, NOYES PUBLICATIONS, Norwich, New York, U.S.A.		
References:		
1. Poole C.P, and Owens F.J., Introduction to Nanotechnology, John Wiley 2003		
2. Nalwa H.S., Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers 2004		
3. Zehetbauer M.J. and Zhu Y.T., Bulk Nanostructured Materials, Wiley 2008		
4. Wang Z.L., Characterization of Nanophase Materials, Wiley 2000		
5. Gutkin Y., Ovid’ko I.A. and Gutkin M., Plastic Deformation in Nanocrystalline Materials, Springer 2004		
Course Outcomes:		Blooms Taxonomy

CO1: Evaluate nanomaterials and understand the different types of nanomaterials													Understand		
CO2: Recognise the effects of dimensionality of materials on the properties.													Analyze		
CO3: Process different nanomaterials and use them in engineering applications													Apply		
CO4: Use appropriate techniques for characterising nanomaterials													Apply		
CO5: . Identify and use different nanomaterials for applications in different engineering fields.													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO5	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
1- Low, 2- Medium, 3- High, '-' -No correlation															

23CE0010	HYDRAULICS AND PNEUMATICS	Category: OEC			
		L	T	P	L
		3	0	0	3
Prerequisites • Engineering Physics – basic fluid properties and pressure concepts • Fluid Mechanics – Bernoulli equation, laminar/turbulent flow, losses • Engineering Mathematics – basic calculus for flow/pressure calculations • Basic Mechanical Engineering – understanding of mechanical components • Engineering Drawing – reading and interpreting hydraulic/pneumatic symbols					
Course Objectives: • To provide the knowledge on the working principles of fluid power systems. • To study the fluids and components used in modern industrial fluid power system. • To develop the design, construction and operation of fluid power circuits. • To learn the working principles of pneumatic power system and its components. • To provide the knowledge of trouble shooting methods in fluid power systems.					
Unit I	FLUID POWER PRINCIPLES AND HYDRAULIC PUMPS				6

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal’s Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power: Pumping Theory— Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of pumps – Fixed and Variable displacement pumps – Problems		
Unit II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	6
Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Rotary Actuators Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Accessories: Reservoirs, Pressure Switches – Filters –types and selection- Applications – Fluid Power ANSI Symbols – Problems		
Unit III	HYDRAULIC CIRCUITS AND SYSTEMS	6
Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Deceleration circuits, Sizing of hydraulic systems, Hydrostatic transmission, Electro hydraulic circuits, –Servo and Proportional valves – Applications- Mechanical, hydraulic servo systems.		
Unit IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	6
Properties of air –Air preparation and distribution – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit –classification- single cylinder and multi cylinder circuits-Cascade method –Integration of fringe circuits, Electro Pneumatic System – Elements – Ladder diagram – timer circuits-Problems, Introduction to fluidics and pneumatic logic circuits		
Unit V	TROUBLE SHOOTING AND APPLICATIONS	6
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Conditioning of hydraulic fluids Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications- mobile hydraulics; Design of Pneumatic circuits for metal working, handling, clamping counter and timer circuits. – Low-cost Automation – Hydraulic and Pneumatic power packs, IOT in Hydraulics and pneumatics Note: (Use of standard Design Data Book is permitted in the University examination)		
Total periods: 45		
Text Books:		
1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.		
2. James A. Sullivan, “Fluid Power Theory and Applications”, Fourth Edition, Prentice Hall, 1997		
References:		
1. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015		
2. Joshi.P., Pneumatic Control”, Wiley India, 2008.		
3. Majumdar, S.R., “Oil Hydraulics Systems – Principles and Maintenance”, TataMcGraw Hill, 2001.		
4. Shanmugasundaram.K., “Hydraulic and Pneumatic Controls”. Chand & Co, 2006.		
5. Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 3rd edition, 2019.		

Course Outcomes:													Blooms Taxonomy		
CO1: Apply the working principles of fluid power systems and hydraulic pumps.													Apply (K3)		
CO2: Apply the working principles of hydraulic actuators and control components.													Apply (K3)		
CO3: Design and develop hydraulic circuits and systems.													Create / Design (K6)		
CO4: Apply the working principles of pneumatic circuits and power system and its components													Apply (K3)		
CO5: Identify various troubles shooting methods in fluid power systems.													Understand / Analyze (K2/K4)		
CO-PO Mapping															
Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2						1		2	3	2	
CO2	3	2	2	2						1		2	3	2	
CO3	3	2	3	3						2		3	3	3	
CO4	3	2	2	2						1		2	3	2	
CO5	2	2	2	2						1		2	2	2	1
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23EEO008	SENSORS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic Electrical and Electronics Engineering • Fundamentals of Measurement and Instrumentation					
Course Objectives: • To learn the various types of sensors, transducers, sensor output signal types, calibration techniques, formulation of system equation and its characteristics. • To understand basic working principle, construction, Application and characteristics of displacement, speed and ranging sensors. • To understand and analyze the working principle, construction, application and characteristics of force, magnetic and heading sensors. • To learn and analyze the working principle, construction, application and characteristics of optical, pressure, temperature and other sensors.					

- To familiarize students with different signal conditioning circuits design and data acquisition system.

Unit I	SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES	9
Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.		
Unit II	DISPLACEMENT, PROXIMITY AND RANGING SENSORS	9
Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.		
Unit III	FORCE, MAGNETIC AND HEADING SENSORS	9
Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement – Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors – Compass, Gyroscope and Inclinometers		
Unit IV	OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS	9
Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non Contact Sensor - Chemical Sensors - MEMS Sensors - Smart Sensors.		
Unit V	SIGNAL CONDITIONING	9
Need for Signal Conditioning – Resistive, Inductive and Capacitive Bridges for Measurement - DC and AC Signal Conditioning - Voltage, Current, Power and Instrumentation Amplifiers – Filter and Isolation Circuits – Fundamentals of Data Acquisition System		
Total periods: 45 PERIODS		
Text Books:		
1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.		
2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.		
References:		
1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.		
2. Davis G. Alciatore and Michael B. Hstand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.		
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.		
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.		

5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.

Course Outcomes:													Blooms Taxonomy		
CO1: Understand various sensor effects, sensor characteristics, signal types, calibration methods and obtain transfer function and empirical relation of sensors. They can also analyze the sensor response.													Understand		
CO2: Analyze and select suitable sensor for displacement, proximity and range measurement..													Analyze		
CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement													Analyze		
CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.													Analyze		
CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal.													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	-	-	-	-	-	-	-	2	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO5	3	2	3	-	-	-	-	-	-	-	-	-	2	2	2
1- Low, 2- Medium, 3- High, ‘- ‘-No correlation															

23MEO005	FOUNDATION OF ROBOTICS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of Engineering Mathematics • Basic knowledge of Mechanics / Kinematics • Fundamentals of Electronics & Sensors • Basics of Programming (C / Python)					

Course Objectives:

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

Unit I	FUNDAMENTALS OF ROBOT	9
Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.		
Unit II	ROBOT KINEMATICS	9
Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.		
Unit III	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9
Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper		
Unit IV	SENSORS IN ROBOTICS	9
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.		
Unit V	PROGRAMMING AND APPLICATIONS OF ROBOT	9
Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.		

Total periods:45 PERIODS

Text Books:

- 1.Ganesh.S.Hedge, "A textbook of Industrial Robotics", Lakshmi Publications, 2006.
- 2.Mikell.P.Groover, "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition 2012.

References:

1.Fu K.S. Gonalz R.C. and ice C.S.G.”Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill book co. 2007.

2.YoramKoren, “Robotics for Engineers”, McGraw Hill Book, Co., 2002.

3.Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill 2005.

4.John. J.Craig, “Introduction to Robotics: Mechanics and Control” 2nd Edition, 2002.

23ECO006	CONCEPTS IN MOBILE ROBOTS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basics of Robotics and Control Systems - Elementary knowledge of Sensors and Signal Processing					
Course Objectives: - To introduce mobile robotic technology and its types in detail. - To learn the kinematics of wheeled and legged robot. - To familiarize the intelligence into the mobile robots using various sensors. - To acquaint the localization strategies and mapping technique for mobile robot. - To aware the collaborative mobile robotics in task planning, navigation and intelligence.					
Unit I	INTRODUCTION TO MOBILE ROBOTICS				9
Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Robots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles					
Unit II	KINEMATICS				9
Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots					
Unit III	PERCEPTION				9
Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.					
Unit IV	LOCALIZATION				9

Localization Based Navigation Versus Programmed Solutions - Map Representation - Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization and Mapping (SLAM).

Unit V	PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS												9		
Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures - Control Localization - Techniques for Decomposition - Case Studies – Collaborative Robots – Swarm Robots.															
Total periods: 45 PERIODS															
Text Books:															
1. Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.															
References:															
1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018															
2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.															
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017															
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.															
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.															
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159.															
Course Outcomes:													Blooms Taxonomy		
CO1: Evaluate the appropriate mobile robots for the desired application.													Evaluate		
CO2: Create the kinematics for given wheeled and legged robot.													Create		
CO3: Analyse the sensors for the intelligence of mobile robotics.													Analyze		
CO4: Create the localization strategies and mapping technique for mobile robot.													Create		
CO5: Create the collaborative mobile robotics for planning, navigation and intelligence for desired applications.													Create		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	2	1
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO4	3	2	3	-	-	-	-	-	-	-	-	-	2	2	2

CO5	3	2	3	-	-	-	-	-	-	-	-	-	2	2	2

1- Low, 2- Medium, 3- High, '-' -No correlation

23MEO015	MARINE PROPULSION	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Fundamentals of fluid mechanics
- Basics of thermodynamics (thermodynamic cycles, energy conversion)
- Basic engineering mechanics (forces, moments, motion)

Course Objectives:

- To impart knowledge on basics of propulsion system and ship dynamic movements
- To educate them on basic layout and propulsion equipment's
- To impart basic knowledge on performance of the ship
- To impart basic knowledge on Ship propeller and its types
- To impart knowledge on ship rudder and its types

Unit I	BASICS SHIP PROPULSION SYSTEM AND EQUIPMENTS	9

law of floatation - Basics principle of propulsion- Earlier methods of propulsion- ship propulsion machinery- boiler, Marine steam engine, diesel engine, ship power transmission system, ship dynamic structure, Marine propulsion equipment - shaft tunnel, Intermediate shaft and bearing, stern tube, stern tube sealing etc. degree of freedom, Modern propelling methods- water jet propulsion , screw propulsion.

Unit II	SHIPS MOVEMENTS AND SHIP STABILIZATION	9

Thrust augmented devices, Ship hull, modern ship propulsion design, bow thruster – Advantages, various methods to stabilize the ship- passive and active stabilizer, fin stabilizer, bilge keel - stabilizing and securing ship in port- effect of tides on ship – effect of river water and sea water sailing vessel, Load line and load line of marking- draught markings.

Unit III	SHIPS SPEED AND ITS PERFORMANCE	9

Ship propulsion factors, factors affecting ships speed, various velocities of ship, hull drag, effects of fouling on ships hull, ship wake, relation between powers, Fuel consumption of ship, cavitations - effects of cavitation's, ship turning radius.

Unit IV	BASICS OF PROPELLER	9

Propeller dimension, Propeller and its types – fixed propeller, control pitch propeller, kort nozzle, ducted propeller, voith schneider, Parts of propeller, 3 blade - 5 blade - 6 blade propellers and its advantages, propeller boss hub, crown nut, propeller skew, pitch of propeller - Thrust creation by propeller. Propeller Material – Propeller balancing- static and dynamic.

Unit V	BASICS OF RUDDER												9		
Rudder dimension, Area of rudder and its design, Rudder arrangements, Rudder fittings- Rudder pintle - Rudder types- Balanced rudder, semi balanced rudder, Spade rudder, merits and demerits of various types of rudders, Propeller and rudder interaction, Rudder stopper, movement of rudders, Basic construction of Rudder															
Total periods: 45 PERIODS															
Text Books:															
1.GP. Ghose, “Basic Ship propulsion”,2015															
2.E.A. Stokoe “Reeds Ship construction for marine engineers”, Vol. 5,2010															
3.E.A. Stokoe, “Reeds Naval architecture for the marine engineers”,4th Edition,2009															
References:															
1.DJ Eyers and GJ Bruse, “Ship Construction”, 7th Edition, 2006.															
2.KJ Rawson and EC Tupper, “Basic Ship theory I” Vol. 1,5th Edition,2001.															
Course Outcomes:													Blooms Taxonomy		
CO1: Explain the basics of propulsion system and ship dynamic movements													Understand		
CO2: Familiarize with various components assisting ship stabilization													Understand		
CO3: Demonstrate the performance of the ship.													Analyze		
CO4: Classify the Propeller and its types, Materials etc.													Understand		
CO5: Categories the Rudder and its types, design criteria of rudder.													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	–	1	–	–	–	–	–	–	2	3	2	–
CO2	2	2	1	–	–	–	2	1	–	–	–	2	2	1	–
CO3	3	3	2	2	2	–	–	–	–	–	–	3	3	2	1
CO4	2	2	1	–	1	–	–	–	–	–	–	2	2	2	–
CO5	2	2	1	–	1	–	–	–	–	–	–	2	2	2	–
1- Low, 2- Medium, 3- High, ‘- ‘-No correlation															

23MEO016	MARINE MERCHANT VESSELS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Engineering Physics (fundamentals of forces, pressure, fluids) • Basic Mechanics (equilibrium, centre of gravity) • Basic Engineering Materials • Introductory knowledge of transportation systems (optional but useful)					

Course Objectives:

- Knowledge on basics of Hydrostatics
- Familiarization on types of merchant ships
- Knowledge on Shipbuilding Materials
- Knowledge on marine propeller and rudder
- Awareness on governing bodies in shipping industry

Unit I	INTRODUCTION TO HYDROSTATICS	9
Archimedes Principle- Laws of floatation– Meta centre – stability of floating and submerged bodies- Density, relative density - Displacement –Pressure –centre of pressure.		
Unit II	TYPES OF SHIP	9
General cargo ship - Refrigerated cargo ships - Container ships - Roll-on Roll-off ships – Oil tankers- Bulk carriers - Liquefied Natural Gas carriers - Liquefied Petroleum Gas carriers - Chemical tankers - Passenger ships		
Unit III	SHIPBUILDING MATERIALS	9
Types of Steels used in Shipbuilding - High tensile steels, Corrosion resistant steels, Steel sandwich panels, Steel castings, Steel forgings - Other shipbuilding materials, Aluminium alloys, Aluminium alloy sandwich panels, Fire protection especially for Aluminium Alloys, Fiber Reinforced Composites		
Unit IV	MARINE PROPELLER AND RUDDER	9
Types of rudder, construction of Rudder-Types of Propeller, Propeller material-Cavitations and its effects on propeller		
Unit V	GOVERNING BODIES FOR SHIPPING INDUSTRY	9
Role of IMO (International Maritime Organization), SOLAS (International Convention for the Safety of Life at Sea), MARPOL (International Convention for the Prevention of Pollution from Ships) , MLC (Maritime Labour Convention), STCW 2010 (International Convention on Standards of Training, Certification and Watch keeping for Seafarers), Classification societies Administration authorities		
Total periods: 45 PERIODS		
Text Books:		
1.D.J.Eyres, “Ship Constructions”, Seventh Edition, Butter Worth Heinemann Publishing, USA, 2015		
2.Dr.DA Taylor, “Merchant Ship Naval Architecture” I. Mar EST publications, 2006		
3.EA Stokoe, E.A, “Naval Architecture for Marine Engineers”, Vol.4, Reeds Publications,2000		
References:		
1.Kemp & Young “Ship Construction Sketches & Notes”, Butter Worth Heinemann Publishing, USA, 2011		
2.MARPOL Consolidated Edition , Bhandakar Publications, 2018		
3.SOLAS Consolidated Edition , Bhandakar Publications, 2016		
Course Outcomes:	Blooms Taxonomy	
CO1: Acquire Knowledge on floatation of ships	Remember	

CO2: Acquire Knowledge on features of various ships													Remember		
CO3: Acquire Knowledge of Shipbuilding Materials													Remember		
CO4: Acquire Knowledge to identify the different types of marine propeller and rudder													Remember		
CO5: Understand the Roles and responsibilities of governing bodies													Remember		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	1	-	-	-	-	-	3	2	-
CO2	3	-	-	-	-	-	2	-	-	-	-	-	3	2	-
CO3	3	3	2	-	-	-	1	-	-	-	-	-	3	3	2
CO4	3	2	2	-	-	-	1	-	-	-	-	-	3	3	2
CO5	-	-	-	-	-	3	3	2	-	-	-	2	2	2	-
1- Low, 2- Medium, 3- High, '-' -No correlation															

23MEO017	ELEMENTS OF MARINE ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of mechanics and thermodynamics • Basic understanding of IC engines • Familiarity with engineering materials • Fundamentals of fluid mechanics (helpful but not mandatory)					
Course Objectives: • Understand the role of Marine machinery systems • Be familiar with Marine propulsion machinery system • Acquaint with Marine Auxiliary machinery system • Have acquired basics of Marine Auxiliary boiler system • Be aware of ship propellers and steering system					
Unit I	ELEMENTARY KNOWLEDGE ON MARINE MACHINERY SYSTEMS				9
Marine Engineering Terminologies, Parts of Ship, Introduction to Machinery systems on board ships – Propulsion Machinery system, Electricity Generator system, Steering gear system, Air compressors & Air reservoirs, Fuel oil and Lubricating Oil Purifiers, Marine Boiler systems					
Unit II	MARINE PROPULSION MACHINERY SYSTEM				9
Two stroke Large Marine slow speed Diesel Engine – General Construction, Basic knowledge of Air starting and reversing mechanism, Cylinder lubrication oil system, Main lubricating oil system and cooling water system					
Unit III	MARINE AUXILIARY MACHINERY SYSTEM				9

Four stroke medium speed Diesel engine – General Construction, Inline, V-type arrangement of engine, Difference between slow speed and medium speed engines – advantages, limitations and applications

Unit IV**MARINE BOILER SYSTEM****9**

Types of Boiler – Difference between Water tube boiler and Fire tube boiler, Need for boiler on board ships, Uses of steam, Advantages of using steam as working medium, Boiler mountings and accessories – importance of mountings, need for accessories

Unit V**SHIP PROPELLERS AND STEERING MECHANISM****9**

Importance of Propellor and Steering gear, Types of propellers - Fixed pitch propellers, Controllable pitch propellers, Water jet propellers, Steering gear systems - 2-Ram and 4 Ram steering gear, Electric steering gear

Total periods: 45 PERIODS**Text Books:**

1. Taylor, “Introduction to Marine engineering”, Revised Second Edition, Butterworth Heinemann, London, 2011

2. J.K.Dhar, “Basic Marine Engineering”, Tenth Edition, G-Maritime Publications, Mumbai, 2011

3. K.Ramaraj, “Text book on Marine Engineering”, Eswar Press, Chennai, 2018

References:

1. Alan L.Rowen, “Introduction to Practical Marine Engineering, Volume 1&2, The Institute of Marine Engineers (India), Mumbai, 2006

2. A.S.Tambwekar, “Naval Architecture and Ship Construction”, The Institute of Marine Engineers (India), Mumbai, 2015

Course Outcomes:**Blooms Taxonomy**

CO1:Distinguish the role of various marine machinery systems

Understand

CO2: Relate the components of marine propulsion machinery system

Understand

CO3:Explain the importance of marine auxiliary machinery system

Understand

CO4: Acquire knowledge of marine boiler system

Understand

CO5: Understand the importance of ship propellers and steering system

Understand

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	2	-	-	-	-	-	3	2	-
CO2	3	2	2	-	-	-	1	-	-	-	-	-	3	3	2
CO3	3	3	-	-	-	-	1	-	-	-	-	-	3	2	-
CO4	3	2	-	-	-	-	2	-	-	-	-	-	3	2	1
CO5	3	2	2	-	-	-	2	-	-	-	-	2	3	3	2

1- Low, 2- Medium, 3- High, ‘-’ -No correlation

23ECO007	DRONE TECHNOLOGIES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of physics (forces, motion, energy) • Basic programming exposure (C / Python preferred) • Understanding of electronics fundamentals (sensors, actuators, batteries) • Familiarity with aerodynamics (advantageous, not mandatory)					
Course Objectives: • To understand the basics of drone concepts • To learn and understand the fundamentals of design, fabrication and programming of drone • To impart the knowledge of an flying and operation of drone • To know about the various applications of drone • To understand the safety risks and guidelines of fly safely					
Unit I	INTRODUCTION TO DRONE TECHNOLOGY				9
Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability					
Unit II	DRONE DESIGN, FABRICATION AND PROGRAMMING				9
Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts -Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program -Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.					
Unit III	DRONE FLYING AND OPERATION				9
Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications					
Unit IV	DRONE COMMERCIAL APPLICATIONS				9
Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing					
Unit V	FUTURE DRONES AND SAFETY				9
The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms					
Total periods: 45 PERIODS					

Text Books:

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.

2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2016

References:

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016

2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

Course Outcomes:**Blooms Taxonomy**

CO1: Know about a various type of drone technology, drone fabrication and programming

Understand

CO2: Execute the suitable operating procedures for functioning a drone

Apply

CO3: Select appropriate sensors and actuators for Drones

Apply

CO4: Develop a drone mechanism for specific applications

Apply

CO5: Create the programs for various drones

Create

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
Apply CO1	3	2	-	-	-	-	2	-	-	-	-	-	3	2	-
CO2	-	3	3	-	2	-	-	-	2	-	-	-	2	3	2
CO3	3	3	-	2	2	-	-	-	-	-	-	-	3	3	2
CO4	-	-	3	3	2	-	-	-	-	-	-	2	2	3	3
CO5	-	3	3	-	3	-	-	-	-	-	-	3	3	2	3

1- Low, 2- Medium, 3- High, '-' -No correlation

23CE0005	GEOGRAPHICAL INFORMATION SYSTEM	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of maps and spatial concepts • Basic knowledge of computer applications • Familiarity with data handling / database concepts (advantageous, not mandatory)					
Course Objectives: • To impart the knowledge on basic components, data preparation and implementation of Geographical Information System.					
Unit I	FUNDAMENTALS OF GIS				9

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

Unit II	SPATIAL DATA MODELS												9		
Database Structures – Relational, Object Oriented – Entities – ER diagram - data models - conceptual, logical and physical models - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models.															
Unit III	DATA INPUT AND TOPOLOGY												9		
Scanner - Raster Data Input – Raster Data File Formats – Georeferencing – Vector Data Input –Digitizer – Datum Projection and reprojection -Coordinate Transformation – Topology - Adjacency, connectivity and containment – Topological Consistency – Non topological file formats - Attribute Data linking – Linking External Databases – GPS Data Integration															
Unit IV	DATA QUALITY AND STANDARDS												9		
Data quality - Basic aspects - completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy and lineage – Metadata – GIS Standards –Interoperability - OGC - Spatial Data Infrastructure															
Unit V	DATA MANAGEMENT AND OUTPUT												9		
Import/Export – Data Management functions- Raster to Vector and Vector to Raster Conversion - Data Output - Map Compilation – Chart/Graphs – Multimedia – Enterprise Vs. Desktop GIS- distributed GIS.															
Total periods: 45 PERIODS															
Text Books:															
1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.															
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, “An Introduction Geographical Information Systems, Pearson Education, 2nd Edition,2007.															
References:															
1.Lo. C. P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006.															
Course Outcomes:													Blooms Taxonomy		
CO1: Have basic idea about the fundamentals of GIS.													Remember		
CO2: Understand the types of data models.													Understand		
CO3: Get knowledge about data input and topology													Apply		
CO4: Gain knowledge on data quality and standards													Understand		
CO5: Understand data management functions and data output													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-

CO2	3	3	-	2	-	-	-	-	-	-	-	-	3	2	-
CO3	3	3	2	-	2	-	-	-	-	-	-	-	3	3	2
CO4	-	3	-	2	-	-	2	-	-	-	-	2	2	3	-
CO5	-	3	2	-	3	-	-	-	-	-	-	3	3	3	2

23CE0006	AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic understanding of agriculture practices
- Fundamental knowledge of economics and business concepts
- Familiarity with rural development and government schemes
- Basic skills in financial literacy and documentation

Course Objectives:

- To introduce the importance of Agri-business management, its characteristics and principles
- To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

Unit I	ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT	9

Entrepreneur Development(ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy- Entrepreneurial and managerial characteristics- Entrepreneurship development programmes (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.

Unit II	AGRICULTURE IN GLOBAL ARENA: LEGAL PERSPECTIVE	9

Importance of agribusiness in Indian economy - International trade-WTO agreements- Provisions related to agreements in agricultural and food commodities - Agreements on Agriculture (AOA)- Domestic supply, market access, export subsidies agreements on sanitary and phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

Unit III	ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE	9

Entrepreneurship - Essence of managerial Knowledge -Management functions- Planning-organizing-Directing- Motivation-ordering-leading-supervision- communication and control-Understanding Financial Aspects of Business - Importance of financial statements-liquidity ratios-leverage ratios, coverage ratios-turnover ratios-Profitability ratios. Agro-based industries-Project-Project cycle-Project appraisal and evaluation techniques-undiscounted measures- Payback period-proceeds per rupee of outlay, Discounted measures-Net Present Value (NPV)-Benefit-Cost Ratio(BCR)-Internal Rate of Return(IRR)-Net benefit investment ratio(N/K ratio)-sensitivity analysis.

Unit IV	ENTREPRENEURIAL OPPORTUNITIES: ECONOMIC GROWTH PERSPECTIVE												9		
Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country- Overview of Indian social, political system and their implications for decision making by individual entrepreneurs- Economic system and its implication for decision making by individual entrepreneurs.															
Unit V	ENTREPRENEURIAL PROMOTION MEASURES AND GOVERNMENT SUPPORT												9		
Social responsibility of business. Morals and ethics in enterprise management- SWOT analysis- Government schemes and incentives for promotions of entrepreneurship. Government policy on small and medium enterprises (SMEs)/SSIs/MSME sectors- Venture capital (VC), contract framing (CF) and Joint Venture (JV), public-private partnerships (PPP) - overview of agricultural engineering industry, characteristics of Indian farm machinery industry.															
Total periods: 45 PERIODS															
Text Books:															
1. Joseph L. Massie, 1995, “Essentials of Management”, prentice Hall of India Pvt limited, New Delhi															
2. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi															
3. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi															
References:															
1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey															
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey															
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.															
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.															
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Judge about agricultural finance, banking and cooperation													Evaluate (K5)		
CO 2: Evaluate basic concepts, principles and functions of financial management													Understand (K2)		
CO 3: Improve the skills on basic banking and insurance schemes available to customers													Apply (K3)		
CO 4: Analyze various financial data for efficient farm management													Analyze (K4)		
CO 5: Identify the financial institutions													Remember (K1)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	-	-	-	-	-	-	1	2	2	-
CO2	2	3	2	2	2	-	-	-	-	-	-	1	2	2	-
CO3	2	2	3	2	2	-	-	-	-	-	-	1	2	2	-

CO4	3	3	2	3	2	-	-	-	-	-	-	1	2	2	-
CO5	2	2	1	1	2	-	-	-	-	-	-	1	2	2	-
1- Low, 2- Medium, 3- High, '-' -No correlation															

23CEO009	BIODIVERSITY CONSERVATION	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basic understanding of biology - General knowledge of ecosystems and environmental science - Familiarity with plant and animal classification at school level					
Course Objectives: The identification of different aspects of biological diversity and conservation techniques					
Unit I	INTRODUCTION				9
Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and them Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.					
Unit II	INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY				9
Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.					
Unit III	MICROBIAL DIVERSITY				9
Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis					
Unit IV	MEGA DIVERSITY				9
Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio-economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.					
Unit V	CONSERVATIONS OF BIODIVERSITY				9
In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species					
Total periods:45 PERIODS					
Textbooks:					
1. A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001					

2. Principles of Systematic Zoology, McGraw-Hill College, Ashlock, P.D., Latest Edition.
3. Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine LaCasse, 13th Edition 2019.

References:

1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.
2. Encyclopaedia of Biodiversity, Academic Press, Simonson Asher Levin.

Course Outcomes:**Blooms Taxonomy****CO1:** An insight into the structure and function of diversity for ecosystem stability.

Understand (K2)

CO2: Understand the concept of animal diversity and taxonomy

Understand (K2)

CO3: Understand socio-economic issues pertaining to biodiversity

analyses (K4)

CO4: An understanding of biodiversity in community resource management.

Apply (K3)

CO5: Student can apply fundamental knowledge of biodiversity conservation to solve problems associated with infrastructure development.

Apply (K3)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1		2	2	1				1	2	2	
CO2	2	2	1	1		1	2	-				1	2	2	
CO3	2	2	1	2		2	3	1				2	2	2	
CO4	2	2	2	2		2	3	2				2	2	3	
CO5	2	2	3	3		2	3	2				2	3	3	

1- Low, 2- Medium, 3- High, - -No correlation

23EE0009	INTRODUCTION TO CONTROL SYSTEMS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of differential equations
- Fundamental concepts of physics
- Basic electrical engineering principles
- Understanding of Laplace transform
- Basic mathematical modeling concepts

Course Objectives:

- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

Unit I	MATHEMATICAL MODELS OF PHYSICAL SYSTEMS	9
Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.		
Unit II	TIME RESPONSE ANALYSIS & ROOT LOCUS TECHNIQUE	9
Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus– Rules for sketching root loci.		
Unit III	FREQUENCY RESPONSE ANALYSIS	9
Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.		
Unit IV	STABILITY CONCEPTS & ANALYSIS	9
Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion – Stability from Bode plot – Relative stability from Nyquist & Bode – Closed loop frequency response		
Unit V	STATE VARIABLE ANALYSIS	9
Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability		
Total periods: 45 PERIODS		
Text Books:		
1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back McGraw Hill Education, 2018.		
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition 2015.		
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.		
References:		
1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.		
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.		
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System Analysis and Design, 5th Edition, CRC PRESS, 2003.		
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.		
5. Yaduvir Singh and S. Janardhanan, Modern Control, Cengage Learning, First Impression 2010.		
Course Outcomes:	Blooms Taxonomy	

CO1: Design the basic mathematical model of physical System.													Apply (K3)		
CO2: Analyze the time response analysis and techniques.													Apply (K3)		
CO3: Analyze the transfer function from different plots.													Apply (K3)		
CO4: Apply the stability concept in various criterion.													Apply (K3)		
CO5: Assess the state models for linear and continuous Systems.													Apply (K3)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	0	0	0	1	1	0	2	3	2	0
CO2	3	3	2	2	1	0	0	0	1	1	0	2	3	2	0
CO3	3	3	2	2	2	0	0	0	1	1	0	2	3	2	0
CO4	3	3	2	2	1	0	0	0	1	1	0	2	3	2	0
CO5	3	3	2	3	2	0	0	0	1	1	0	2	3	3	0
1- Low, 2- Medium, 3- High, ‘- ‘-No correlation															

23EE0010	ENERGY TECHNOLOGY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of physics and chemistry • Fundamentals of thermodynamics • Awareness of energy sources and environmental issues • Basic mathematical skills • Elementary understanding of power plants and industrial processes					
Course Objectives: • To provide basic knowledge on various forms of energy and their global/Indian availability. • To impart understanding of conventional energy systems such as thermal, hydel, and nuclear power plants. • To introduce non-conventional and renewable energy technologies like solar, wind, tidal, geothermal, and biomass energy. • To develop knowledge on energy storage systems and fuel cell technologies. • To familiarize students with energy conservation techniques and energy audit methods in process industries.					
Unit I	INTRODUCTION				9
Units of energy, conversion factors, general classification of energy, world energy resources and energy consumption, Indian energy resources and energy consumption, energy crisis, energy alternatives, Renewable and non-renewable energy sources and their availability. Prospects of Renewable energy sources					
Unit II	CONVENTIONAL ENERGY				9

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

Unit III	NON-CONVENTIONAL ENERGY	9
Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.		
Unit IV	BIOMASS ENERGY	9
Biomass energy resources, thermo-chemical and biochemical methods of biomass conversion, combustion, gasification, pyrolysis, biogas production, ethanol, fuel cells, alkaline fuel cell, phosphoric acid fuel cell, molten carbonate fuel cell, solid oxide fuel cell, solid polymer electrolyte fuel cell, magneto hydrodynamic power generation, energy storage routes like thermal energy storage, chemical, mechanical storage and electrical storage.		
Unit V	ENERGY CONSERVATION	9
Energy conservation in chemical process plants, energy audit, energy saving in heat exchangers, distillation columns, dryers, ovens and furnaces and boilers, steam economy in chemical plants, energy conservation.		
Total periods: 45 PERIODS		
Text Books:		
1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.		
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.		
3. Bansal, N.K., Kleeman, M. and Meliss, M., Renewable Energy Sources and Conversion Technology, Tata McGraw Hill, 1990.		
4. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.		
References:		
1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.		
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.		
3. Sukhatme. S.P., Solar Enery - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.		
Course Outcomes:	Blooms Taxonomy	
CO1: Students will be able to describe the fundamentals and main characteristics of renewable energy sources and their differences compared to fossil fuels.	Understand (K2)	
CO2: Students will excel as professionals in the various fields of energy engineering	Apply (K3)	
CO3: Compare different renewable energy technologies and choose the most appropriate based on local conditions.	Analyze (K4)	
CO4: Explain the technological basis for harnessing renewable energy sources.	Understand (K2)	

CO5: Identify and critically evaluate current developments and emerging trends within the field of renewable energy technologies and to develop in-depth technical understanding of energy problems at an advanced level.													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	3	2	1	1	1	3	3	2	1
CO2	3	3	2	2	2	2	3	2	1	1	1	3	3	3	1
CO3	3	3	3	2	2	2	3	2	1	1	1	3	3	3	2
CO4	3	2	2	2	2	2	3	2	1	1	1	3	3	2	1
CO5	3	3	3	2	2	3	3	3	1	1	1	3	3	3	2
1- Low, 2- Medium, 3- High, ‘- ‘-No correlation															

23MEO021	INTRODUCTION TO INDUSTRIAL AUTOMATION SYSTEMS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of sensors and actuators • Fundamentals of electrical circuits and power electronics • Basic programming and logic concepts • Elementary control systems and instrumentation concepts • Familiarity with communication/network basics					
Course Objectives: • To educate on design of signal conditioning circuits for various applications. • To Introduce signal transmission techniques and their design. • Study of components used in data acquisition systems interface techniques • To educate on the components used in distributed control systems • To introduce the communication buses used in automation industries.					
Unit I	INTRODUCTION				9
Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus & Profibus					
Unit II	AUTOMATION COMPONENTS				9
Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.					
Unit III	COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS				9
Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation.					
Unit IV	PROGRAMMABLE LOGIC CONTROLLERS				9
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.					
Unit V	DISTRIBUTED CONTROL SYSTEM				9
Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.					

Total periods: 45 PERIODS**Text Books:**

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.
3. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.

References:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003.
2. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011.
4. Gary Dunning, Thomson Delmar,"Programmable Logic Controller", CeneageLearning, 3 rd Edition,2005.

Course Outcomes:**Blooms Taxonomy****CO1:** Design a signal conditioning circuits for various application (L3).

Apply (K3)

CO2: Acquire a detail knowledge on data acquisition system interface and DCS system (L2).

Understand (K2)

CO3: Understand the basics and Importance of communication buses in applied automation Engineering (L2).

Understand (K2)

CO4: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.(L3)

Apply (K3)

CO5: Able to develop a PLC logic for a specific application on real world problem. (L5)

Evaluate (K5)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	-	2	1	-	-	-	1	-	-	3	2	-
CO2	3	2	2	-	2	1	-	-	-	1	-	-	3	2	-
CO3	2	3	2	-	3	1	-	-	-	1	-	-	2	2	-
CO4	2	3	3	2	2	1	2	-	-	2	-	-	3	3	-
CO5	2	3	3	3	3	2	2	-	-	3	-	-	3	3	-

1- Low, 2- Medium, 3- High, '-' -No correlation**23BTO004****FUNDAMENTALS OF FOOD ENGINEERING****Category: OEC****L****T****P****C****3****0****0****3****Prerequisites**

- Basic knowledge of Physics (mechanics, heat transfer)
- Basic Chemistry (properties of materials)
- Fundamentals of Mathematics

Course Objectives:

- Acquaint and equip the students with different techniques of measurement of engineering properties.
- Make the students understand the nature of food constituents in the design of processing equipment

Unit I		9
Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties		
Unit II		9
Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foam mat dryers		
Unit III		9
Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer mills and impactors, attrition mills, buhr mill, tumbling mills, ultra fine grinders, fluid jet pulveriser, colloid mill, cutting machines (slicing, dicing, shredding, pulping)		
Unit IV		9
Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for low- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids		
Unit V		9
Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro-dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.		
Total periods: 45 PERIODS		
Textbooks:		

- 1.R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Institute of Food Science & Technology, Nze. Warren L. McCabe, Julian Smith, Peter Harriott. 2004
- 2.Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003
- 3.Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA
- 4.George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science Business Media, New York, USA.

References:

1. R. L. Earle (2004) – *Unit Operations in Food Processing*, The New Zealand Institute of Food Science & Technology, New Zealand.
2. Warren L. McCabe, Julian Smith & Peter Harriott (2004) – *Unit Operations of Chemical Engineering*, 7th Ed., McGraw-Hill, New York, USA.
3. Christie John Geankoplis (2003) – *Transport Processes and Separation Process Principles (Includes Unit Operations)*, 4th Ed., Prentice-Hall, New York, USA.

Course Outcomes:**Blooms Taxonomy****CO 1:**understand the importance of food polymers**CO2:**understand the effect of various methods of processing on the structure and texture of food materials**Understand (K2)****CO3:**understand the interaction of food constituents with respect to thermal and electrical properties to develop new technologies for processing and preservation.**Understand (K2)****CO4:**Explain the physical, thermal, mechanical, optical, and electromagnetic properties of food materials and their significance in designing food processing operations.**Understand (K2)****CO5:**Analyses drying and dehydration mechanisms, interprets drying rate curves, and select appropriate dryers for various food materials.**analyses (K4)****CO-PO Mapping**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1								1			2	1	
CO2	2	2	1							1			2	2	
CO3	3	2	2	1	1					1		1	3	2	1
CO4	3	2	2	2	2					1		1	3	3	1
CO5	3	3	2	2	2					1		1	3	3	2

1- Low, 2- Medium, 3- High, - 'No correlation

23BTO005	FOOD SAFETY AND QUALITY REGULATIONS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of food chemistry
- Basic understanding of microbiology
- Familiarity with food processing operations

Course Objectives:

- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To help become skilled in systems for food safety surveillance
- To be aware of the regulatory and statutory bodies in India and the world
- To ensure processed food meets global standards

Unit I		9
Introduction to food safety and security: Hygienic design of food plants and equipment's, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labelling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation		
Unit II		9
Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities		
Unit III		9
Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication		
Unit IV		9
Indian and global regulations: FAO in India, Technical Cooperation programmes, Biosecurity in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)		
Unit V		9
Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – Tor, Functions, Shadow Committees etc.		
Total periods: 45 PERIODS		
Textbooks:		
1. S. S. Deshpande (2002) – <i>Handbook of Food Toxicology</i> .		
2. Cynthia A. Roberts (2009) – <i>The Food Safety Information Handbook</i> .		
3. Tannenbaum S. R. (1979) – <i>Nutritional and Safety Aspects of Food Processing</i> , Marcel Dekker Inc., New York.		

4. Hobbs B. C. (1973) – *Microbiological Safety of Food*.

References:

1. Handbook of food toxicology by S. S. Deshpande, 2002

2. The food safety information handbook by Cynthia A. Robert, 2009

3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979

4. Microbiological safety of Food by Hobbs BC, 1973

5. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003

Course Outcomes:

Blooms Taxonomy

CO 1: Identify and evaluate physical, chemical, and biological food hazards and apply hygienic design, sanitation, and contamination control measures in food industries and service establishments.

Understand (K2)

CO2: Explain food quality attributes and use instrumental, chemical, microbial, and sensory evaluation methods for assessing food quality.

Understand (K2)

CO3: Apply HACCP principles, identify critical control points, and use risk assessment models (microbial risk, dose–response, exposure assessment) for ensuring food safety across processing stages.

Apply (K3)

CO4: Understand the roles of Indian and international regulatory bodies such as FAO, WHO, OIE, and IPPC in global food safety and biosecurity.

Remember (K1)

CO5: Interpret and apply Codex Alimentarius standards, understand the structure of Codex India, and the functioning of NCCP and national codex committees in setting and maintaining food safety standards.

Understand (K2)

CO-PO Mapping

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	2	2	1	2		2	3	2	1
CO2	2	2	1	2	2	1			1	2		1	2	2	
CO3	3	3	3	3	2	2	2	2		2		3	3	3	2
CO4	2	2	1	1	1	2	3	3		1		2	2	3	1
CO5	2	2	2	1	1	2	3	3		1		2	3	3	2

1- Low, 2- Medium, 3- High, - 'No correlation

23BTO006	NUTRACEUTICALS	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
Basics of food science and chemistry					

- Fundamentals of human nutrition and biochemistry

Course Objectives:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.

Unit I	INTRODUCTION AND SIGNIFICANCE	9
Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoo chemicals and microbes in food, plants, animals and microbes.		
Unit II	PHYTOCHEMICALS AS NUTRACEUTICALS	9
Phytoestrogens in plants; isoflavones; flavanols, polyphenols, tannins, saponins, lignans, lycopene, chitin, carotenoids. Manufacturing practice of selected nutraceuticals such as lycopene, is flavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues		
Unit III	ASSESSMENT OF ANTIOXIDANT ACTIVITY	9
In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different <i>in vitro</i> methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources		
Unit IV	ROLE IN HEALTH AND DISEASE	9
The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.		
Unit V	SAFETY ISSUES	9
Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national		
Total periods:45 PERIODS		
Textbooks:		
1.Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.		
2.Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006		
3.WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006		
4.Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.		
References:		

- 1.Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
- 2.Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
- 3.Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
- 4.Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
- 5.Hanson, James R. "Natural Products: The Secondary Metabolites", Royal Society of Chemistry, 2003

Course Outcomes:													Blooms Taxonomy		
CO 1: Acquire knowledge about nutraceuticals and functional foods, their classification and benefits.													Remember (K1)		
CO2: Acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants, animals and microbes													Remember (K1)		
CO3: Attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.													Understand (K2)		
CO4: Distinguish the various <i>in vitro</i> and <i>in vivo</i> assessment of antioxidant activity of compounds from plant sources.													Understand (K2)		
CO5: Gain information about the health benefits of various functional foods and nutraceuticals in the prevention and treatment of various lifestyle diseases													Understand (K2)		
CO-PO Mapping															
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	1	1	1		1	1	3	2	1
CO2	3	2	1	1	1	2	1	1	1		1	1	3	2	1
CO3	2	2	2	2	2	2	2	2	2		2	2	3	3	2
CO4	2	3	2	3	2	2	2	2	2		2	2	3	3	2
CO5	2	3	3	2	2	2	2	2	2		2	2	3	3	3
1- Low, 2- Medium, 3- High, - 'No correlation															

23CHO010	BASICS OF DYEING AND PRINTING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basics of textile fibers and fabric structures - Elementary knowledge of chemistry of dyes and textile processing					

Course Objectives:

- To enable the students to learn about the basics of Pretreatment, dyeing, printing and machinery in textile processing.

Unit I	INTRODUCTION	9
Impurities present in different fibres, Inspection of grey goods and lot preparation. Shearing,		
Unit II	PRE TREATMENT	9
Desizing-Objective of Desizing- types of Desizing- Objective of Scouring- Mechanism of Scouring– Degumming of Silk, Scouring of wool - Bio Scouring. Bleaching -Objective of Bleaching: Bleaching mechanism of Hydrogen Peroxide, Hypo chlorites. Objective of Mercerizing - Physical and Chemical changes of Mercerizing.		
Unit III	DYEING	9
Dye - Affinity, Substantively, Reactivity, Exhaustion and Fixation. Classification of dyes. Direct dyes: General properties, principles and method of application on cellulosic materials. Reactive dyes – principles and method of application on cellulosic materials hot brand, cold brand		
Unit IV	PRINTING	9
Definition of printing – Difference between printing and dyeing- Classification thickeners – Requirements to be good thickener, printing paste Preparation - different styles of printing		
Unit V	MACHINERIES	9
Fabric Processing - winch, jigger and soft flow machines. Beam dyeing machines: Printing -flat bed screen - Rotary screen. Thermo transfer printing machinery. Garment dyeing machines		
Total periods: 45 PERIODS		
Text Books:		
1.Trotman, E.R., Textile Scouring and Bleaching, Charless Griffins, Com. Ltd., London 1990.		
2.Shenai V.A. “Technology of Textile Processing Vol. IV” 1998, Sevak Publications, Mumbai.		
References:		
1.Trotman E. R., “Dyeing and Chemical Technology of Textile Fibres”, Charles Griffin & Co. Ltd., U.K., 1984, ISBN : 0 85264 165 6.		
2.Dr. N N Mahapatra., “Textile dyeing”, Wood head publishing India, 2018		
3.Mathews Kolanjikombil., ”Dyeing of Textile substrates III –Fibres, Yarns and Knitted fabrics”, Wood head publishing India , 2021		
4.Bleaching & Mercerizing – BTRA Silver Jubilee Monograph series		
5.Chakraborty, J.N, "Fundamentals and Practices in colouration of Textiles", Wood head Publishing India, 2009, ISBN-13:978-81-908001-4-		
Course Outcomes:	Blooms Taxonomy	
CO 1: Basics of grey fabric	Remember (K1)	
CO2: Basics of pre treatment	Understand (K2)	

CO3: Concept of Dyeing													Understand (K2)		
CO4: Concept of Printing													Understand (K2)		
CO5: Machinery in processing industry													Understand (K2)		
CO-PO Mapping															
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	–	1	1	3	1	1
CO2	3	2	2	2	2	2	1	1	1	–	1	1	3	2	1
CO3	2	2	2	2	2	2	1	1	1	–	1	1	3	2	2
CO4	2	2	2	2	2	2	1	1	1	–	1	1	3	2	2
CO5	2	2	3	2	2	2	2	1	1	–	1	1	3	2	2

23CHO011	FIBRE SCIENCE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basic knowledge of polymers and chemistry of materials - Understanding of fundamental textile terms and processes					
Course Objectives: To enable the students to learn about the types of fibre and its properties					
Unit I	INTRODUCTION TO TEXTILE FIBRES				9
Definition of various forms of textile fibres - staple fibre, filament, bicomponent fibres. Classification of Natural and Man-made fibres, essential and desirable properties of Fibres. Production and cultivation of Natural Fibers: Cotton, Silk, Wool -Physical and chemical structure of the above fibres.					
Unit II	DESIGN OF CYLINDER AND PISTON COMPONENTS				9
Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel					
Unit III	SYNTHEITC FIBRES				9
Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization					
Unit IV	SOECIALITY FIBRES				9
Properties and end uses of high tenacity and high modulus fibres, high temperature and flame retardant fibres, Chemical resistant fibres					
Unit V	FUNCTIONAL SOECIALITY FIBRES				9
Properties and end uses : Fibres for medical application – Biodegradable fibres based on PLA ,Super absorbent fibres elastomeric fibres, ultra-fine fibres, electrospun nano fibres, metallic fibres – Gold and Silver coated.					
Total periods: 45					
Text Books:					
1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95					
2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU ISBN-13:					
3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute,1992, ISBN: 1870812379					
References:					
1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698					
2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.					

3. Raheel M. (ed.), "Modern Textile Characterization Methods", Marcel Dekker, 1995, ISBN:0824794737

4. Mukhopadhyay. S. K., "The Structure and Properties of Typical Melt Spun Fibres", Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115

5. Hearle J.W.S., "Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1", Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

Course Outcomes:**Blooms Taxonomy**

CO 1: Understand the process sequence of various fibres

Understand (K2)

CO 2: Understand the properties of various fibres

Understand (K2)

CO 3: Apply fibre science concepts to identify fibres and interpret their structural characteristics.

Apply (K3)

CO 4: Analyse the performance behaviour of sOECiality fibres under different conditions.

Analyse (K4)

CO 5: Evaluate the suitability of functional sOECiality fibres for sOECific technical and medical applications.

Evaluate (K5)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	–	–	–	1	–	–	3	2	–
CO2	3	2	–	–	–	–	–	–	–	1	–	–	3	3	–
CO3	2	2	2	1	–	–	–	–	–	1	–	–	2	3	2
CO4	2	3	2	3	–	–	–	–	–	1	–	–	3	3	3
CO5	1	3	2	3	–	–	–	–	–	1	–	–	3	3	3

1- Low, 2- Medium, 3- High, – -No correlation

23CHO012	GARMENT MANUFACTURING TECHNOLOGY	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of textiles and garment components
- Understanding of fabric structure and properties

Course Objectives:

- To enable the students to understand the basics of pattern making, cutting and sewing.
- To expose the students to various problems & remedies during garment manufacturing

Unit I	PATTERN MAKING, MARKER PLANNING, CUTTING	9
Anthropometry, sOECification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting		
Unit II	TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES	9

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

Unit III**COMPONENTS AND TRIMS USED IN GARMENT****9**

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

Unit IV**GARMENT INSPECTION AND DIMENSIONAL CHANGES****9**

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

Unit V**GARMENT PRESSING, PACKING AND CARE LABELING****9**

Garment pressing – categories and equipment, packing; care labelling of apparels

Total periods: 45**Text Books:**

1. Carr H., and Latham B., “The Technology of Clothing Manufacture”, Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, “Introduction to Clothing Manufacture” Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.

References:

1. Winifred Aldrich., “Metric Pattern Cutting”, Blackwell Science Ltd., Oxford, 1994
2. Peggal H., “The Complete Dress Maker”, Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., “Sewing Thread”, NITRA, 1994
4. Ruth Glock, Grace I. Kunz, “Apparel Manufacturing”, Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, “An Introduction to Quality Control for the Apparel Industry”, J.S.N. Internationals, 1992.

Course Outcomes:**Blooms Taxonomy****CO 1:** Pattern making, marker planning, cutting

Understand (K2)

CO 2: Types of seams, stitches and functions of needles

Understand (K2)

CO 3: Components and trims used in garment

Apply (K3)

CO 4: Garment inspection and dimensional changes

Analyse (K4)

CO 5: Garment pressing, packing and care labelling

Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	-	2	-	1	1	-	2	3	1	2	3	1
CO2	2	2	1	1	1	-	1	1	-	2	2	1	2	2	1
CO3	1	1	1	1	1	1	1	1	-	1	2	1	1	3	1
CO4	2	1	1	1	2	2	2	1	1	2	3	1	2	3	1
CO5	2	2	1	1	1	1	2	1	-	2	2	1	2	2	1

1- Low, 2- Medium, 3- High, ‘-’ -No correlation

23CEO008	INDUSTRIAL SAFETY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basic knowledge of workplace environment and industrial operations - Understanding of fundamental science (Physics & Chemistry) related to safety hazards					
Course Objectives: - To educate about the health hazards and the safety measures to be followed in the industrial environment. - Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings - Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards					
Unit I	INTRODUCTION				9
Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.					
Unit II	OCCUPATIONAL HEALTH AND HYGIENE				9
Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.					
Unit III	WORKPLACE SAFETY AND SAFETY SYSTEMS				9
Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.					
Unit IV	HAZARDS AND RISK MANAGEMENT				9
Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.					
Unit V	ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT				9
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.					
Total periods: 45					
Text Books:					

1. Morton W. E., and Hearle J. W. S., “Physical Properties of Textile Fibres”, The Textile Institute, Washington D.C., 2008, ISBN 978-1-84569-220-95

2. Meredith R., and Hearle J. W. S., “Physical Methods of Investigation of Textiles”, Wiley Publication, New York, 1989, ISBN: B00JCV6ZWU | ISBN-13:

3. Mukhopadhyay S. K., “Advances in Fibre Science”, The Textile Institute, 1992, ISBN: 1870812379

References:

1. Meredith R., “Mechanical Properties of Textile Fibres”, North Holland, Amsterdam, 1986, ISBN: 1114790699, ISBN-13: 9781114790698

2. Hearle J. W. S., Lomas B., and Cooke W. D., “Atlas of Fibre Fracture and Damage to Textiles”, The Textile Institute, 2nd Edition, 1998, ISBN: 1855733196.

3. Raheel M. (ed.), “Modern Textile Characterization Methods”, Marcel Dekker, 1995, ISBN:0824794737

4. Mukhopadhyay S. K., “The Structure and Properties of Typical Melt Spun Fibres”, Textile Progress, Vol. 18, No. 4, Textile Institute, 1989, ISBN: 1870812115

5. Hearle J.W.S., “Polymers and Their Properties: Fundamentals of Structures and Mechanics Vol 1”, Ellis Horwood, England, 1982, ISBN: 047027302X | ISBN-13: 9780470273029 36

Course Outcomes:

Blooms Taxonomy

CO 1: Describe, with example, the common work-related diseases and accidents in occupational setting

Understand (K2)

CO 2: Name essential members of the Occupational Health team

Understand (K2)

CO 3: What roles can a community health practitioners play in an Occupational setting to ensure the protection, promotion and maintenance of the health of the employee

Understand (K2)

CO 4: Analyse workplace hazards and apply suitable risk management and accident prevention strategies.

Analyse (K4)

CO 5: Evaluate and propose effective Environmental Health & Safety (EHS) management systems for an industry.

Evaluate (K5)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	–	1	–	2	3	1	–	2	–	1	2	2	–
CO2	2	2	–	1	–	2	2	1	–	1	–	1	2	1	–
CO3	2	2	1	2	–	2	3	2	1	2	2	1	3	2	1
CO4	3	3	2	3	2	3	3	2	2	3	2	2	3	3	2
CO5	3	3	2	3	2	3	3	2	2	3	3	2	3	3	3

1- Low, 2- Medium, 3- High, ‘- ‘-No correlation

23CHO013	UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Basic knowledge of Physics and Chemistry - Fundamentals of Mathematics (Calculus, Differential equations) - Introductory knowledge of Chemical process principles					
Course Objectives: To impart to the student basic knowledge on fluid mechanics, mechanical operations, heat transfer operations and mass transfer operations.					
Unit I	FLUID MECHANICS CONCEPTS				9
Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton’s Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler’s equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.					
Unit II	FLOW MEASUREMENTS & MECHANICAL OPERATIONS				9
Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numerical of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.					
Unit III	CONDUCTIVE & CONVECTIVE HEAT TRANSFER				9
Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficient, log mean temperature difference, individual and overall heat transfer co-efficient, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications).					
Unit IV	BASICS OF MASS TRANSFER				9
Diffusion-Fick’s law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.					
Unit V	MASS TRANSFER OPERATIONS				9

Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Drying-drying operations, batch and continuous drying. Conceptual numerical.

Total periods: 45

Text Books:

1. Unit operations in Chemical Engineering Warren L. McCabe, Julian C. Smith & Peter Harriot McGraw-Hill Education (India) Edition 2014

2. Fluid Mechanics K L Kumar S Chand & Company Ltd 2008

3. Introduction to Chemical Engineering Badger W.I. and Banchero, J.T., Tata McGraw Hill New York 1997

References:

1. Principles of Unit Operations Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson John Wiley & Sons 2nd edition 2008

2. Unit Operations of Chemical Engineering, Vol I & II Chattopadhyaya Khanna Publishers, Delhi-6 1996

3. Heat Transfer J P Holman McGraw Hill International Ed

Course Outcomes:

Blooms Taxonomy

CO 1: State and describe the nature and properties of the fluids.

Understand (K2)

CO 2: Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.

Understand (K2)

CO 3: Comprehend the laws governing the heat and mass transfer operations to solve the problems.

Apply (K3)

CO 4: Design the heat transfer equipment suitable for specific requirement.

Analyse (K4)

CO 5: Apply mass transfer principles in distillation, extraction and drying operations to solve chemical engineering problems.

Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	–	–	–	–	–	1	–	1	3	2	–
CO2	3	2	2	2	–	–	–	1	–	1	–	1	3	3	1
CO3	3	3	2	3	1	–	–	1	–	1	–	2	3	3	2
CO4	3	3	3	3	2	–	–	1	–	2	1	2	3	3	3
CO5	3	3	2	3	1	–	–	1	–	1	–	2	3	3	2

1- Low, 2- Medium, 3- High, – -No correlation

23MEO018	PLASTIC MATERIALS FOR ENGINEERS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of polymer chemistry
- Fundamentals of material science
- Understanding of molecular structures and material behavior

Course Objectives:

- Understand the advantages, disadvantages and general classification of plastic materials
- To know the manufacturing, sources, and applications of engineering thermoplastics
- Understand the basics as well as the advanced applications of various plastic materials in the industry
- To understand the preparation methods of thermosetting materials
- Select suitable sOECialty plastics for different end applications

Unit I	INTRODUCTION TO PLASTIC MATERIALS	9
Introduction to Plastics – Brief history of plastics, advantages and disadvantages, thermoplastic and thermosetting behavior, amorphous polymers, crystalline polymers and cross-linked structures. General purpose thermoplastics/Commodity plastics: manufacture, structure, properties and applications of polyethylene (PE), cross-linked PE, chlorinated PE, polypropylene, polyvinyl chloride-compounding, formulation, polypropylene (PP)		
Unit II	ENGINEERING THERMOPLASTICS AND APPLICATIONS	9
Engineering thermoplastics – Aliphatic polyamides: structure, properties, manufacture and applications of Nylon 6, Nylon 66. Polyesters: manufacture, structure, properties and uses of PET, PBT. Manufacture, structure, properties and uses of Polycarbonates, acetal resins, polyimides, PMMA, polyphenylene oxide, thermoplastic polyurethane (PU)		
Unit III	THERMOSETTING PLASTICS	9
Thermosetting Plastics – Manufacture, curing, moulding powder, laminates, properties and uses of phenol formaldehyde resins, urea formaldehyde, melamine formaldehyde, unsaturated polyester resin, epoxy resin, silicone resins, polyurethane resins.		
Unit IV	MISCELLANEOUS PLASTICS FOR END APPLICATIONS	9
Miscellaneous plastics- Manufacture, properties and uses of polystyrene, HIPS, ABS, SAN, poly(tetrafluoroethylene) (PTFE), TFE and copolymers, PVDF, PVA, poly (vinyl acetate), poly (vinyl carbazole), cellulose acetate, PEEK, High energy absorbing polymers, super absorbent polymers- their synthesis, properties and applications		
Unit V	PLASTICS MATERIALS FOR BIOMEDICAL APPLICATIONS	9
Sources, raw materials, methods of manufacturing, properties and applications of bio-based polymers- poly lactic acid (PLA), poly hydroxy alkanoates (PHA), PBAT, bioplastics- bio-PE, bio-PP, bio-PET, polymers for biomedical applications		
Total periods: 45		
Text Books:		
1. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, 3rd Edition, McGraw Hill Education, 2011.		

2. V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International Publishers, 2017.

3. R.K. Roy, Polymer Chemistry, New Age International Publishers, 2003.

References:

1. Marianne Gilbert (Ed.), Brydson's Plastics Materials, 8th Edn., Elsevier (2017).

2. J.A. Brydson, Plastics Materials, 7th Edn., Butterworth Heinemann (1999).

3. Manas Chanda, Salil K. Roy, Plastics Technology Handbook, 4th Edn., CRC press (2006).

4. A. Brent Strong, Plastics: Materials and Processing, 3rd Edn., Pearson Prentice Hall (2006).

5. Olagoke Olabisi, Kolapo Adewale (Eds.), Handbook of Thermoplastics 2nd Edn., CRC press (2016).

6. Charles A. Harper, Modern Plastics Handbook, McGraw-Hill, New York, 1999.

7. H. Dominighaus, Plastics for Engineers, Hanser Publishers, Munich, 1988.

Course Outcomes:

Blooms Taxonomy

CO 1: To study the importance, advantages and classification of plastic materials

Understand (K2)

CO 2: Summarize the raw materials, sources, production, properties and applications of various engineering thermoplastics

Understand (K2)

CO 3: To understand the application of polyamides, polyesters and other engineering thermoplastics, thermosetting resins

Analyze (K2)

CO 4: Know the manufacture, properties and uses of thermosetting resins based on polyester, epoxy, silicone and PU

Understand (K2)

CO 5: To understand the engineering applications of various polymers in miscellaneous areas and applications of different biopolymers

Evaluate (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	–	–	–	–	1	–	–	–	–	1	3	1	–
CO2	3	2	–	–	–	–	1	–	–	–	–	1	3	2	–
CO3	3	3	2	2	–	–	–	–	–	–	–	2	3	3	2
CO4	3	2	–	–	–	–	1	–	–	–	–	1	3	2	–
CO5	3	2	1	2	–	–	2	1	–	–	–	2	3	3	2

1- Low, 2- Medium, 3- High, – ‘-No correlation

23MEO019	PROPERTIES AND TESTING OF PLASTICS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Fundamentals of polymer science – structure, types of polymers, and polymerization basics
- Basic chemistry – chemical bonding, molecular structure, physical properties

- Basic material science concepts – stress–strain, mechanical behavior, thermal behavior
- Introductory plastics processing – molding, extrusion, shaping methods (at basic level)

Course Objectives:

- To understand the relevance of standards and sOECifications as well as the sOECimen preparation for polymer testing.
- To study the mechanical properties and testing of polymer materials and their structural property relationships.
- To understand the thermal properties of polymers and their testing methods.
- To gain knowledge on the electrical and optical properties of polymers and their testing methods.
- To study about the environmental effects and prevent polymer degradation.

Unit I	INTRODUCTION TO CHARACTERIZATION AND TESTING OF POLYMERS	9
Introduction- Standard organizations: BIS, ASTM, ISO, BS, DIN etc. Standards and sOECifications. Importance of standards in the quality control of polymers and polymer products. Preparation of test pieces, conditioning and test atmospheres. Tests on elastomers: processability parameters of rubbers – plasticity, Mooney viscosity, scorch time, cure time, cure rate index, Processability tests carried out on thermoplastics and thermosets: MFI, cup flow index, gel time, bulk density, bulk factor.		
Unit II	MECHANICAL PROPERTIES	9
Mechanical properties: Tensile, compression, flexural, shear, tear strength, hardness, impact strength, resilience, abrasion resistance, creep and stress relaxation, compression set, dynamic fatigue, ageing properties, Basic concepts of stress and strain, short term tests: Viscoelastic behavior (simple models: Kelvin model for creep and stress relaxation, Maxwell-Voigt model, strain recovery and dynamic response), Effect of structure and composition on mechanical properties, Behavior of reinforced polymers		
Unit III	THERMAL RHEOLOGICAL PROPERTIES	9
Thermal properties: Transition temperatures, sOECific heat, thermal conductivity, co-efficient of thermal expansion, heat deflection temperature, Vicat softening point, shrinkage, brittleness temperature, thermal stability and flammability. Product testing: Plastic films, sheeting, pipes, laminates, foams, containers, cables and tubes.		
Unit IV	ELECTRICAL AND OPTICAL PROPERTIES	9
Electrical properties: volume and surface resistivity, dielectric strength, dielectric constant and power factor, arc resistance, tracking resistance, dielectric behavior of polymers (dielectric co-efficient, dielectric polarization), dissipation factor and its importance. Optical properties: transparency, refractive index, haze, gloss, clarity, birefringence.		
Unit V	ENVIRONMENTAL AND CHEMICAL RESISTANCE	9
Environmental stress crack resistance (ESCR), water absorption, weathering, aging, ozone resistance, permeability and adhesion. Tests for chemical resistance. Acids, alkalies, Flammability tests- oxygen index test.		
Total periods: 45		
Text Books:		

1. Vishu Shah, Handbook of Plastic Testing Technology, 3rd Edition, John Wiley & Sons, 2007.

2. A. B. Mathur & I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., 2003.

3. R. P. Brown, Plastic Test Methods, 2nd Edition, Harlond, Longman Scientific, 1981.

References:

1. F.Majewska, H.Zowall, Handbook of analysis of synthetic polymers and plastics, Ellis Horwood Limited Publisher 1977.

2. J.F.Rabek, Experimental Methods in Polymer Chemistry, John Wiley and Sons 1980.

3. R.P.Brown, Plastic test methods, 2nd Edn., Harlond, Longman Scientific, 1981.

4. A. B. Mathur, I. S. Bharadwaj, Testing and Evaluation of Plastics, Allied Publishers Pvt. Ltd., New Delhi, 2003.

5. Vishu Shah, Handbook of Plastic Testing Technology, 3rd Edn., John Wiley & Sons 2007.

S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.

Course Outcomes:

Blooms Taxonomy

CO 1: Understand the relevance of standards and specifications.

Understand (K2)

CO 2: Summarize the various test methods for evaluating the mechanical properties of the polymers.

Understand (K2)

CO 3: To know the thermal, electrical & optical properties of polymers.

Understand (K2)

CO 4: Identify various techniques used for characterizing polymers.

Apply (K3)

CO 5: Distinguish the processability tests used for thermoplastics, thermosets and elastomers.

Analyze (K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	–	–	–	–	–	–	–	–	–	1	2	1	–
CO2	2	2	1	–	–	–	–	–	–	–	–	1	2	1	–
CO3	2	1	–	–	–	–	–	–	–	–	–	1	2	1	–
CO4	2	2	2	1	–	–	–	–	–	–	–	1	3	2	1
CO5	2	2	1	–	–	–	–	–	–	–	–	1	2	2	1

1- Low, 2- Medium, 3- High, '–' -No correlation

23ECO008	VLSI DESIGN	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basics of Digital Electronics • Fundamentals of Semiconductor Devices • Basic Knowledge of Logic Circuits					

Course Objectives:

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

Unit I	MOS TRANSISTOR PRINCIPLES	9
MOS logic families (NMOS and CMOS), Ideal and Non Ideal IV Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics ,small signal analysis of MOSFET		
Unit II	COMBINATIONAL LOGIC CIRCUITS	9
Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.		
Unit III	SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES	9
Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design .		
Unit IV	INTERCONNECT, MEMORY ARCHITECTURE	9
Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.		
Unit V	DESIGN OF ARITHMETIC BUILDING BLOCKS	9
Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.		
Total periods: 45 PERIODS		
Text Books:		
1. Jan D Rabaey, Anantha Chandrakasan, "Digital Integrated Circuits: A Design Perspective", PHI, 2016.(Units II, III IV and V).		
2. Neil H E Weste, Kamran Eshraghian, "Principles of CMOS VLSI Design: A System Perspective," Addison Wesley, 2009.(Units - I)		
References:		
1. . D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983		
2. . P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001		
3. Samiha Mourad and Yervant Zorian, "Principles of Testing Electronic Systems", Wiley 2000		
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits", Kluwer Academic Publishers,2000		

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the working principle and characteristics of MOSFET													Understand (K2)		
CO2: : Design Combinational Logic Circuits													Understand (K2)		
CO3: : Design Sequential Logic Circuits and Clocking systems													Apply (K3)		
CO4: : Understand Memory architecture and interconnects													Apply (K3)		
CO5: Design of arithmetic building blocks.													Analyze (K4)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	1	3	2	1
CO2	3	3	3	2	2	-	-	-	-	-	-	1	3	3	2
CO3	3	2	3	2	2	-	-	-	-	-	-	1	3	3	2
CO4	2	2	2	2	2	-	-	-	-	-	-	1	2	2	2
CO5	3	2	3	2	2	-	-	-	-	-	-	1	3	3	3
1- Low, 2- Medium, 3- High, '-' -No correlation															

23ECO009	WEARABLE DEVICES	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basics of Electronics and Sensors • Fundamentals of Wireless Communication • Basic Knowledge of Biomedical Engineering					
Course Objectives: • To know the hardware requirement of wearable systems • To understand the communication and security aspects in the wearable devices • To know the applications of wearable devices in the field of medicine					
Unit I	INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS				9
Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Impedance plethysmography, Wearable ground reaction force sensor					
Unit II	SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES				9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

Unit III	WIRELESS HEALTH SYSTEMS												9		
Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.															
Unit IV	SMART TEXTILE												9		
Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.															
Unit V	APPLICATIONS OF WEARABLE SYSTEMS												9		
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine															
Total periods: 45 PERIODS															
Text Books:															
1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011															
2. . Zhang and Yuan-Ting, Wearable Medical Sensors and Systems, Springer, 2013															
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014															
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012															
References:															
1. . Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.															
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006															
Course Outcomes:													Blooms Taxonomy		
CO 1: Describe the concepts of wearable system.													Understand (K2)		
CO2: Explain the energy harvestings in wearable device.													Understand (K2)		
CO3: Use the concepts of BAN in health care.													Analyze (K4)		
CO4: Illustrate the concept of smart textile													Apply (K3)		
CO5: Compare the various wearable devices in healthcare system													Understand (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	2	-	-	-	-	-	-	1	2	1	-
CO2	3	2	2	2	2	-	-	-	-	-	-	1	3	2	1

CO3	3	2	3	2	2	-	-	-	-	-	-	1	3	3	1
CO4	3	2	2	2	2	-	-	-	-	-	-	1	2	2	1
CO5	3	2	2	2	2	-	-	-	-	-	-	1	3	2	2

1- Low, 2- Medium, 3- High, ‘-’ -No correlation

23BMO004	MEDICAL INFORMATICS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basics of Computer Science
- Fundamentals of Biology and Healthcare Systems
- Basic Knowledge of Information Technology

Course Objectives:

- To study the applications of information technology in health care management.
- This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

Unit I	INTRODUCTION TO MEDICAL INFORMATICS.	9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

Unit II	COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING	9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance

Unit III	COMPUTERISED PATIENT RECORD	9

Introduction - conventional patient record, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients

Unit IV	COMPUTER ASSISTED MEDICAL DECISION-MAKING	9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer-assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped

Unit V	RECENT TRENDS IN MEDICAL INFORMATICS	9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

Total periods: 45 PERIODS

Text Books:

1. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003

2. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill, 2005

References:

1. I. Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3rd Edition, Springer, 2006.

Course Outcomes:

Blooms Taxonomy

CO 1: Explain the structure and functional capabilities of Hospital Information System.

Understand (K2)

CO2: Describe the need of computers in medical imaging and automated clinical laboratory

Apply (K3)

CO3: Articulate the functioning of information storage and retrieval in computerized patient record system.

Understand (K2)

CO4: Apply the suitable decision support system for automated clinical diagnosis

Understand (K2)

CO5: Discuss the application of virtual reality and telehealth technology in medical industry.

Understand (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	-	-	-	-	-	-	1	2	1	-
CO2	3	2	2	2	2	-	-	-	-	-	-	1	2	2	1
CO3	3	2	2	2	2	-	-	-	-	-	-	1	2	2	1
CO4	3	3	3	2	2	-	-	-	-	-	-	1	3	3	2
CO5	2	3	2	2	2	-	-	-	-	-	-	1	3	2	2

1- Low, 2- Medium, 3- High, '-' -No correlation

MINOR DEGREE

VERTICAL I : FINTECH AND BLOCK CHAIN

23CMG001	FINANCIAL MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of commerce or accounting • Understanding of fundamental business concepts • Ability to perform simple mathematical and analytical calculations					
Course Objectives: • To acquire the knowledge of the decision areas in finance. • To learn the various sources of Finance • To describe about capital budgeting and cost of capital • To discuss on how to construct a robust capital structure and dividend policy • To develop an understanding of tools on Working Capital Management.					
Unit I	INTRODUCTION TO FINANCIAL MANGEMENT				9
Definition and Scope of Finance Functions - Objectives of Financial Management - Profit Maximization and Wealth Maximization- Time Value of money- Risk and return concepts.					
Unit II	SOURCES OF FINANCE				9
Long term sources of Finance -Equity Shares – Debentures - Preferred Stock – Features – Merits and Demerits. Short term sources - Bank Sources, Trade Credit, Overdrafts, Commercial Papers, Certificate of Deposits, Money market mutual funds etc					
Unit III	INVESTMENT DECISIONS				9
Investment Decisions: capital budgeting – Need and Importance – Techniques of Capital Budgeting — Payback - ARR – NPV – IRR –Profitability Index. Cost of Capital - Cost of Specific Sources of Capital - Equity -Preferred Stock- Debt - Reserves - Concept and measurement of cost of capital - Weighted Average Cost of Capital.					

Unit IV	FINANCING AND DIVIDEND DECISION												9		
Operating Leverage and Financial Leverage- EBIT-EPS analysis. Capital Structure – determinants of Capital structure- Designing an Optimum capital structure. Dividend policy - Aspects of dividend policy - practical consideration - forms of dividend policy - - Determinants of Dividend Policy															
Unit V	WORKING CAPITAL DECISION												9		
Working Capital Management: Working Capital Management - concepts - importance -Determinants of Working capital. Cash Management: Motives for holding cash – Objectives and Strategies of Cash Management. Receivables Management: Objectives - Credit policies.															
Total periods: 45															
Text Books:															
1. M.Y. Khan and P.K.Jain Financial management, Text, Tata McGraw Hill															
2. M. Pandey Financial Management, Vikas Publishing House Pvt. Ltd															
References:															
1. James C. Vanhorne –Fundamentals of Financial Management– PHI Learning,.															
2. Prasanna Chandra, Financial Management,															
3. Srivatsava, Mishra, Financial Management, Oxford University Press, 2011															
Course Outcomes:													Blooms Taxonomy		
CO 1: To acquire knowledge of major financial decision areas in organizations													Understand (K2)		
CO2: To understand various long-term and short-term sources of finance													Understand (K2)		
CO3: To learn capital budgeting techniques and cost of capital													Apply (K3)		
CO4: To understand capital structure and dividend policy decisions													Analyze (K4)		
CO5: To develop skills in working capital management tools and techniques													Evaluate (K5)		
CO-PO Mapping															
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1						2		2	3		
CO2	3	2	1	1						2		2	2		
CO3	3	3	2	3						2		3	3		
CO4	3	3	2	3						3		3	3		
CO5	3	3	2	3						2		3	3		
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG002	FUNDAMENTALS OF INVESTMENT	Category:PEC			
		L	T	P	C
		3	0	0	3
Prerequisites					

- Basic understanding of financial terms
- Fundamental knowledge of markets and economics
- Ability to perform simple mathematical calculations

Course Objectives:

- Describe the investment environment in which investment decisions are taken.
- Explain how to Value bonds and equities
- Explain the various approaches to value securities
- Describe how to create efficient portfolios through diversification
- Discuss the mechanism of investor protection in India.

Unit I	THE INVESTMENT ENVIRONMENT	9
The investment decision process, Types of Investments – Commodities, Real Estate and Financial Assets, the Indian securities market, the market participants and trading of securities, security market indices, sources of financial information, Concept of return and risk, Impact of Taxes and Inflation on return.		
Unit II	FIXED INCOME SECURITIES	9
Bond features, types of bonds, estimating bond yields, Bond Valuation types of bond risks, default risk and credit rating.		
Unit III	APPROACHES TO EQUITY ANALYSIS	9
Introduction to Fundamental Analysis, Technical Analysis and Efficient Market Hypothesis, dividend capitalisation models, and price-earnings multiple approach to equity valuation.		
Unit IV	PORTFOLIO ANALYSIS AND FINANCIAL DERIVATIVES	9
Portfolio and Diversification, Portfolio Risk and Return; Mutual Funds; Introduction to Financial Derivatives; Financial Derivatives Markets in India		
Unit V	INVESTOR PROTECTION	9
Role of SEBI and stock exchanges in investor protection; Investor grievances and their redressal system, insider trading, investors' awareness and activism		
Total periods: 45		
Text Books:		
1. Charles P. Jones – <i>Investments: Analysis and Management</i> , Wiley, 14th Edition, 2019		
2. Prasanna Chandra – <i>Investment Analysis and Portfolio Management</i> , McGraw Hill, 5th Edition, 2017		
3. R. P. Rustagi – <i>Investment Management: Theory and Practice</i> , Sultan Chand & Sons, 2021		
References:		
1. Charles P. Jones, Gerald R. Jensen. <i>Investments: analysis and management</i> . Wiley, 14TH Edition, 2019.		
2. Chandra, Prasanna. <i>Investment analysis and portfolio management</i> . McGraw-hill education, 5th, Edition, 2017		
3. Rustagi, R. P. <i>Investment Management Theory and Practice</i> . Sultan Chand & Sons, 2021.		
4. Zvi Bodie, Alex Kane, Alan J Marcus, Pitabhus Mohanty, <i>Investments</i> , McGraw Hill Education (India), 11		

Edition(SIE), 2019															
Course Outcomes:													Blooms Taxonomy		
CO 1: Explain the investment environment, types of investments, and functioning of securities markets													Understand (K2)		
CO2: Apply valuation methods for fixed-income securities and understand bond risks													Apply (K3)		
CO3: Analyze equity valuation using fundamental, technical, and EMH approaches													Analyze (K4)		
CO4: Evaluate portfolio construction, diversification, mutual funds, and derivatives													Evaluate (K5)		
CO5: Explain investor protection mechanisms, SEBI regulations, and grievance redressal													Understand (K2)		
CO-PO Mapping															
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1						2		2	3		
CO2	3	3	2	2						2		2	3		
CO3	3	3	2	3						2		3	3		
CO4	3	3	2	3						3		3	3		
CO5	2	2	1	2						2		2	2		
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CMG003	BANKING, FINANCIAL SERVICES AND INSURANCE	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of money and financial systems • Fundamental knowledge of markets and financial institutions					
Course Objectives: • Understand the Banking system in India • Grasp how banks raise their sources and how they deploy it • Understand the development in banking technology • Understand the financial services in India • Understand the insurance Industry in India					
Unit I	INTRODUCTION TO INDIAN BANKING SYSTEM				9
Overview of Banking system – Structure – Functions –Banking system in India - Key Regulations in Indian Banking sector –RBI. Relationship between Banker and Customer - Retail & Wholesale Banking – types of Accounts - Opening and operation of Accounts.					
Unit II	MANAGING BANK FUNDS/ PRODUCTS				9
Liquid Assets - Investment in securities - Advances - Loans.Negotiable Instruments – Cheques, Bills of Exchange & Promissory Notes.Designing deposit schemes– Asset and Liability Management – NPA’s – Current issues on NPA’s					

– M&A's of banks into securities market

Unit III**DEVELOPMENT IN BANKING TECHNOLOGY****9**

Payment system in India – paper based – e payment –electronic banking –plastic money – e-money forecasting of cash demand at ATM's –The Information Technology Act, 2000 in India – RBI's Financial Sector Technology vision document – security threats in e-banking & RBI's Initiative.

Unit IV**FINANCIAL SERVICES****9**

Introduction – Need for Financial Services – Financial Services Market in India – NBFC — Leasing and Hire Purchase — mutual funds. Venture Capital Financing –Bill discounting –factoring – Merchant Banking

Unit V**INSURANCE****9**

Insurance –Concept - Need - History of Insurance industry in India. Insurance Act, 1938 –IRDA – Regulations – Life Insurance - Annuities and Unit Linked Policies - Lapse of the Policy – revival – settlement of claim

Total periods:45**Text Books:**

1. Padmalatha Suresh & Justin Paul — *Management of Banking and Financial Services*, Pearson, 2017
2. Meera Sharma — *Management of Financial Institutions with Emphasis on Bank and Risk Management*, PHI Learning, 2010
3. Peter S. Rose & Sylvia C. Hudgins — *Bank Management and Financial Services*, Tata McGraw Hill, 2017

References:

1. . Padmalatha Suresh and Justin Paul, "Management of Banking and Financial Services, Pearson, Delhi, 2017.
2. Meera Sharma, "Management of Financial Institutions – with emphasis on Bank and Risk Management", PHI Learning Pvt. Ltd., New Delhi 2010
3. Peter S. Rose and Sylvia C. and Hudgins, "Bank Management and Financial Services", Tata McGraw Hill, New Delhi, 2017

Course Outcomes:**Blooms Taxonomy**

CO 1: Explain the Indian banking system, structure, functions, and customer–banker relationship	Understand (K2)
CO2: Apply knowledge of bank fund management, negotiable instruments, ALM, and NPAs	Apply (K3)
CO3: Analyze developments in banking technology, e-payments, IT Act, and security issues	Analyze (K4)
CO4: Understand major financial services such as NBFCs, leasing, factoring, mutual funds, merchant banking, and venture capital	Understand (K2)
CO5: Explain the concepts of insurance, regulations, IRDA, policy lapse, revival, and settlement	Understand (K2)

CO-PO Mapping															
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1						2		2	3		
CO2	3	3	2	2						2		2	3		
CO3	3	3	2	3						3		3	3		
CO4	2	2	1	2						2		2	2		
CO5	2	2	1	2						2		2	2		
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CMG004	INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of computer networks • Understanding of cryptography fundamentals (helpful but not mandatory) • Familiarity with programming concepts					
Course Objectives: • Understand the fundamentals, architecture, and evolution of blockchain. • Explain decentralization, consensus mechanisms, and blockchain components. • Learn cryptocurrency concepts including Bitcoin, altcoins, mining, and wallets. • Explore Ethereum architecture, EVM, and smart contract development. • Understand Web3, Hyperledger frameworks, and emerging blockchain trends.					
Unit I	INTRODUCTION TO BLOCKCHAIN				9
Blockchain: The growth of blockchain technology - Distributed systems - The history of blockchain and Bitcoin - Features of a blockchain - Types of blockchain, Consensus: Consensus mechanism - Types of consensus mechanisms - Consensus in blockchain. Decentralization: Decentralization using blockchain - Methods of decentralization - Routes to decentralization- Blockchain and full ecosystem decentralization - Smart contracts - Decentralized Organizations- Platforms for decentralization.					
Unit II	INTRODUCTION TO CRYPTOCURRENCY				9
Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts- Deploying smart contracts on a blockchain					
Unit III	ETHEREUM				9

Introduction - The Ethereum network - Components of the Ethereum ecosystem - Transactions and messages - Ether cryptocurrency / tokens (ETC and ETH) - The Ethereum Virtual Machine (EVM), Ethereum Development Environment: Test networks - Setting up a private net - Starting up the private network

Unit IV	WEB3 AND HYPERLEDGE	9

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

Unit V	EMERGING TRENDS	9

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

Total periods: 45

Text Books:

1. Imran Bashir, *Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained*, Packt Publishing, 2nd Edition, 2018

2. Peter Borovykh, *Blockchain Applications in Finance*, Blockchain Driven, 2nd Edition, 2018

3. Arshdeep Bahga, Vijay Madiseti, *Blockchain Applications: A Hands-On Approach*, VPT, 2017

References:

1. Imran. Bashir. Mastering block chain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained. Packt Publishing, 2nd Edition, 2018

2. Peter Borovykh , Blockchain Application in Finance, Blockchain Driven, 2nd Edition, 2018

3. ArshdeepBahga, Vijay Madiseti, “Blockchain Applications: A Hands On Approach”, VPT, 2017.

Course Outcomes:	Blooms Taxonomy
CO 1: Explain the fundamentals and architecture of blockchain systems	Understand (K2)
CO2: Analyze cryptocurrencies, Bitcoin mechanics, and alternative coins	Analyze (K4)
CO3: Develop and deploy smart contracts on Ethereum	Apply (K3)
CO4: Utilize Web3 and Hyperledger tools for decentralized applications	Apply (K3)
CO5: Evaluate emerging blockchain technologies, scalability, and privacy challenges	Evaluate (K5)

CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	1					2			3	2	1
CO2	3	3	2	2	1					2		1	3	2	1
CO3	2	2	3	3	2	1				3	1		3	3	2
CO4	2	2	3	3	3	1				3	1	1	3	3	2
CO5	3	3	2	3	3	1				3	1	2	3	3	3

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CMG005	FINTECH PERSONAL FINANCE AND PAYMENTS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of finance concepts • Familiarity with digital payments • Knowledge of basic computer and internet usage					
Course Objectives: • Understand cryptocurrencies, digital wallets, and modern payment systems • Learn the evolution and impact of digital and alternative finance • Understand InsureTech innovations using AI/ML and IoT • Explore peer-to-peer lending, crowdfunding, and marketplace lending • Study regulatory frameworks, RegTech, and fraud detection technologies					
Unit I	CURRENCY EXCHANGE AND PAYMENT				9
Understand the concept of Crypto currency- Bitcoin and Applications -Cryptocurrencies and Digital Crypto Wallets - Types of Cryptocurrencies - Cryptocurrencies and Applications, block chain, Artificial Intelligence, machine learning. Fintech users, Individual Payments, RTGS Systems, Immediate Page 54 of 90 Payment Service (IMPS), Unified Payments Interface (UPI).Legal and Regulatory Implications of Crypto currencies, Payment systems and their regulations.Digital Payments Smart Cards, Stored-Value Cards, EC Micropayments, Payment Gateways, Mobile Payments, Digital and Virtual Currencies, Security, Ethical, Legal, Privacy, and Technology Issues					
Unit II	DIGITAL FINANCE AND ALTERNATIVE FINANCE				9
A Brief History of Financial Innovation, Digitization of Financial Services, Crowd funding, Charity and Equity,. Introduction to the concept of Initial Coin Offering					
Unit III	INSURETECH				9
InsurTech Introduction , Business model disruption AI/ML in InsurTech IoT and InsurTech ,Risk Modeling ,Fraud Detection Processing claims and Underwriting Innovations in Insurance Services					
Unit IV	PEER TO PEER LENDING				9
P2P and Marketplace Lending, New Models and New Products in market place lending P2P Infrastructure and technologies, Concept of Crowdfunding Crowdfunding Architecture and Technology ,P2P and Crowdfunding unicorns and business models , SME/MSME Lending: Unique opportunities and Challenges, Solutions and Innovations					
Unit V	REGULATORY ISSUES				9
FinTech Regulations: Global Regulations and Domestic Regulations, Evolution of RegTech, RegTech Ecosystem: Financial Institutions, RegTech Ecosystem: StartupsRegTech, Startups: Challenges, RegTech Ecosystem: Regulators, Use of AI in regulation and Fraud detection					

Total periods:45**Text Books:**

1. Swanson Seth, *Fintech for Beginners: Understanding and Utilizing the Power of Technology*, 2016
2. Tanda & Models, *Fintech BigTech and Banks*, Springer, 2019
3. Henning Diedrich, *Ethereum: Blockchains, Digital Assets, Smart Contracts*, 2016
4. Jacob William, *FinTech: The Beginner's Guide to Financial Technology*, 2016

References:

1. Swanson Seth, *Fintech for Beginners: Understanding and Utilizing the power of technology*, Createspace Independent Publishing Platform, 2016.
2. Models AuTanda, *Fintech Bigtech And Banks Digitalization and Its Impact On Banking Business*, Springer, 2019
3. Henning Diedrich, *Ethereum: Blockchains, Digital Assets, Smart Contracts, Decentralized Autonomous Organizations*, Wildfire Publishing, 2016
4. Jacob William, *FinTech: The Beginner's Guide to Financial Technology*, Createspace Independent Publishing Platform, 2016
5. IIBF, *Digital Banking*, Taxmann Publication, 2016
6. Jacob William, *Financial Technology*, Create space Independent Pub, 2016
7. Luke Sutton, *Financial Technology: Bitcoin & Blockchain*, Createspace Independent Pub, 2016

Course Outcomes:**Blooms Taxonomy**

CO 1: Explain cryptocurrencies, digital wallets, and modern payment systems	Understand (K2)
CO2: Analyze digital finance, alternative finance, and ICO mechanisms	Analyze (K4)
CO3: Apply InsureTech tools such as AI, ML, and IoT in insurance operations	Apply (K3)
CO4: Evaluate P2P lending, crowdfunding models, and SME lending innovations	Evaluate (K5)
CO5: Examine regulatory frameworks, RegTech applications, and fraud detection systems	Evaluate (K5)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	2	2					2			3	2	1
CO2	3	3	2	3	2					2	1	1	3	2	1
CO3	2	2	3	3	3	1				3	1		3	3	2
CO4	3	3	3	3	3	1				3	1	2	3	3	3
CO5	3	3	2	3	3	1				3	1	3	3	3	3

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CMG006	INTRODUCTION TO FINTECH	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of financial systems
- Basic understanding of digital technology and internet usage

Course Objectives:

- To learn about history, importance and evolution of Fintech
- To acquire the knowledge of Fintech in payment industry
- To acquire the knowledge of Fintech in insurance industry
- To learn the Fintech developments around the world
- To know about the future of Fintech

Unit I	INTRODUCTION	9
Fintech - Definition, History, concept, meaning, architecture, significance, Goals, key areas in Fintech, Importance of Fintech, role of Fintech in economic development, opportunities and challenges in Fintech, Evolution of Fintech in different sectors of the industry - Infrastructure, Banking Industry, Startups and Emerging Markets, recent developments in FinTech, future prospects and potential issues with Fintech.		
Unit II	PAYMENT INDUSTRY	9
FinTech in Payment Industry-Multichannel digital wallets, applications supporting wallets, onboarding and KYC application, FinTech in Lending Industry- Formal lending, Informal lending, P2P lending, POS lending, Online lending, Payday lending, Microfinance, Crowdfunding.		
Unit III	INSURANCE INDUSTRY	9
FinTech in Wealth Management Industry-Financial Advice, Automated investing, Socially responsible investing, Fractional Investing, Social Investing. FinTech in Insurance Industry- P2P insurance, On-Demand Insurance, On-Demand Consultation, Customer engagement through Quote to sell, policy servicing, Claims Management, Investment linked health insurance.		
Unit IV	FINTECH AROUND THE GLOBE	9
FinTech developments - US, Europe and UK, Germany, Sweden, France, China, India, Africa, Australia, New Zealand, Brazil and Middle East, Regulatory and Policy Assessment for Growth of FinTech. FinTech as disruptors, Financial institutions collaborating with FinTech companies, The new financial world.		
Unit V	FUTURE OF FINTECH	9
How emerging technologies will change financial services, the future of financial services, banking on innovation through data, why FinTech banks will rule the world, The FinTech Supermarket, Banks partnering with FinTech start-ups, The rise of BankTech, Fintech impact on Retail Banking, A future without money, Ethics in Fintech.		
Total periods: 45		

Text Books:

1. Arner D., Barbers J., Buckley R. The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis. The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen. FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar. FinTech: The Technology Driving Disruption in the financial service industry. CRC Press, 2018

References:

1. Arner D., Barbers J., Buckley R, The evolution of FinTech: a new post crisis paradigm, University of New South Wales Research Series, 2015
2. Susanne Chishti, Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, Wiley Publications, 2016
3. Richard Hayen, FinTech: The Impact and Influence of Financial Technology on Banking and the Finance Industry, 2016
4. Parag Y Arjunwadkar, FinTech: The Technology Driving Disruption in the financial service industry CRC Press, 2018
5. Sanjay Phadke, Fintech Future : The Digital DNA of Finance Paperback .Sage Publications, 2020
6. Pranay Gupta, T. Mandy Tham, Fintech: The New DNA of Financial Services Paperback, 2018

Course Outcomes:**Blooms Taxonomy**

CO 1: Explain the fundamentals of FinTech including definition, history, significance, architecture and evolution

Understand (K2)

CO2: Analyze the role of FinTech in payment and lending industries

Analyze (K4)

CO3: Apply FinTech concepts in wealth management and insurance industries

Apply (K3)

CO4: Evaluate global FinTech developments and regulatory frameworks

Evaluate (K5)

CO5: Assess the future of FinTech including emerging technologies, BankTech and ethics

Evaluate (K5)

CO-PO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1					1			2	1	
CO2	2	3	2	2	2					1			3	2	1

CO3	2	2	3	2	3					1			3	3	2
CO4	1	2	2	3	2	1				2		1	2	2	
CO5	1	2	3	3	3	1				2		1	3	3	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

VERTICAL II : ENTREPRENERUSHIP

23CMG007	FOUNDATIONS OF ENTREPRENERUSHIP	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic understanding of business concepts and organizational structure.
- Fundamental knowledge of economics and market environment.
- Awareness of innovation, creativity, and problem-solving concepts.
- Basic communication and interpersonal skills.
- Interest in technology-driven business and entrepreneurial thinking.

Course Objectives:

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businessess.
- To empower the learners to run a Technology driven business efficiently and effectively
- To familiarize learners with emerging trends and modern practices in entrepreneurship locally and globally.

Unit I	INTRODUCTION TO ENTREPRENEURSHIP	9
Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development – Achievement Motivation – Contributions of Entrepreneurship to Economic Development.		
Unit II	BUSINESS OWNERSHIP & ENVIRONMENT	9
Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological-Technological- Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration		
Unit III	FUNDAMENTALS OF TECHNOPRENEURSHIP	9
Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportunities in Technopreneurship - Recent trends		
Unit IV	APPLICATIONS OF TECHNOPRENEURSHIP	9
Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities – Launching - Managing Technology based Product / Service entrepreneurship – Success Stories of Technopreneurs - Case Studies		
Unit V	EMERGING TRENDS IN ENTREPRENEURSHIP	9
Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local – National – Global perspectives.		
Total periods: 45		
Text Books:		
1. S.S.Khanka, “Entrepreneurial Development” S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.		
2. Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning.		
References:		
1. Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. Prentice Hall		
2. Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Eds: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.		
3. Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.		
4. David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,		
5. HarperBusiness, https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf		
6. JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009		
7. Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP		

8. Journal articles pertaining to Entrepreneurship

Course Outcomes:													Blooms Taxonomy		
CO1: Learn the basics of Entrepreneurship													Remember (K1), Understand (K2)		
CO2: Understand the business ownership patterns and environment													Understand (K2)		
CO3: Understand the Job opportunities in Industries relating to Technopreneurship													Understand (K2), Apply (K3)		
CO4: Learn about applications of technopreneurship and successful technopreneurs													Apply (K3), Analyze (K4)		
CO5: Acquaint with the recent and emerging trends in entrepreneurship													Analyze (K4), Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1							1	2					
CO2	2	2	1						2	2		1			
CO3	1	2	2						2	2		1			
CO4		2	3	2	1				3	3	1	1	1		
CO5		1	2	2	2				3	3	1	2	1		
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CMG008	TEAM BUILDING AND LEADERSHIP MANAGEMENT FOR BUSINESS	Category:PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of organizational structure and communication. • Awareness of human behavior and group dynamics. • Basic knowledge of business management concepts. • Interest in leadership development and team-based activities. • Fundamental interpersonal and decision-making skills.					
Course Objectives: • To develop and strengthen the Leadership qualities and motivation of learners. • To impart the Leadership skills and traits essential to become successful entrepreneurs. • To apply the principles and theories of Team Building in managing Technology oriented businesses. • To empower the learners to build robust teams for running and leading a business efficiently and effectively • To provide knowledge of leadership styles, effectiveness, and global leadership trends.					

Unit I	INTRODUCTION TO MANAGING TEAMS	9
Introduction to Team - Team Dynamics - Team Formation – Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) - Multicultural Teams.		
Unit II	MANAGING AND DEVELOPING EFFECTIVE TEAMS	9
Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.		
Unit III	INTRODUCTION TO LEADERSHIP	9
Introduction to Leadership - Leadership Myths – Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .		
Unit IV	LEADERSHIP IN ORGANISATIONS	9
Leadership Styles – LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory – Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.		
Unit V	LEADERSHIP EFFECTIVENESS	9
Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership - Culture and Leadership - Global Leadership – Recent Trends in Leadership.		
Total periods: 45		
Text Books:		
1. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.		
2. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5th ed, Jossey-Bass, (2013).		
References:		
1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience, 9th Ed, McGraw Hill Education, Chennai, India. (2019).		
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).		
3. Halder, U.K., Leadership and Team Building, Oxford University Press, (2010).		
4. Daft, R.L., The Leadership Experience, Cengage, (2015).		
Course Outcomes:		Blooms Taxonomy
CO1: Learn the basics of managing teams for business.		Remember (K1), Understand (K2)

CO2: Understand developing effective teams for business management.													Understand (K2), Apply (K3)		
CO3: Understand the fundamentals of leadership for running a business.													Understand (K2)		
CO4: Learn about the importance of leadership for business development.													Apply (K3), Analyze (K4)		
CO5: Acquaint with emerging trends in leadership effectiveness for entrepreneurs.													Analyze (K4), Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1						2	2		1			
CO2	1	2	2	1					2	2		1			
CO3	2	2	1						2	3		1			
CO4		2	3	2	1				3	3	1	1	1		
CO5		1	2	2	2				3	3	1	2	1		
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CMG009	CREATIVITY AND INNOVATION IN ENTREPRENEURSHIP	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites Basic understanding of entrepreneurship and business fundamentals. Awareness of creative thinking and problem-solving skills. Fundamental knowledge of innovation concepts. Interest in developing new ideas, products, or business models. Basic analytical and decision-making skills.					
Course Objectives: To develop the creativity skills among the learners To impart the knowledge of creative intelligence essential for entrepreneurs To know the applications of innovation in entrepreneurship. To develop innovative business models for business. To develop innovative and sustainable business models for successful enterprises.					
Unit I	CREATIVITY				9
Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity- Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.					

Unit II	CREATIVE INTELLIGENCE	9
Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training--Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.		
Unit III	INNOVATION	9
Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation – Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system		
Unit IV	INNOVATION AND ENTREPRENEURSHIP	9
Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies – Technology Pull/Market Push – Product -Market fit		
Unit V	INNOVATIVE BUSINESS MODELS	9
Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models – Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.		
Total periods: 45		
SUGGESTED READINGS:		
1. Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand		
2. Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.		
3. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.		
4. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.		
5. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.		
6. Dale Timpe, Creativity, Jaico Publishing House, 2003.		
7. Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.		
8. Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.		
Course Outcomes:		Blooms Taxonomy
CO1: Learn the basics of creativity for developing Entrepreneurship		Remember (K1), Understand (K2)
CO2: Understand the importance of creative intelligence for business growth		Understand (K2), Apply (K3)
CO3: Understand the advances through Innovation in Industries		Understand (K2), Analyze (K4)
CO4: Learn about applications of innovation in building successful ventures		Apply (K3), Analyze (K4)

CO5: Acquaint with developing innovative business models to run the business effecientlty and effectively													Analyze (K4), Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1							2	2		1			
CO2	1	2	2						2	3		1			
CO3	1	2	2	1					2	3		1			
CO4		2	3	2	1				3	3	1	1	1		
CO5		1	2	2	2				3	3	1	2	1		
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG010	PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of business operations and entrepreneurship. • Awareness of customer needs and buying behavior. • Fundamental knowledge of economics and business environment. • Interest in marketing strategies, branding, and product development. • Basic analytical and communication skills.					
Course Objectives: • To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs • To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners. • To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners. • To provide an understanding of marketing mix decisions, environmental analysis, and customer-focused strategies. • To enable learners to apply marketing concepts to develop solutions for contemporary marketing challenges.					
Unit I	INTRODUCTION TO MARKETING MANAGEMENT				9
Introduction - Market and Marketing – Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.					
Unit II	MARKETING ENVIRONMENT				9

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment – Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

Unit III**PRODUCT AND PRICING MANAGEMENT****9**

Product- Meaning, Classification, Levels of Products – Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

Unit IV**PROMOTION AND DISTRIBUTION MANAGEMENT****9**

Introduction to Promotion – Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion – Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

Unit V**CONTEMPORARY ISSUES IN MARKETING MANAGEMENT****9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development – Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

Total periods: 45**Text Books:**

1. Philip Kotler, Gary Armstrong, Principles of Marketing, Pearson Education, 17th Edition, 2018.
2. Ramaswamy V.S., Namakumari S., Marketing Management: Global Perspective – Indian Context, McGraw Hill Education, 5th Edition, 2018
3. C.B. Gupta, Rajan Nair, Marketing Management: Text and Cases, Sultan Chand & Sons, 17th Edition, 2017.

References:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management, Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
3. Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy & S.Namakumari, Macmillan Publishers India, 5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

Course Outcomes:**Blooms Taxonomy****CO1:** Have the awareness of marketing management processRemember (K1),
Understand (K2)**CO2:** Understand the marketing environment

Understand (K2),

													Analyze (K4)		
CO3: Acquaint about product and pricing strategies													Understand (K2), Apply (K3)		
CO4: Knowledge of promotion and distribution in marketing management.													Apply (K3), Analyze (K4)		
CO5: Comprehend the contemporary marketing scenairos and offer solutions to marketing issues.													Analyze (K4), Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1							2	2		1			
CO2	1	2	2	1					2	3		1			
CO3	1	2	2	2	1				3	3		1	1		
CO4		2	3	2	2				3	3	1	1	1		
CO5		1	2	2	2				3	3	1	2	1		
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG011	HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of organizational structure and management principles. • Awareness of fundamental business operations and entrepreneurial functions.					
Course Objectives: • To introduce the basic concepts, structure and functions of human resource management for entrepreneurs. • To create an awareness of the roles, functions and functioning of human resource department. • To understand the methods and techniques followed by Human Resource Management practitioners. • To impart understanding of training methods, employee development and compensation systems. • To enable students to understand HR controlling techniques such as performance appraisal, discipline and grievance handling.					
Unit I	INTRODUCTION TO HRM				9
Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.					
Unit II	HUMAN RESOURCE PLANNING				9
HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends					

Unit III	RECRUITMENT AND SELECTION												9		
Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.															
Unit IV	TRAINING AND EMPLOYEE DEVELOPMENT												9		
Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis – Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration – Health and Social Security Measures- Green HRM Practices															
Unit V	CONTROLLING HUMAN RESOURCES												9		
Performance Appraisal – Types - Methods - Collective Bargaining - Grievances Redressal Methods – Employee Discipline – Promotion – Demotion - Transfer – Dismissal - Retrenchment - Union Management Relationship - Recent Trends															
Total periods: 45															
Text Books:															
1. K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.															
2. Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012															
References:															
1. Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.															
2. Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.															
3. David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014															
4. R. Wayne Mondy, Human Resource Management, Pearson , 2015.															
5. Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012															
6. John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.															
Course Outcomes:												Blooms Taxonomy			
CO1: To understand the Evolution of HRM and Challenges faced by HR Managers												Remember (K1), Understand (K2)			
CO2: To learn about the HR Planning Methods and practices.												Understand (K2), Apply (K3)			
CO3: To acquaint about the Recruitment and Selection Techniques followed in Industries.												Understand (K2), Apply (K3)			
CO4: To known about the methods of Training and Employee Development.												Apply (K3), Analyze (K4)			
CO5: To comprehend the techniques of controlling human resources in organisations.												Analyze (K4), Evaluate (K5)			
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

CO1	3	2	1	1	1	2	1	1	2	3	2	1	3	2	1
CO2	2	3	2	2	1	2	1	1	2	3	2	1	3	2	1
CO3	2	2	3	2	1	2	1	1	3	3	2	1	3	2	2
CO4	2	2	3	3	2	2	1	1	3	3	2	2	3	2	2
CO5	2	2	2	3	2	3	1	2	3	3	2	2	3	2	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG012	FINANCING NEW BUSINESS VENTURES	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic knowledge of accounting and financial statements
- Understanding of fundamental business concepts
- Awareness of entrepreneurship and new venture creation basics

Course Objectives:

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.
- To empower learners to apply effective fund-raising methods for new ventures

Unit I	ESSENTIALS OF NEW BUSINES VENTURE	9
Setting up new Business Ventures – Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans – Financial Institutions - SFC, IDBI, NSIC and SIDCO.		
Unit II	INTRODUCTION TO VENTURE FINANCING	9
Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types - Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.		
Unit III	SOURCES OF DEBT FINANCING	9
Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.		
Unit IV	SOURCES OF EQUITY FINANCING	9
Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.		
Unit V	METHODS OF FUND RAISING FOR NEW VENTURES	9

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria – Process- Methods- Recent Trends

Total periods: 45

Text Books:

1. **Prasanna Chandra**, *Financial Management: Theory and Practice*, McGraw Hill Education, Latest Edition.

2. **I.M. Pandey**, *Financial Management*, Vikas Publishing House, Latest Edition.

3. **Bhabatosh Banerjee**, *Fundamentals of Financial Management*, PHI Learning, Latest Edition.

References:

1. Principles of Corporate Finance by Brealey and Myers et al., 12TH ed, McGraw Hill Education (India) Private Limited, 2018

2. Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.

3. Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.

4. Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.

5. Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.

6. May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.

7. Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.

8. Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.

9. Byers, Thomas. Technology Ventures: From Idea To Enterprise. McGraw2014.

10. Lerner, Josh; Leamon, Ann; Financing Of Entrepreneurship. 2012.

Course Outcomes:

Blooms Taxonomy

CO1: Learn the basics of starting a new business venture.

Remember (K1)

CO2: Understand the basics of venture financing.

Understand (K2)

CO3: Understand the sources of debt financing.

Apply (K3)

CO4: Understand the sources of equity financing.

Analyze (K4)

CO5: Acquaint with the methods of fund raising for new business ventures.

Evaluate (K5)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	1	1	2	3	2	1	3	2	1
CO2	3	3	2	2	1	2	1	1	2	3	2	1	3	2	1
CO3	2	3	3	2	1	2	1	1	3	3	2	1	3	2	2

CO4	2	3	3	3	2	2	1	1	3	3	2	2	3	2	2
CO5	2	3	3	3	2	3	1	2	3	3	2	2	3	2	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

VERTICAL III: PUBLIC ADMINISTRATION

23CMG013	PRINCIPLES OF PUBLIC ADMINISTRATION	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic understanding of social sciences (recommended, not mandatory).
- No formal prerequisites.

Course Objectives:

- To Introduce the meaning, nature, scope and significance of Public Administration.
- To Explain the evolution and changing trends in Public Administration including NPA and NPM.
- To Familiarize students with classical, scientific, bureaucratic, human relations and ecological approaches.
- To Explore the interdisciplinary relationships between Public Administration, Political Science, History, and Sociology.
- To Develop understanding of leadership, communication and decision-making processes within administrative systems.

Unit I	9
1. Meaning, Nature and Scope of Public Administration 2. Importance of Public Administration 3. Evolution of Public Administration	
Unit II	9
1. New Public Administration 2. New Public Management 3. Public and Private Administration	
Unit III	9
1. Relationships with Political Science, History and Sociology 2. Classical Approach 3. Scientific Management Approach	
Unit IV	9
1. Bureaucratic Approach: Max Weber 2. Human Relations Approach : Elton Mayo	

3. Ecological Approach : Riggs

Unit V

9

1. Leadership: Leadership - Styles - Approaches
2. Communication: Communication Types - Process - Barriers
3. Decision Making: Decision Making - Types, Techniques and Processes.

Total periods: 45

Text Books:

1. Avasthi and Maheshwari, *Public Administration in India*, Lakshmi Narain Agarwal, Agra, 2013.
2. Rumki Basu, *Public Administration: Concepts and Theories*, Sterling Publishers, New Delhi, 2013.

References:

1. Avasthi and Maheswari: Public Administration in India, Agra: Lakshmi Narain Agarwal, 2013.
2. Ramesh K Arora: Indian Public Administration, New Delhi: Wishwa Prakashan, 2012.
3. R.B. Jain: Public Administration in India, 21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.
4. Rumki Basu: Public Administration: Concept and Theories, New Delhi: Sterling, 2013.
5. R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.

Course Outcomes:

Blooms Taxonomy

CO1: Analyze the meaning, nature, scope and evolution of Public Administration.	Analyze (K4)
CO2: Analyze New Public Administration, New Public Management and compare public-private administration.	Analyze (K4)
CO3: Evaluate classical, scientific, bureaucratic, human relations and ecological approaches.	Evaluate (K5)
CO4: Create administrative frameworks using classical and modern administrative theories.	Create (K6)
CO5: Apply leadership, communication and decision-making techniques in administrative contexts.	Applying (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1					2	3			1		
CO2	2	1		2					2	3			1		
CO3	2	2	2	3					2	3			2		
CO4	1			2				1	3	3			1		
CO5								1	3	3			2	1	

1 - Low, 2 - Medium, 3 - High, ‘ ‘ No correlation

23CMG014	CONSTITUTION OF INDIA	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of Indian history and civics (recommended but not mandatory). • No formal prerequisites.					
Course Objectives: • To provide knowledge about the constitutional developments and the making of the Indian Constitution. • To enable students to understand Fundamental Rights, Duties, and Directive Principles of State Policy. • Familiarize students with the structure and functioning of the Union Government – President, Parliament, Supreme Court. • To explain the functioning of State Government institutions – Governor, State Legislature, High Courts. • To develop awareness on secularism, social justice, and minority rights in the Indian constitutional framework.					
Unit I					9
1. Constitutional Development Since 1909 to 1947					
2. Making of the Constitution.					
3. Constituent Assembly					
Unit II					9
1. Fundamental Rights					
2. Fundamental Duties					
3. Directive Principles of State Policy					
Unit III					9
1. President					
2. Parliament					
3. Supreme Court					
Unit IV					9
1. Governor					
2. State Legislature					
3. High Court					
Unit V					9

1. Secularism
2. Social Justice
3. Minority Safeguards

Total periods: 45**Text Books:**

- 1.D.D. Basu – Introduction to the Constitution of India, LexisNexis / Prentice Hall of India.
- 2.M. Laxmikanth – Indian Polity, McGraw Hill Education.

References:

1. Basu. D.D.: Introduction to Indian Constitution ; Prentice Hall; New Delhi.
2. Kapur. A.C: Indian Government and Political System; S.Chand and Company Ltd., New Delhi.
3. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi
4. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi

Course Outcomes:**Blooms Taxonomy**

CO1: Explain the historical evolution, constitutional development (1909–1947), and making of the Constitution.

Understand(K2)

CO2: Describe and interpret the Fundamental Rights, Fundamental Duties, and Directive Principles of State Policy, and their significance in the Indian constitutional framework.

Understand (K2)

CO3: Analyze the structure, powers, and functions of the President, Parliament, and Supreme Court, and evaluate their roles in the Union Government.

Analyze (K4)

CO4: Explain the functioning of State Government institutions—Governor, State Legislature, and High Courts—and compare their roles with corresponding Union institutions.

Analyze (K4)

CO5: Examine the concepts of secularism, social justice, and constitutional safeguards for minorities, and assess their relevance in contemporary India.

Evaluate (K5)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1					1	2		1			1		
CO2	2	2		1			2	2		1			1		
CO3	2	2	1	2			2	2		1			2	1	
CO4	1	2	1	2			2	2		1			2	1	
CO5	1	1		1			3	3		1			2	1	

1 - Low, 2 - Medium, 3 - High , ‘ ‘ No correlation

23CMG015	PUBLIC PERSONNEL ADMINISTRATION	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- No formal prerequisites.
- Basic understanding of public administration and governance (recommended).

Course Objectives:

- To understand the meaning, scope, and significance of personnel administration in public organizations.
- To familiarize students with various personnel systems and administrative structures.
- To explain recruitment, training, promotion, and their role in administrative efficiency.
- To analyze the relationship between civil servants, political executives, and integrity systems.
- To provide insights into employer–employee relations, wage systems, and employee benefits in public administration.

Unit I**9**

1. Meaning, Scope and Importance of Personnel Administration
2. Types of Personnel Systems: Bureaucratic, Democratic and Representative systems

Unit II**9**

1. Generalist Vs Specialist
2. Civil Servants' Relationship with Political Executive
3. Integrity in Administration.

Unit III**9**

1. Recruitment: Direct Recruitment and Recruitment from Within
2. Training: Kinds of Training
3. Promotion

Unit IV**9**

1. Governor
2. State Legislature
3. High Court

Unit V**9**

1. Employer Employee Relations
2. Wage and Salary Administration
3. Allowances and Benefits

Total periods: 45**Text Books:**

1. Stahl, Glenn O. – Public Personnel Administration

References:

1. Stahl Glenn O: Public Personnel Administration

2. Parnandikar Pai V.A: Personnel System for Development Administration.

3. Bhambhiru . P: Bureaucracy and Policy in India.

4. Dwivedi O.P and Jain R.B: India's Administrative state.

5. Muttalis M.A: Union Public Service Commission.

6. Bhakara Rao .V: Employer Employee Relations in India.

7. Davar R.S. Personnel Management & Industrial Relations

Course Outcomes:													Blooms Taxonomy		
CO1: Analyze the meaning, scope, importance, and types of personnel administration systems.													Analyze (K4)		
CO2: Analyze the functions of generalists and specialists, political-administrative relationships, and integrity mechanisms.													Analyze(K4)		
CO3: Evaluate recruitment, training, and promotion processes in public personnel administration.													Evaluate(K5)		
CO4: Create effective personnel management strategies relating to Governor, State Legislature, and High Court functions in the administrative system.													Create(K6)		
CO5: Apply concepts of employer-employee relations, wage systems, allowances, and benefits in public organizational settings.													Applying(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2			1				2	3				1		
CO2	2	1		2				2	3				1		
CO3	2	2	2	3				2	3				2	1	
CO4	1			2			1	3	3				1		
CO5								1	3	3			2	1	
1 - Low, 2 - Medium, 3 - High , ' ' No correlation															

23CMG016	ADMINISTRATIVE THEORIES	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • No formal prerequisites. • Basic understanding of public administration and management concepts (recommended).					

Course Objectives:

- To understand the meaning, scope, and significance of Public Administration.
- To study the evolution of Public Administration as a discipline and its identity.
- To learn classical, scientific, and human relations theories of organization.
- To analyze organizational behavior, design, and group dynamics.
- To examine motivation and leadership theories and the contributions of eminent administrative thinkers.

Unit I		9
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration		
Unit II		9
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory		
Unit III		9
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.		
Unit IV		9
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making		
Unit V		9
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker		
Total periods: 45		
Text Books:		
1.Shum Sun Nisa Alvi – <i>Eminent Administrative Thinkers</i>		
2.Keith Davis – <i>Organization Theory</i>		
References:		
1. Crozier M : The Bureaucratic phenomenon (Chand)		
2. Blau. P.M and Scott. W : Formal Organizations (RKP)		
3. Presthus. R : The Organizational Society (MAC)		
4. Alvi, Shum Sun Nisa : Eminent Administrative Thinkers.		
5. Keith Davis : Organization Theory (MAC)		
Course Outcomes:	Blooms Taxonomy	
CO1: Explain the meaning, scope, significance, and evolution of Public Administration.	Understand(K2)	
CO2: Analyze organizational theories: Scientific Management, Classical, and Human Relations approaches.	Analyze(K4)	
CO3: Examine organizational behavior, group dynamics, and organizational design.	Analyze(K4)	
CO4: Evaluate motivation and leadership theories and apply decision-making techniques.	Evaluate(K5)	
CO5: Assess contributions of eminent administrative thinkers and their relevance to	Evaluate(K5)	

contemporary administration.

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1		1				2	2				1		
CO2	2	2	1	2				2	3				1		
CO3	2	2	1	2				2	3				1	1	
CO4	2	1	1	3				2	3				2	1	
CO5	2	1	1	3				2	3				2	1	

1 - Low, 2 - Medium, 3 - High, ‘ ‘ No correlation

23CMG017	INDIAN ADMINISTRATIVE SYSTEM	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- No formal prerequisites.
- Basic understanding of Indian polity and governance (recommended).

Course Objectives:

- To understand the evolution and constitutional context of Indian Administration.
- To examine the role and functions of key constitutional authorities and administrative offices.
- To analyze the role of district administration and local governance in development programmes.
- To evaluate the impact of coalition politics, integrity, and vigilance mechanisms in administration.
- To understand anti-corruption mechanisms, Ombudsman, Lok Pal, and Lok Ayuktha in India.

Unit I	9
Evolution and Constitutional Context of Indian Administration, Constitutional Authorities: Finance Commission, Union Public Services Commission, Election Commission, Comptroller and Auditor General of India, Attorney General of India	
Unit II	9
Role & Functions of the District Collector, Relationship between the District Collector and Superintendent of Police, Role of Block Development Officer in development programmes, Local Government	
Unit III	9
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992	
Unit IV	9
Coalition politics in India, Integrity and Vigilance in Indian Administration	
Unit V	9

Corruption – Ombudsman, Lok Pal & Lok Ayuktha

Total periods: 45

Text Books:

1.S.R. Maheswari – Indian Administration.

References:

1. S.R. Maheswari : Indian Administration

2. Khera. S.S : Administration in India

3. Ramesh K. Arora : Indian Public Administration

4. T.N. Chaturvedi : State administration in India

5. Basu, D.D : Introduction to the Constitution of India

Course Outcomes:**Blooms Taxonomy****CO1:** Analyze the evolution and constitutional framework of Indian Administration.

Analyze (K4)

CO2: Analyze the roles and functions of district and local administrative offices.

Analyze(K4)

CO3: Evaluate the impact of 73rd & 74th Constitutional Amendments on local governance.

Evaluate(K5)

CO4: Create administrative strategies to enhance integrity, vigilance, and governance effectiveness.

Create(K6)

CO5: Apply knowledge of anti-corruption mechanisms like Ombudsman, Lok Pal & Lok Ayuktha.

Applying(K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1		1				2	2				1		
CO2	2	2	1	2				2	3				1		
CO3	2	2	1	3				2	3				2	1	
CO4	1	1	1	3			2	3	3				2	1	
CO5	1			2				2	3				2	1	

1 - Low, 2 - Medium, 3 - High, ‘ ‘ No correlation

23CMG018

PUBLIC POLICY ADMINISTRATION

Category: PEC

L

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3

Prerequisites

- No formal prerequisites.
- Basic understanding of political science, public administration, and governance (recommended).

Course Objectives:

- To understand the meaning, nature, scope, and importance of public policy.
- To examine the relationship of public policy with social sciences, political science, and public administration.
- To explore approaches to policy analysis, including institutional, incremental, system, and Dror's optimal model.
- To analyze stages in the policy-making process: formulation, implementation, and evaluation.
- To study the institutional framework of policy-making and the role of bureaucracy, interest groups, and political parties.

Unit I**9**

Meaning and Definition of Public Policy - Nature, Scope and Importance of public policy – Public policy relationship with social sciences especially with political science and Public Administration.

Unit II**9**

Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System's Approach – Dror's Optimal Mode

Unit III**9**

Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.

Unit IV**9**

Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.

Unit V**9**

Introduction to the following Public Policies – New Economic Policy – Population Policy – Agriculture policy - Information Technology Policy.

Total periods: 45**Text Books:**

1. Rajesh Chakrabarti & Kaushik Sanyal – Public Policy in India, Oxford University Press, 2016

References:

1. Rajesh Chakrabarti & Kaushik Sanyal : Public Policy in India, Oxford University Press, 2016.

2. Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.

3. Bidyut Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.

4. Pradeep Saxena : Public Policy Administration and Development

5. Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016

Course Outcomes:**Blooms Taxonomy**

CO1: Explain the meaning, nature, scope, and significance of public policy.

Understand(K2)

CO2: Analyze various approaches to policy analysis, including institutional, incremental, system, and Dror's optimal mode.													Analyze(K4)		
CO3: Evaluate the policy formulation process and assess the factors influencing effective policy design.													Evaluate(K5)		
CO4: Examine the institutional framework of policy-making and the roles of bureaucracy, political parties, and interest groups.													Analyze(K4)		
CO5: Apply knowledge of public policies in India, including economic, population, agriculture, and IT policies.													Apply(K3)		
CO - PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1		1				2	2				1		
CO2	2	2	1	2				2	3				1		
CO3	2	2	1	3				2	3				2	1	
CO4	1			2			1	3	3				1		
CO5								1	3	3			2	1	
1 - Low, 2 - Medium, 3 - High , ' ' No correlation															

VERTICAL IV : BUSINESS DATA ANALYTICS

23CMG019	STATISTICS FOR MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	1
Prerequisites • A strong foundational knowledge of high school level algebra and arithmetic operations is required. • Basic familiarity with using spreadsheet software applications like Microsoft Excel for data entry. • The ability to interpret and analyze basic statistical charts and graphical representations of data. • An introductory understanding of mathematical concepts such as set theory and logical reasoning. • Possession of basic analytical thinking skills to solve numerical problems effectively.					
Course Objectives: • To learn the various applications of statistical methods in modern business decision-making processes. • To understand the fundamental concepts of probability distributions and their real-world implications. • To apply different sampling techniques and estimation methods to calculate population parameters. • To perform parametric and non-parametric hypothesis testing to validate business assumptions. • To analyze the relationships between multiple business variables using correlation and regression techniques.					
Unit I	INTRODUCTION				9

Basic definitions and rules for probability, Baye's theorem and random variables, Probability distributions: Binomial, Poisson, Uniform and Normal distributions.

Unit II	SAMPLING DISTRIBUTION AND ESTIMATION	9
Introduction to sampling distributions, Central limit theorem and applications, sampling techniques, Point and interval estimates of population parameters.		
Unit III	TESTING OF HYPOTHESIS - PARAMETIRC TESTS	9
Hypothesis testing: one sample and two sample tests for means of large samples (z-test), one sample and two sample tests for means of small samples (t-test), ANOVA one way.		
Unit IV	NON-PARAMETRIC TESTS	9
Chi-square tests for independence of attributes and goodness of fit, Kolmogorov-Smirnov – test for goodness of fit, Mann – Whitney U test and Kruskal Wallis test.		
Unit V	CORRELATION AND REGRESSION	9
Correlation –Rank Correlation – Regression – Estimation of Regression line – Method of Least Squares – Standard Error of estimate.		
Total periods: 45		
Text Books:		
1.Statistics for Management by Levin, Rubin, et al. (Pearson, 2017)		
2.Applied Business Statistics by Ken Black (Wiley, 2012)		
References:		
1. Richard I. Levin, David S. Rubin, Masood H.Siddiqui, Sanjay Rastogi, Statistics for Management, Pearson Education, 8th Edition, 2017.		
2.Prem. S. Mann, Introductory Statistics, Wiley Publications, 9th Edition, 2015		
3. T N Srivastava and Shailaja Rego, Statistics for Management, Tata McGraw Hill, 3rd Edition 2017.		
4. Ken Black, Applied Business Statistics, 7th Edition, Wiley India Edition, 2012.		
5. David R. Anderson, Dennis J. Sweeney, Thomas A.Williams, Jeffrey D.Camm, James		
6.Cochran, Statistics for business and economics, 13th edition, Thomson (South – Western) Asia, Singapore, 2016.		
7.N. D. Vohra, Business Statistics, Tata McGraw Hill, 2017.		
Course Outcomes	Blooms Taxonomy	
CO1: To facilitate objective solutions in business decision making.	Apply (K3)	
CO2: To understand and solve business problems.	Understand (K2)	
CO3: To apply statistical techniques to data sets, and correctly interpret the results.	Analyze (K4)	
CO4: To develop skill-set that is in demand in both the research and business	Evaluate (K5)	

environments.															
CO5: To enable the students to apply the statistical techniques in a work setting.													Create (K6)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2													
CO2	3	3													
CO3	3	3	2										3		
CO4	3	3	2	2										3	
CO5	3	3	3												3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CMG020	DATAMINING FOR BUSINESS INTELLIGENCE	Category: PEC			
		L	T	P	L
		3	0	0	3

Prerequisites

- A solid foundational knowledge of basic statistical concepts and probability theory is essential.
- Basic understanding of database management systems and how data is structured and stored.
- Familiarity with fundamental programming logic or algorithm development for data processing.
- Understanding of linear algebra concepts including matrix operations and vector spaces.
- Basic knowledge of core business processes and how decision-making occurs in organizations.

Course Objectives:

- To know how to derive meaningful insights from huge volumes of complex data and information.
- To understand how the knowledge discovery process is utilized in effective business decision-making.
- To apply advanced prediction techniques including time series analysis and data visualization methods.
- To implement classification and clustering algorithms to segment data for business analysis.
- To understand the integration and application of machine learning and AI in data mining.

Unit I	INTRODUCTION	9
Data mining, Text mining, Web mining, Data ware house.		

Unit II	DATA MINING PROCESS	9
Datamining process – KDD, CRISP-DM, SEMMA Prediction performance measures		
Unit III	PREDICTION TECHNIQUES	9
Data visualization, Time series – ARIMA, Winter Holts,		
Unit IV	CLASSIFICATION AND CLUSTERING TECHNIQUES	9
Classification, Association, Clustering.		
Unit V	MACHINE LEARNING AND AI	9
Genetic algorithms, Neural network, Fuzzy logic, Ant Colony optimization, Particle Swarm optimization		
Total periods: 45		
Text Books:		
1.Data Mining Concepts and Techniques by Han & Kamber (2006)		
2.Business Intelligence by Turban et al. (2008)		
References:		
1. Jaiwei Ham and Micheline Kamber, Data Mining concepts and techniques, Kauffmann Publishers 2006		
2. Efraim Turban, Ramesh Sharda, Jay E. Aronson and David King, Business Intelligence, Prentice Hall, 2008.		
3. W.H.Inmon, Building the Data Warehouse, fourth edition Wiley India pvt. Ltd. 2005.		
4. Ralph Kimball and Richard Merz, The data warehouse toolkit, John Wiley, 3rd edition,2013.		
5. Michel Berry and Gordon Linoff, Mastering Data mining, John Wiley and Sons Inc, 2nd Edition, 2011		
6. Michel Berry and Gordon Linoff, Data mining techniques for Marketing, Sales and Customer support, John Wiley, 2011		
7. G. K. Gupta, Introduction to Data mining with Case Studies, Prentice hall of India, 2011		
8. Giudici, Applied Data mining – Statistical Methods for Business and Industry, John Wiley. 2009		
9. Elizabeth Vitt, Michael Luckevich Stacia Misner, Business Intelligence, Microsoft, 2011		
10. Michalewicz Z., Schmidt M. Michalewicz M and Chiriac C, Adaptive Business Intelligence, Springer – Verlag, 2007		
11. GalitShmueli, Nitin R. Patel and Peter C. Bruce, Data Mining for Business Intelligence – Concepts, Techniques and Applications Wiley, India, 2010.		
Course Outcomes		Blooms Taxonomy
CO1: Learn to apply various data mining techniques into various areas of different domains.		Apply (K3)
CO2: Be able to interact competently on the topic of data mining for business intelligence.		Understand (K2)
CO3: Apply various prediction techniques.		Analyze (K4)

CO4: Learn about supervised and unsupervised learning technique.													Evaluate (K5)		
CO5: To enable the students to apply the statistical techniques in a work setting.													Create (K6)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	2	2								2					
CO3	3	3	3											3	
CO4	3	3		2											
CO5	3		3												3
1 - Low, 2 - Medium, 3 - High, '-' No correlation															

23CMG021	HUMAN RESOURCE ANALYTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Basic understanding of the core functions and responsibilities within human resource management.
- Familiarity with key organizational behavior concepts and employee performance dynamics.
- Fundamental skills in statistics and the ability to interpret data patterns correctly.
- Proficiency in using spreadsheet tools for performing calculations and organizing workforce data.
- Understanding of strategic management principles and overall organizational business goals.

Course Objectives:

- To develop the ability of the learners to define and implement HR metrics that are aligned with the overall business strategy.
- To know the different types of HR metrics and understand their respective impact and application.
- To understand the impact and use of HR metrics and their connection with HR analytics.
- To understand common workforce issues and resolving them using people analytics.
- To measure the return on investment (ROI) for various training and development initiatives.

Unit I	INTRODUCTION TO HR ANALYTICS	9
People Analytics - stages of maturity - Human Capital in the Value Chain : impact on business – HR metrics and KPIs.		
Unit II	HR ANALYTICS I: RECRUITMENT	9
Recruitment Metrics : Fill-up ratio - Time to hire - Cost per hire - Early turnover - Employee referral hires - Agency hires - Lateral hires - Fulfillment ratio- Quality of hire.		
Unit III	HR ANALYTICS - TRAINING AND DEVELOPMENT	9

Training & Development Metrics : Percentage of employees trained- Internally and externally trained -Training hours and cost per employee - ROI.

Unit IV**HR ANALYTICS EMPLOYEE ENGAGEMENT AND CAREER PROGRESSION****9**

Employee Engagement Metrics :Talent Retention index - Voluntary and involuntary turnover- grades, performance, and service tenure - Internal hired index Career Progression Metrics: Promotion index - Rotation index - Career path index.

Unit V**HR ANALYTICS IV: WORKFORCE DIVERSITY AND DEVELOPMENT****9**

Workforce Diversity and Development Metrics : Employees per manager – Workforce age profiling - Workforce service profiling - Churnover index - Workforce diversity index - Gender mix

Total periods: 45**Text Books:**

1.The New HR Analytics by Jac Fitz-enz (2010)

2.Predictive HR Analytics by Edwards & Edwards (2016)

References:

1. JacFitzenz , The New HR Analytics, AMACOM , 2010.

2. Edwards M. R., & Edwards K, Predictive HR Analytics: Mastering the HR Metric.London: Kogan Page.2016.

3. Human Resources kit for Dummies – 3 rd edition – Max Messmer, 2003

4. Dipak Kumar Bhattacharyya, HR Analytics ,Understanding Theories and Applications, SAGE Publications India ,2017.

5. Sesil, J. C. , Applying advanced analytics to HR management decisions: Methods fo selection, developing incentives, and improving collaboration. Upper Saddle River,New Jersey: Pearson Education,2014.

6. Pease, G., & Beresford, B, Developing Human Capital: Using Analytics to Plan and Optimize Your Learning and Development Investments. Wiley ,2014.

7. Phillips, J., & Phillips, P.P, Making Human Capital Analytics Work: Measuring the ROI of Human Capital Processes and OUTCOME. McGraw-Hill,2014.

Course Outcomes**Blooms Taxonomy**

CO1: The learners will be conversant about HR metrics and ready to apply at work settings.

Understand (K2)

CO2: The learners will be able to resolve HR issues using people analytics.

Apply (K3)

CO3: Analyze workforce data to identify trends and patterns in employee behavior.

Analyze (K4)

CO4: Evaluate the effectiveness of HR interventions and training programs using ROI.

Evaluate (K5)

CO5: Create strategic HR plans based on predictive analytics models.

Create (K6)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2					2		2							

CO2	3	3											3		
CO3	3	3	2											2	
CO4	3	3		2											
CO5	3		3								2				3

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CMG022	MARKETING AND SOCIAL MEDIA WEB ANALYTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Fundamental understanding of marketing management principles and consumer engagement strategies.
- Basic knowledge of internet technologies, web architecture, and social networking platforms.
- Understanding of consumer behavior models and current digital marketing trends.
- Basic statistical analysis skills required for interpreting marketing performance data.
- Familiarity with various digital communication channels and online community dynamics

Course Objectives:

- To showcase the opportunities that exist today to leverage the power of the web and social media.
- To understand the methods for marketing budget allocation and performance measurement analysis.
- To analyze the strategies for community building and understanding the viral impact of social media.
- To implement effective web analytics strategies and define key performance indicators for success.
- To apply search engine optimization techniques and traffic analysis to improve online visibility

Unit I	MARKETING ANALYTICS	9
Marketing Budget and Marketing Performance Measure, Marketing - Geographical Mapping, Data Exploration, Market Basket Analysis		
Unit II	COMMUNITY BUILDING AND MANAGEMENT	9
History and Evolution of Social Media-Understanding Science of Social Media –Goals for using Social Media- Social Media Audience and Influencers - Digital PR- Promoting Social Media Pages- Linking Social Media Accounts-The Viral Impact of Social Media.		
Unit III	SOCIAL MEDIA POLICIES AND MEASUREMENTS	9
Social Media Policies-Etiquette, Privacy- ethical problems posed by emerging social media technologies - The Basics of Tracking Social Media.		
Unit IV	WEB ANALYTICS	9
Data Collection, Overview of Qualitative Analysis, Business Analysis, KPI and Planning, Critical Components of a		

Successful Web Analytics Strategy, Proposals & Reports, Web Data Analysis.

Unit V**SEARCH ANALYTICS****9**

Search engine optimization (SEO), user engagement, user-generated content, web traffic analysis, online security, online ethics, data visualization.

Total periods: 45**Text Books:**

1. Web Analytics: An Hour a Day by Avinash Kaushik (2007)

2. Social Media in Business and Governance by K. M. Shrivastava (2013)

References:

1. K. M. Shrivastava, Social Media in Business and Governance, Sterling Publishers Private Limited, 2013

2. Christian Fuchs, Social Media a critical introduction, SAGE Publications Ltd, 2014

3. Bittu Kumar, Social Networking, V & S Publishers, 2013

4. Avinash Kaushik, Web Analytics - An Hour a Day, Wiley Publishing, 2007

5. Ric T. Peterson, Web Analytics Demystified, Celilo Group Media and CafePress 2004

6. Takeshi Moriguchi, Web Analytics Consultant Official Textbook, 7th Edition, 2016

Course Outcomes**Blooms Taxonomy****CO1:** Understand the role of web and social media in modern marketing strategies.

Understand (K2)

CO2: Apply marketing analytics tools to measure performance and budget allocation.

Apply (K3)

CO3: Analyze social media audiences and influencers to optimize digital PR.

Analyze (K4)

CO4: Evaluate web traffic data and key performance indicators (KPIs) for strategy.

Evaluate (K5)

CO5: Create comprehensive reports and proposals based on web and social data.

Create (K6)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2				3										
CO2	3	2											3		
CO3	3	3	2											3	
CO4	3			3		2									
CO5	3		3												3

1 - Low, 2 - Medium, 3 - High, '-' - No correlation**23CMG023****OPERATION AND SUPPLY CHAIN ANALYTICS****Category: PEC****L****T****P****C****3****0****0****3****Prerequisites**

- Basic understanding of operations management principles and supply chain logistics flows.

- Familiarity with linear programming concepts and mathematical optimization problems.
- Fundamental knowledge of calculus and algebra to solve operational equations.
- Understanding of logistics, warehousing, and distribution concepts in a business context.
- Basic probability skills to assess risks within supply chain networks

Course Objectives:

- To understand various location models and layout methods for optimizing facility placement.
- To analyze warehousing decisions using heuristic approaches and dynamic location models.
- To apply inventory management strategies and risk pooling techniques to optimize stock levels.
- To optimize transportation network models using spanning tree and shortest path algorithms.
- To apply multi-criteria decision-making models like AHP and TOPSIS to operational problems.

Unit I	INTRODUCTION	9
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.		
Unit II	WAREHOUSING DECISIONS	9
P-Median Methods - Guided LP Approach, Greedy Drop Heuristics, Dynamic Location Models, Space Determination and Layout Methods.		
Unit III	INVENTORY MANAGEMENT	9
Dynamic Lot sizing Methods, Multi-Echelon Inventory models, Aggregate Inventory system and LIMIT, Risk Analysis in Supply Chain, Risk pooling strategies.		
Unit IV	TRANSPORTATION NETWORK MODELS	9
Minimal Spanning Tree, Shortest Path Algorithms, Maximal Flow Problems, Transportation Problems, Set covering and Set Partitioning Problems, Travelling Salesman Problem, Scheduling Algorithms.		
Unit V	MCDM MODELS	9
Analytic Hierarchy Process(AHP), Data Envelopment Analysis (DEA), Fuzzy Logic an Techniques, the analytical network process (ANP), TOPSIS.		
Total periods: 45		
Text Books:		
1.Big Data Driven Supply Chain Management by Nada R. Sanders (2014)		
2.Supply Chain Network Design by Watson et al. (2013)		
References:		
1. Nada R. Sanders, Big data driven supply chain management: A framework for implementing analytics and turning information into intelligence, Pearson Education, 2014.		
2. Michael Watson, Sara Lewis, Peter Cacioppi, Jay Jayaraman, Supply Chain Network Design:		

Applying Optimization and Analytics to the Global Supply Chain, Pearson Education, 2013.

3. Anna Nagurney, Min Yu, Amir H. Masoumi, Ladimer S. Nagurney, Networks Against Time:

Course Outcomes													Blooms Taxonomy		
CO1: Apply optimization models to solve facility location and layout problems.													Apply (K3)		
CO2: Analyze inventory systems and warehousing decisions using data.													Analyze (K4)		
CO3: Evaluate transportation networks and risks using simulation and algorithms.													Evaluate (K5)		
CO4: Create efficient supply chain strategies using multi-criteria decision models.													Create (K6)		
CO5: Understand the fundamental concepts of supply chain analytics and logistics.													Understand (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											2		
CO2	3	3	3											3	
CO3	3	3		2											
CO4	3		3												3
CO5	2				2										
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CMG024	FINANCIAL ANALYTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Understanding of fundamental financial accounting principles and financial reporting standards.
- Knowledge of time value of money concepts and their application in finance.
- Basic understanding of probability theory and statistical analysis for financial data.
- Familiarity with the functioning of financial markets and various investment instruments.
- Proficiency in using Excel for creating financial models and analyzing datasets.

Course Objectives:

- To apply corporate financial predictive modeling techniques for project and cash flow analysis.
- To estimate and predict the risk and return associated with bond and stock investments.
- To perform portfolio analysis using the capital asset pricing model and option pricing models.
- To use technical analysis charts and market indicators for the prediction of share prices.
- ☐ To evaluate credit risk models using techniques like logistic regression and decision trees.

Unit I	CORPORATE FINANCE ANALYSIS	9
Basic corporate financial predictive modelling- Project analysis- cash flow analysis- cost of capital, Financial Break even modelling, Capital Budget model-Payback, NPV, IRR.		

Unit II	FINANCIAL MARKET ANALYSIS												9		
Estimation and prediction of risk and return (bond investment and stock investment) –Time series-examining nature of data, Value at risk, ARMA, ARCH and GARCH.															
Unit III	PORTFOLIO ANALYSIS												9		
Portfolio Analysis – capital asset pricing model, Sharpe ratio, Option pricing models- binomial model for options, Black Scholes model and Option implied volatility.															
Unit IV	TECHNICAL ANALYSIS												9		
Prediction using charts and fundamentals – RSI, ROC, MACD, moving average and candle charts, simulating trading strategies. Prediction of share prices.															
Unit V	CREDIT RISK ANALYSIS												9		
Credit Risk analysis- Data processing, Decision trees, logistic regression and evaluating credit risk model.															
Total periods: 45															
Text Books:															
1. Financial Analytics with R by Bennett & Hugen															
2.Quantitative Financial Analytics by Williams & Dobelman															
References:															
1. Financial analytics with R by Mark J. Bennett, Dirk L. Hugen, Cambridge university press.															
2. Haskell Financial Data Modeling and Predictive Analytics Paperback – Import, 25 Oct 2013 by Pavel Ryzhov.															
3. Quantitative Financial Analytics: The Path To Investment Profits Paperback – Import, 11 Sep 2017 by Edward E Williams (Author), John A Dobelman.															
Course Outcomes												Blooms Taxonomy			
CO1: Apply financial predictive modeling techniques to project and cash flow analysis.												Apply (K3)			
CO2: Analyze financial market data to estimate risk, return, and volatility.												Analyze (K4)			
CO3: Evaluate portfolio performance using CAPM and option pricing models.												Evaluate (K5)			
CO4: Create trading strategies based on technical analysis and chart patterns.												Create (K6)			
CO5: Understand the principles of credit risk analysis and decision modeling.												Understand (K2)			
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3									3		3		
CO2	3	3	3											3	
CO3	3	3		3											
CO4	3		3												3
CO5	2										2				
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

VERTICAL V : ENVIRONMENT AND SUSTAINABILITY

23CES001	SUSTAINABLE INFRASTRUCTURE DEVELOPMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of civil engineering fundamentals and construction materials • Awareness of environmental studies and basic sustainable development concepts					
Course Objectives: • To impart knowledge about sustainable Infrastructure development goals, practices • To understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects. • To familiarize sustainable construction techniques and material selection. • To assess environmental, economic and social impacts of infrastructure projects. • To introduce modern tools and technologies for sustainable infrastructure management.					
Unit I	SUSTAINABLE DEVELOPMENT GOALS				9
Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands– Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.					
Unit II	SUSTAINABLE INFRASTRUCTURE PLANNING				9
Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).					
Unit III	SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES				9
Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast					

concrete technology, Pre-engineered buildings.

Unit IV	SUSTAINABLE CONSTRUCTION MATERIALS	9
Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Advances in LCA: Hybrid LCA, Thermodynamic LCA - Extending LCA - economic dimension, social dimension - Life cycle costing (LCC) - Combining LCA and LCC – Case studies		
Unit V	SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS	9
Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .		
Total periods:45		
Text Books:		
1. Charles J. Kibert, Sustainable Construction: Green Building Design and Delivery, 4th Edition, Wiley Publishers, 2016.		
2. Steve Goodhew, Sustainable Construction Processes, Wiley-Blackwell, UK, 2016.		
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth-Heinemann, 2011.		
4. William P. Spence, Construction Materials, Methods and Techniques, Yesdee Publication Pvt. Ltd., 2016.		
References:		
1. Charles J Kibert, Sustainable Construction : Green Building Design & Delivery, 4th Edition , Wiley Publishers 2016.		
2. Steve Goodhew, Sustainable Construction Process, Wiley Blackwell,UK, 2016.		
3. Craig A. Langston & Grace K.C. Ding, Sustainable Practices in the Built Environment, Butterworth Heinemann Publishers, 2011.		
4. William P Spence, Construction Materials, Methods & Techniques (3e), Yesdee Publication Pvt. Ltd, 2016.		
5. New Building Materials and Construction World magazine		
6. Kerry Turner. R, "Sustainable Environmental Management", Principles and Practice Publisher:Belhaven		

Press,ISBN:1852930039.

7. Munier N, "Introduction to Sustainability", Springer2005

8. Sharma, "Sustainable Smart Cities In India: Challenges And Future Perspectives", SPRINGER, 2022.

9. Ralph Horne, Tim Grant, KarliVerghese, Life Cycle Assessment: Principles, Practice and Prospects, Csiro Publishing,2009

10. European Commission - Joint Research Centre - Institute for Environment and Sustainability: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance. Luxembourg. European Union;2010

11. Hudson, Haas, Uddin, Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation, McGraw Hill, (1997).

12. GregerLundesjö, Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment, Kogan Page Publishers, 2015.

Course Outcomes:													Blooms Taxonomy		
CO1: Understand the environment sustainability goals at global and Indian scenario.													Understand (K2)		
CO2: Understand risks in development of projects and suggest mitigation measures.													Understand (K2)		
CO3: Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.													Apply (K3)		
CO4: Explain Life Cycle Analysis and life cycle cost of construction materials.													Explain (K2)		
CO5: Explain the new technologies for maintenance of infrastructure projects.													Explain (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1		2			2		1	2		
CO2	3	3	2		2		2			2		1	3	1	
CO3	3	3	3	2	2		2	1		3		1	3	2	1
CO4	2	3	2	2	2	1	2	2		3		2	3	2	1
CO5	2	2	2	2	3	1	3	2	1	3		2	3	2	1

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CES002	SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites:

- Basic understanding of ecology and environmental science
- Fundamental knowledge of agriculture and natural resource management

Course Objectives:

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.
- To develop understanding of soil, water, nutrient and pest management for sustainable farming.
- To introduce sustainable strategies for energy use and waste management in agriculture.
- To enable evaluation of agroecosystem sustainability using appropriate indicators.
- To promote sustainable agricultural practices for long-term environmental balance and food security.

Unit I	AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS	9
Ecosystem definition - Biotic Vs. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems		
Unit II	SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT	9
Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control		
Unit III	WATER MANAGEMENT	9
Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use		
Unit IV	ENERGY AND WASTE MANAGEMENT	9
Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture		
Unit V	EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS	9
Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies		
Total periods:45		

Text Books:

1. Lal, R., Sustainable Agriculture and the Environment, CRC Press, 2016.
2. Pretty, J., Sustainable Agriculture and Food Systems, Earthscan Publications, 2008.
3. Gliessman, S.R., Agroecology: The Ecology of Sustainable Food Systems, CRC Press, 2015.
4. Altieri, M.A., Agroecology: The Science of Sustainable Agriculture, Westview Press, 2012.

References:

1. Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming, Oberc, B.P. & Arroyo Schnell, A., IUCN, Belgium, 2020
2. Natural bioactive products in sustainable agriculture, Singh, J. & Yadav, A.N., Springer, 2020
3. Organic Farming for Sustainable Agriculture, Nandwani, D., Springer, 2016
4. Principles of Agronomy for Sustainable Agriculture, Villalobos, F.J. & Fereres, E., Springer, 2016
5. Sustainable Agriculture for Food Security: A Global Perspective, Balkrishna, A., CRC Press, 2021
6. Sustainable Energy Solutions in Agriculture, Bundschuh, J. & Chen, G., CRC Press, 2014

Course Outcomes:													Blooms Taxonomy		
CO1: Have an in-depth knowledge about the concepts, principles and advantages of sustainable agriculture													Understand (K2)		
CO2: Discuss the sustainable ways in managing soil health, nutrients, pests and diseases													Analyze (K4)		
CO3: Suggest the ways to optimize the use of water in agriculture to promote an ecological use of resources													Apply (K3)		
CO4: Develop energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas													Create (K6)		
CO5: Assess an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system through the redesign of a conventional agroecosystem													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2			1		2			2		1	2		
CO2	3	3	2		2		2			2		1	3	1	
CO3	3	3	2	1	2		2	1		3		1	3	2	1
CO4	2	3	2	2	2	1	2	2		3		2	3	2	1
CO5	2	2	2	2	3	1	3	2	1	3		2	3	2	1
1 - Low, 2 - Medium, 3 - High, ‘-’ No correlation															

23CES003	SUSTAINABLE BIO MATERIALS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites: • Basic knowledge of materials science. • Introductory understanding of chemistry and biology.					
Course Objectives: • To Impart knowledge of biomaterials and their properties • To learn about Fundamentals aspects of Biopolymers and their applications					

- To learn about bioceramics and biopolymers
- To introduce the students about metals as biomaterials and their usage as implants
- To make the students understand the significance of bionanomaterials and its applications.

Unit I	INTRODUCTION TO BIOMATERIALS	9
Introduction: Definition of biomaterials, requirements & classification of biomaterials- Types of Biomaterials- Degradable and resorbable biomaterials- engineered natural materials- Biocompatibility-Hydrogels-pyrolitic carbon for long term medical implants-textured and porous materials-Bonding types- crystal structure-imperfection in crystalline structure-surface properties and adhesion of materials –strength of biological tissues-performance of implants-tissue response to implants- Impact and Future of Biomaterials		
Unit II	BIO POLYMERS	9
Molecular structure of polymers -Molecular weight - Types of polymerization techniques–Types of polymerization reactions- Physical states of polymers- Common polymeric biomaterials -Polyethylene -Polymethylmethacrylate (PMMA-Polylactic acid (PLA) and polyglycolic acid (PGA) -Polycaprolactone (PCL) - Other biodegradable polymers –Polyurethan- reactions polymers for medical purposes - Collagens- Elastin- Cellulose and derivatives- Synthetic polymeric membranes and their biological applications		
Unit III	BIO CERAMICS AND BIOCOMPOSITES	9
General properties- Bio ceramics -Silicate glass - Alumina (Al ₂ O ₃) -Zirconia (ZrO ₂)-Carbon- Calcium phosphates (CaP)- Resorbable Ceramics- surface reactive ceramics- Biomedical Composites-Polymer Matrix Composite(PMC)- Ceramic Matrix Composite(CMC)-Metal Matrix Composite (MMC)–glass ceramics - Orthopedic implants-Tissue engineering scaffolds		
Unit IV	METALS AS BIOMATERIALS	9
Biomedical metals-types and properties-stainless steel-Cobalt chromium alloys-Titanium alloys-Tantalum-Nickel titanium alloy (Nitinol)- magnesium-based biodegradable alloys-surface properties of metal implants for osteointegration-medical application-corrosion of metallic implants – biological tolerance of implant metals		
Unit V	NANOBIOMATERIALS	9
Metallicnanobiomaterials–Nanopolymers-Nanoceramics- Nanocomposites -Carbon based nanobiomaterials - transport of nanoparticles- release rate-positive and negative effect of nanosize-nanofibres-Nano and micro features and their importance in implant performance-Nanosurface and coats-Applications nanoantibiotics-Nanomedicines- Biochips – Biomimetics- BioNEMs -Biosensor-Bioimaging/Molecular Imaging- challenges and future perspective.		
Total periods:45		
Text Books:		
1. Buddy D. Ratner et al., Biomaterials Science: An Introduction to Materials in Medicine, Elsevier, 2013.		
2. D. Williams, Essential Biomaterials Science, Cambridge University Press, 2014.		
3. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.		
4. Joon Park and R.S. Lakes, Biomaterials: An Introduction, Springer, 2007.		

References:

1. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford, Gopinath Mani "Introduction to Biomaterials Basic Theory with Engineering Applications" Cambridge University Press, 2014.
2. Donglu shi "Introduction to Biomaterials" Tsinghua University press, 2006.
3. Joon Park, R.S.Lakes "Biomaterials An Introduction" third edition, Springer 2007.
4. M.Jaffe, W.Hammond, P.Tolias and T.Arinzeh "Characterization of Biomaterials" Wood head publishing, 2013.
5. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science "An Introduction to Material in Medicine" Third Edition, 2013.
6. VasifHasirci, NesrinHasirci "Fundamentals of Biomaterials" Springer, 2018
7. Leopoldo Javier Rios Gonzalez. "Handbook of Research on Bioenergy and Biomaterials: Consolidated and green process" Apple academic press, 2021.
8. Devarajan Thangadurai, Jeyabalan Sangeetha, Ram Prasad "Functional Bionanomaterials" springer, 2020.
9. Sujata.V.Bhat Biomaterials; Narosa Publishing house, 2002.

Course Outcomes:**Blooms Taxonomy**

CO 1: Students will gain familiarity with Biomaterials and they will understand their importance.

Understand (K2)

CO2: Students will get an overview of different biopolymers and their properties

Understand (K2)

CO3: Students gain knowledge on some of the important Bioceramics and Biocomposite materials

Understand (K2)

CO4: Students gain knowledge on metals as biomaterials

Understand (K2)

CO5: Student gains knowledge on the importance of nanobiomaterials in biomedical applications.

Understand (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				1	2	2					2	1	
CO2	2	2	2		2	1	2	2					2	2	
CO3	2	3	3	2	2	1	2	2					3	2	1
CO4	2	3	3	2	2	1	2	2					3	3	1
CO5	2	3	3	3	2	2	3	2					3	3	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CES004	MATERIALS FOR ENERGY SUSTAINABILITY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of physics and chemistry. • Fundamental knowledge of energy systems and materials.					
Course Objectives: • To familiarize the students about the challenges and demands of energy sustainability • To provide fundamental knowledge about electrochemical devices and the materials used. • To introduce the students to various types of fuel cell • To enable students to appreciate novel materials and their usage in photovoltaic application • To introduce students to the basic principles of various types Supercapacitors and the materials used.					
Unit I	SUSTAINABLE ENERGY SOURCES				9
Introduction to energy demand and challenges ahead – sustainable source of energy (wind, solar etc.) – electrochemical energy systems for energy harvesting and storage – materials for sustainable electrochemical systems building – India centric solutions based on locally available materials – Economics of wind and solar power generators vs. conventional coal plants – Nuclear energy					
Unit II	ELECTROCHEMICAL DEVICES				9
Electrochemical Energy – Difference between primary and secondary batteries – Secondary battery (Li-ion battery, Sodium-ion battery, Li-S battery, Li-O2 battery, Nickel Cadmium, Nickel Metal Hydride) – Primary battery (Alkaline battery, Zinc-Carbon battery) – Materials for battery (Anode materials – Lithiated graphite, Sodiated hard carbon, Silicon doped graphene, Lithium Titanate) (Cathode Materials – S, LiCoO2, LiFePO4, LiMn2O4) – Electrolytes for Lithium-ion battery (ethylene carbonate and propylene carbonate based)					
Unit III	FUEL CELLS				9
Principle of operation of fuel cells – types of fuel cells (Proton exchange membrane fuel cells, alkaline fuel cell, direct methanol fuel cells, direct borohydride fuel cells, phosphoric acid fuel cells, solid oxide fuel cells, and molten carbonate fuel cells) – Thermodynamics of fuel cell – Fuel utilization – electrolyte membrane (proton conducting and anion conducting) – Catalysts (Platinum, Platinum alloys, carbon supported platinum systems and metal oxide supported platinum catalysts) – Anatomy of fuel cells (gas diffusion layer, catalyst layer, flow field plate, current conductors, bipolar plates and monopolar plates).					
Unit IV	PHOTOVOLTAICS				9
Physics of the solar cell – Theoretical limits of photovoltaic conversion – bulk crystal growth of Si and wafering for photovoltaic application - Crystalline silicon solar cells – thin film silicon solar cells – multijunction solar cells – amorphous silicon based solar cells – photovoltaic concentrators – Cu(InGa)Se2 solar cells – Cadmium Telluride solar cells – dye sensitized solar cells – Perovskite solar cells – Measurement and characterization of solar cells - Materials					

used in solar cells (metallic oxides, CNT films, graphene, OD fullerenes, single-multi walled carbon nanotubes, two-dimensional Graphene, organic or Small molecule-based solar cells materials - copper-phthalocyanine and perylenetetracarboxylicbis - benzine – fullerenes - boron subphthalocyanine- tin (II) phthalocyanine)

Unit V	SUPERCAPACITORS	9
Supercapacitor –types of supercapacitors (electrostatic double-layer capacitors, pseudo capacitors and hybrid capacitors) - design of supercapacitor-three and two electrode cell-parameters of supercapacitor- Faradaic and non - Faradaic capacitance – electrode materials (transition metal oxides (MO), mixed metal oxides, conducting polymers (CP), Mxenes, nanocarbons, non-noble metal, chalcogenides, hydroxides and 1D-3D metal-organic frame work (MOF), activated carbon fibres (ACF)- Hydroxides-Based Materials - Polyaniline (PANI), a ternary hybrid composite- conductive polypyrrole hydrogels – Different types of nanocomposites for the SC electrodes (carbon– carbon composites, carbon-MOs composites, carbon-CPs composites and MOs-CPs composites) - Two-Dimensional (2D) Electrode Materials - 2D transition metal carbides, carbonitrides, and nitrides.		
Total periods:45		
Text Books:		
1. David S. Ginley and David Cahen, Fundamentals of Materials for Energy and Environmental Sustainability, Cambridge University Press, 2012.		
2. John A. Turner, Sustainable Hydrogen Production Processes, Wiley, 2014.		
3. Mark Z. Jacobson, Renewable Energy and the Environment, Academic Press, 2018.		
4. Vikas Mittal, Advanced Materials for Energy Conversion and Storage, Wiley, 2019.		
References:		
1. Functional materials for sustainable energy applications; John A. Kilner, Stephen J. Skinner, Stuart J. C. Irvine and Peter P. Edwards.		
2. Hand Book of Fuel Cells: Fuel Cell Technology and Applications, Wolf Vielstich, Arnold Lamm, Hubert Andreas Gasteiger, Harumi Yokokawa, Wiley, London 2003.		
3. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.		
4. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.		
5. Materials for Supercapacitor applications; B.Viswanathan. M.Aulice Scibioh		
6. Electrode Materials for Supercapacitors: A Review of Recent Advances, Parnia Forouzandeh, Vignesh Kumaravel and Suresh C. Pillai, catalysts 2020.		
7. Recent advances, practical challenges, and perspectives of intermediate temperature solid oxide fuel cell cathodes Amanda Ndubuisi, Sara Abouali, Kalpana Singh and VenkataramanThangadurai, J. Mater. Chem. A, 2022.		
8. Review of next generation photovoltaic solar cell technology and comparative materialistic development Neeraj Kant, Pushpendra Singh, Materials Today: Proceedings, 2022.		
Course Outcomes:	Blooms Taxonomy	

CO 1: Students will acquire knowledge about energy sustainability.													Understand (K2)		
CO2: Students understand the principles of different electrochemical devices.													Understand (K2)		
CO3: Students learn about the working of fuel cells and their application.													Apply (K3)		
CO4: Students will learn about various Photovoltaic applications and the materials used.													Apply (K3)		
CO5: The students gain knowledge on different types of supercapacitors and the performance of various materials													Understand (K2)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				2	3	2					2	1	
CO2	2	3	2		2	2	3	2					2	2	
CO3	2	3	3	2	2	2	3	2					3	2	1
CO4	2	2	3	2	2	2	3	2					3	2	2
CO5	2	3	3	3	2	2	3	2					3	3	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CES005	GREEN TECHNOLOGY	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of chemistry and environmental science. • Awareness of pollution and sustainability concepts.					
Course Objectives: • To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability. • To provide green engineering solutions to energy demand, reduced energy footprint. • To encourage sustainable design of products and industrial processes. • To promote the application of green synthesis and green reagents. • To analyze the role of green nanotechnology in environmental protection.					
Unit I	PRINCIPLES OF GREEN CHEMISTRY				9
Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.					
Unit II	POLLUTION TYPES				9
Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical,					

physical and biochemical methods of waste minimization and recycling.

Unit III**GREEN REAGENTS AND GREEN SYNTHESIS****9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

Unit IV**DESIGNING GREEN PROCESSES****9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention

Unit V**GREEN NANOTECHNOLOGY****9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology

Total periods: 45**Text Books:**

1. Green technology and design for the environment, Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, Washington, DC, ©1997

2. Green Chemistry – An introductory text - M. Lancaster, RSC, 2016.

3. Green chemistry metrics - Alexi Lapkin and David Constable (Eds) , Wiley publications, 2008

References:

1. Environmental chemistry, Stanley E Manahan, Taylor and Francis, 2017

Course Outcomes:**Blooms Taxonomy**

CO1: To understand the principles of green engineering and technology

Understand (K2)

CO2: To learn about pollution using hazardous chemicals and solvents

Understand (K2)

CO3: To modify processes and products to make them green and safe.

Apply (K3)

CO4: To design processes and products using green technology

Create (K6)

CO5: To understand advanced technology in green synthesis

Understand (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				3	3	2					2	1	
CO2	2	3			2	3	3	2					2	2	
CO3	2	3	3	2	2	3	3	2					3	2	1
CO4	2	2	3	3	2	3	3	2					3	2	2
CO5	2	3	3	3	2	3	3	2					3	3	2

1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation

23CES006	ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of environmental science. • Knowledge of basic analytical and scientific measurement methods.					
Course Objectives: • To understand and study the complexity of the environment in relation to pollutants generated due to industrial activity. • To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment. • To introduce instrumental methods used in environmental quality assessment. • To analyze environmental risk and monitoring programmes. • To develop skills in interpreting environmental data for quality control.					
Unit I	ENVIRONMENTAL MONITORING AND STANDARDS				9
Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.					
Unit II	MONITORING OF ENVIRONMENTAL PARAMETERS				9
Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring - screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.					
Unit III	ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING				9
Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods - Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis					
Unit IV	ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT				9
Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification- exposure assessment- dose-response assessment; risk characterization.					
Unit V	AUTOMATED DATA ACQUISITION AND PROCESSING				9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks - Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

Total periods:45

Text Books:

1. Environmental monitoring Handbook, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. Handbook of environmental analysis: chemical pollutants in the air, water, soil, and solid wastes / Pradyot Patnaik, © 1997 by CRC Press, Inc

References:

1. Environmental monitoring / edited by G. Bruce Wiersma, © 2004 by CRC Press LLC.
2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) Environmental Data Handling. John Wiley & Sons. New York.

Course Outcomes:

Blooms Taxonomy

CO 1: Basic concepts of environmental standards and monitoring.

Understand (K2)

CO2: The ambient air quality and water quality standards;

Understand (K2)

CO3: The various instrumental methods and their principles for environmental monitoring

Analyze (K4)

CO4: The significance of environmental standards in monitoring quality and sustainability of the environment.

Evaluate (K5)

CO5: The various ways of raising environmental awareness among the people.

Understand (K2)

CO-PO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				3	3	2					2	1	
CO2	2	3		2	2	3	3	2					2	2	
CO3	2	3	3	2	2	3	3	2					3	2	1
CO4	2	2	3	3	2	3	3	2					3	2	2
CO5	2	2			2	3	3	2					2	1	

1 - Low, 2 - Medium, 3 - High , '-' No correlation

23CES007	INTEGRATED ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Fundamental knowledge of energy resources and environmental studies. - Basic awareness of sustainable development concepts.					
Course Objectives: - To create awareness on the energy scenario of India with respect to world - To understand the fundamentals of energy sources, energy efficiency and resulting environmental implications of energy utilisation - Familiarisation on the concept of sustainable development and its benefits - Recognize the potential of renewable energy sources and its conversion technologies for attaining sustainable development - Acquainting with energy policies and energy planning for sustainable development					
Unit I	ENERGY SCENARIO				9
Comparison of energy scenario – India and World (energy sources, generation mix, consumption pattern, T&D losses, energy demand, per capita energy consumption) – energy pricing – Energy security					
Unit II	ENERGY AND ENVIRONMENT				9
Conventional Energy Sources - Emissions from fuels – Air, Water and Land pollution – Environmental standards - measurement and controls					
Unit III	SUSTAINABLE DEVELOPMENT				9
Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG) - Social development: Poverty, conceptual issues and measures, impact of poverty. Globalization and Economic growth - Economic development: Economic inequalities, Income and growth.					
Unit IV	RENEWABLE ENERGY TECHNOLOGY				9
Renewable Energy – Sources and Potential – Technologies for harnessing from Solar, Wind, Hydro, Biomass and Oceans – Principle of operation, relative merits and demerits					
Unit V	ENERGY PLANNING FOR SUSTAINABLE DEVELOPMENT				9
National & State Energy Policy - National solar mission - Framework of Central Electricity Authority - National Hydrogen Mission - Energy and climate policy - State Energy Action Plan, RE integration, Road map for ethanol blending, Energy Efficiency and Energy Mix					
Total periods:45					
Text Books:					
1. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 2012.					
2. Virendra K. Vijay, Energy Planning and Policy for Sustainable Development, Springer, 2016.					

3. Vaclav Smil, Energy and Civilization: A History, MIT Press, 2017.

4. R. K. Rajput, Energy Management and Conservation, Laxmi Publications, 2014.

References:

1. Energy Manager Training Manual (4 Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India. 2004

2. Robert Ristirer and Jack P. Kraushaar, "Energy and the environment", Willey, 2005.

3. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012

4. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

5. Dhandapani Alagiri, Energy Security in India Current Scenario, The ICFAI University Press, 2006.

6. M.H. Fulekar, Bhawana Pathak, R K Kale, "Environment and Sustainable Development" Springer, 2016

7. <https://www.niti.gov.in/verticals/energy>

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the world and Indian energy scenario													Understand (K2)		
CO2: Analyse energy projects, its impact on environment and suggest control strategies													Analyze (K4)		
CO3: Recognise the need of Sustainable development and its impact on human resource development													Understand (K2)		
CO4: Apply renewable energy technologies for sustainable development													Apply (K3)		
CO5: Fathom Energy policies and planning for sustainable development.													Evaluate (K5)		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2				2	3	2					2	1	
CO2	2	3	2	2	2	2	3	2					2	2	
CO3	2	2	3	2	2	2	3	2					3	2	1
CO4	2	2	3	3	2	2	3	2					3	2	2
CO5	2	3	3	3	2	2	3	2					3	3	2

1 - Low, 2 - Medium, 3 - High, '-' No correlation

23CES008	ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT	Category: PEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of energy systems and environmental impact. • Introductory knowledge of sustainability principles					
Course Objectives: • To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation • To create awareness on energy audit and its impacts • To acquaint the techniques adopted for performance evaluation of thermal utilities • To familiarise on the procedures adopted for performance evaluation of electrical utilities • To learn the concept of sustainable development and the implication of energy usage					
Unit I	ENERGY AND ENVIRONMENT				9
Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP					
Unit II	ENERGY AUDITING				9
Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments					
Unit III	ENERGY EFFICIENCY IN THERMAL UTILITIES				9
Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression					
Unit IV	ENERGY CONSERVATION IN ELECTRICAL UTILITIES				9
Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers					
Unit V	SUSTAINABLE DEVELOPMENT				9
Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty,					
Total periods: 45					
Text Books:					
1. Eastop T.D. and Croft D.R., Energy Efficiency for Engineers and Technologists, Longman Scientific & Technical, 1990.					

2. W.R. Murphy and G. McKay, Energy Management, Butterworths, London, 1987.

3. Pramod Verma, Energy Audit and Conservation, McGraw Hill, 2015.

4. A. Thumann and Terry Niehus, Handbook of Energy Audits, Fairmont Press, 2010.

References:

1. Energy Manager Training Manual (4Volumes) available at <http://www.em-ea.org/gbook1.asp>, a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.2004

2. Eastop.T.D& Croft D.R, “Energy Efficiency for Engineers and Technologists”, Logman Scientific & Technical, ISBN-0-582-03184, 1990

3. W.R. Murphy and G. McKay “Energy Management” Butterworths, London 1987

4. Pratap Bhattacharyya, “Climate Change and Greenhouse Gas Emission”, New India Publishing Agency-Nipa,2020

5. Matthew John Franchetti , Defne Apul “Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies” CRC Press,2012 6. Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, “Energy and the Environment”, 4th Edition,Wiley,2022

7. M.H. Fulekar,Bhawana Pathak, R K Kale,“Environment and Sustainable Development” Springer,2016

8. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF, 2011.

Course Outcomes:													Blooms Taxonomy		
CO 1: Understand the prevailing energy scenario													Understand (K2)		
CO2: Familiarise on energy audits and its relevance													Understand (K2)		
CO3: Apply the concept of energy audit on thermal utilities													Apply (K3)		
CO4: Employ relevant techniques for energy improvement in electrical utilities													Apply (K3)		
CO5: Understand Sustainable development and its impact on human resource development													Understand (K2)		
CO-PO Mapping															

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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CO3	2	3	3	2	2	2	3	2					3	2	1
CO4	2	2	3	3	2	2	3	2					3	2	2
CO5	2	2			2	2	3	2					2	1	

1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation