

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
BIOTECHNOLOGY**

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 accomplish eminence in academic excellence through quality teaching with latest technology and innovations in the areas of agriculture, environment, health care and entrepreneurship for the welfare of the society.

Mission

•	Disseminate a blending of knowledge acquisition and its application in real-life situations to the students.
•	Equip the students to adapt to changing global and local needs through well designed curriculum and syllabus.
•	Groom students to uphold professional ethics and develop leadership qualities.
•	Train students on issues related to social welfare.

III. Program Educational Objectives(PEOs)

PEO1:	Successful professional career and/or higher studies by gaining knowledge in fundamental mathematics and biological principles.
PEO2:	Provide strong foundation in the core biotechnology courses to evaluate real life problems and to propose biotechnological solutions with economical and social viability.
PEO3:	Sensitize on environmental, health and bioethical issues, Intellectual property rights, professional ethics and life-long learning through application orientated activities.

IV. Program Outcomes(POs)

Graduates of the BIOTECHNOLOGY will be able to

PO1:	Engineering knowledge Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2:	Problem analysis Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3:	Design/development of solutions Design solutions for complex engineering problems and design system components or 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 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 knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in 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 BIOTECHNOLOGY will be able to

PSO1:	Apply the 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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PEO1	3	3	3	1	-	-	-	-	2	2	1	2	3	2	-
PEO2	3	3	3	3	3	2	2	2	3	3	3	3	3	3	-
PEO3	1	1	1	1	-	3	3	3	2	2	2	3	2	3	3

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

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

Sem	Course Name	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
I	Induction Programme	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Professional English I	1.6	2.2	1.8	2.2	1.2	3	3	3	1.6	3	1.2	3	0	0	0
	Matrices and Calculus	3	2	1	1	0	0	0	0	0	0	0	1	0	0	0

Sem	Course Name	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	Engineering Physics	3	3	1.6	1.2	1.8	1	0	0	0	0	0	0.2	0	0	0
	Engineering Chemistry	3	1	0	0	0.6	1	1	0	0	0	0.8	1	0	0	0
	Programming in C	2	2.4	2.2	1	2.2	1	1.2	1	2	0	3	2.4	1.8	2.2	0
	Heritage of Tamils	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Programming in C Laboratory	1.8	2.4	2.6	1.6	1.4	1.6	0	0	2.2	0.4	2.4	2.4	2.4	2.4	0
	Physics and Chemistry Laboratory	3	2.4	2.6	1	1	1	1	0	2	0	0.4	1	0	0	0
	English Laboratory	1.6	2.2	1.8	2.2	1.2	3	3	3	1.6	3	1.2	3	0	0	0
II	Professional English - II	1	0	0	0	0	0	1	2	1	3	2	3	0	0	0
	Computation Methods	3	2	2	2	2	1	0	0	0	0	0	1	0	0	0
	Engineering Graphics	2.6	2.2	1.8	1.6	2.4	1	1	1	2	2	1	2	2.6	1.6	1.4
	Material Science for Biotechnologists	3	1.2	1.8	0.4	1	1.4	0.8	0	0	0	0	0.2	0	0	0
	Basic Electrical, Electronics and Instrumentation Engineering	2.2	1.6	1.6	0.8	0	0.4	0.4	1.2	0	0.8	0	3	1	0	2
	Bioorganic Chemistry	2.4	2	1.8	0.8	1.4	1.4	1.8	2	1.8	0	0	1.8	2.2	2	2
	Tamils and Technology	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Engineering Practices Laboratory	2.4	2.4	2.6	1.4	1.6	2	1	1	2	1.4	1	2	2	1.6	1.4
	Communication Laboratory	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0
	Bioorganic Chemistry Laboratory	3	2.6	2.6	2.2	1.6	1	1	1	1.6	1.6	1	2	3	2	1.6
III	Transforms and Partial Differential Equations	3	3	3	3	0	1	0	0	0	0	0	1	0	0	0
	Biochemical Thermodynamics	3	-	3	2	2.6	-	2.4	2.4	-	-	2.2	1.7	2.4	2	2
	Cell Biology	2.6	2	3	2	2.5	1.5	1.8	1.5	2.6	-	1.7	2	2.8	2.5	2
	Basic Industrial Biotechnology	2.6	2.3	2.8	2	2.4	1.5	1.8	1.3	2.6	-	1.7	2	3	2.5	2
	Microbiology	3	2.8	2.6	2.8	2.6	2	2.6	2	2	2.4	2.2	2.2	2.8	2.2	2.6
	Biochemistry	2.4	2	1.6	2.2	1.6	1.4	1.8	2	1.8	1.6	2.2	1.6	2.2	2	2
	Professional Development Lab	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0
	Biochemistry Laboratory	2	2	2.6	2	2.4	2	2.4	2	1.8	1.8	2	1.6	2.2	2	2.2
	Cell Biology and Microbiology Laboratory	2.2	3	2.4	3	2.4	2.2	1.8	1.8	2.8	3	2.8	3	3	3	3
IV	Molecular Biology	2.6	2	2	1.8	-	1	1	1.2	-	-	1.4	0.4	2.2	2	2
	Fluid Flow and Heat Transfer Operations	3.0	2.4	2.2	2.2	2.4	1.6	1.4	1.0	1.0	1.4	1.2	2.0	3.0	2.4	2.2
	Industrial Enzymology	2.8	2.2	2.2	2.4	2.2	1.8	2.5	2.4	1.6	1.8	1.5	2.3	2.6	2.2	2
	Chemical Process Calculations	3.0	2.2	2.6	1.8	2.4	1.0	1.0	1.0	1.0	1.4	1.0	2.0	3.0	2.2	1.8
	Analytical Techniques In Biotechnology	3.0	2.8	2.2	1.8	2.6	1.2	1.0	1.0	1.4	1.4	1.4	2.0	2.8	2.4	1.4
	Environmental Science and Sustainability	3	1	0.2	0	0.6	1	2	0	1.2	0	1	1	0	0	0
	Chemical Engineering Laboratory for Biotechnologists	3	2.6	2.8	2.2	1.8	1.2	1	1	1.8	1.8	1	2	3	2.2	1.8

Sem	Course Name	PO												PSO		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	Analytical Instrumentation Laboratory	3	2.6	2.8	2.6	2	1	1	1	1.6	1.6	1	2	3	2	2
V	Genetic Engineering	3.0	3.0	2.8	2.4	2.6	1.0	1.0	1.0	1.4	1.2	1.0	2.0	3.0	2.8	2.6
	Bioprocess Principles	3.0	2.8	2.6	2.4	3.0	1.0	1.0	1.0	1.4	1.2	1.4	2.0	3.0	2.8	2.0
	Immunology	1.8	0.8	0.8	1.4	0.7	0.6	0.8	1.2	2.2	0.2	1.8	2.4	2.6	1.2	2.2
	Professional Elective I	As per the Elective Chosen														
	Professional Elective II	As per the Elective Chosen														
	Professional Elective III	As per the Elective Chosen														
	Industrial Internship / Training - I	As per the Training Module														
	Immunology Laboratory	3	2.8	2.8	2	2	2	1	1	1.8	1.8	1	2	3	2.8	2
	Molecular Biology & Genetic Engineering Laboratory	3	2.8	2.8	2.4	2.4	2	1	1	2	1.6	1	2	3	2.6	2
VI	Bioinformatics	3.0	3.0	2.8	2.8	3.0	1.0	1.0	1.0	1.8	1.6	1.0	2.0	3.0	2.8	2.6
	Bioprocess Engineering	3	2.8	2.8	2.6	1.8	1	2	1.2	1.6	1.2	1.4	2	3	2.6	2.8
	Professional Elective IV	As per the Elective Chosen														
	Professional Elective V	As per the Elective Chosen														
	Open Elective – I	As per the Elective Chosen														
	Mini Project	As Per the Project done by Students														
	Bioprocess Laboratory	2.8	2.8	2.8	2.6	2	1.4	1.2	1.4	2.2	1.8	1.2	2.2	2.8	3	2
	Bioinformatics Laboratory	3	2.8	2.8	2.6	2.2	1	1	1	1.8	1.8	1	2	3	2.8	2.2
VII	Human Values and Ethics	2.6	2	3	2	2	0.6	1.4	3	2.6	1.2	0.6	2	2.8	2	1.2
	Downstream Processing	1.8	1.6	2.6	2.8	1.8	1.2	0	0	0	0	2	1	2.2	2	1.8
	Professional Elective VI	As per the Elective Chosen														
	Open Elective – II	As per the Elective Chosen														
	Open Elective – III	As per the Elective Chosen														
	Industrial Internship / Training - II	As per the Training Module														
	Downstream Processing Laboratory	3	3	3	2.6	2.4	1	1	1	2	1.6	1	2	3	3	2
	Project Work – Part I	As Per the Project done by Students														
VIII	Project Work – Part II	As Per the Project done by Students														
	Elective- Management	As per the Elective Chosen														
	Open Elective – IV	As per the Elective Chosen														

B.Tech. BIOTECHNOLOGY
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	2	2	0	4	4
7	23GET102	Heritage of Tamils	HSMC	40 / 60	1	0	0	1	1
PRACTICALS									
8	23BSP101	Physics and Chemistry Lab	BSC	60 /40	0	0	4	4	2
9	23GET101	Programming in 'C' Lab	ESC	60 /40	0	0	4	4	2
10	23HSP102	English Laboratory	EEC	100	0	0	2	2	1
TOTAL				-	15	3	10	28	23

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	BSC	40 / 60	2	0	0	2	2
2	23MAT201	Computational Methods	BSC	40 / 60	3	1	0	4	4
3	23PHT206	Materials Science for Biotechnologists	BSC	40 / 60	3	0	0	3	3
4	23EET203	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40 / 60	3	0	0	3	3
5	23GET201	Engineering Graphics	ESC	40 / 60	1	0	4	5	3
6	23BTT201	Bioorganic Chemistry	PCC	40 / 60	3	0	0	3	3
7	23GET202	Tamils And Technology	HSMC	40 / 60	1	0	0	1	1
PRACTICALS									
7	23GEP201	Engineering Practices	ESC	60 /40	0	0	4	4	2

		Laboratory							
8	23GEP202	Communication Laboratory	EEC	60 /40	0	0	4	4	2
9	23BTP201	Bioorganic Chemistry Laboratory	PCC	60 /40	0	0	4	4	2
TOTAL				-	16	1	16	33	25

SEMESTER III

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23MAT301	Transform and Partial Differential Equations	BSC	40 / 60	3	1	0	4	4
2	23BTT301	Biochemistry	PCC	40 / 60	3	0	0	3	3
3	23BTT302	Cell Biology	PCC	40 / 60	3	0	0	3	3
4	23BTT303	Microbiology	PCC	40 / 60	3	0	0	3	3
5	23BTT304	Biochemical Thermodynamics	PCC	40 / 60	3	0	0	3	3
6	23BTT305	Basic Industrial Biotechnology	PCC	40 / 60	3	0	0	3	3
PRACTICALS									
7	23BTP301	Biochemistry Laboratory	PCC	60 /40	0	0	3	3	1.5
8	23BTP302	Cell and Microbiology Laboratory	PCC	60 /40	0	0	3	3	1.5
9	23GEP301	Professional Development Lab	EEC	100	0	0	2	2	1
TOTAL				-	18	1	6	25	23

SEMESTER IV

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23BTT401	Molecular Biology	PCC	40 / 60	3	0	0	3	3
2	23BTT402	Fluid Flow and Heat Transfer Operations	ESC	40 / 60	3	0	0	3	3
3	23BTT403	Analytical Techniques in Biotechnology	PCC	40 / 60	3	0	0	3	3
4	23BTT404	Chemical Process Calculations in Biotechnologist	PCC	40 / 60	3	0	0	3	3
5	23BTT405	Industrial Enzymology	PCC	40 / 60	3	0	0	3	3
6	23GET401	Environmental Sciences and Sustainability	BSC	40 / 60	2	0	0	2	2

PRACTICALS									
7	23BTP401	Chemical Engineering Laboratory for Biotechnologists	PCC	60 /40	0	0	3	3	1.5
8	23BTP402	Analytical Instrumentation Laboratory	PCC	60 /40	0	0	3	3	1.5
TOTAL				-	17	0	6	23	20

SEMESTER V

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23BTT501	Bioprocess Principles	PCC	40 / 60	3	0	0	3	3
2	23BTT502	Immunology	PCC	40 / 60	3	0	0	3	3
3	23BTT503	Genetic Engineering	PCC	40 / 60	3	0	0	3	3
4		Professional Elective - I	PEC	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
7		Mandatory Course-I	MNC	100	3	0	0	0	0
PRACTICALS									
8	23BTP501	Molecular Biology & Genetic Engineering Laboratory	PCC	60 /40	0	0	3	3	1.5
9	23BTP502	Immunology Laboratory	PCC	60 /40	0	0	3	3	1.5
10	23BTP503	Industrial training / Internship - I	EEC	100	0	0	0	2 weeks	2
TOTAL				-	21	0	6	27 + 2weeks	23

SEMESTER VI

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23BTT601	Bioinformatics	PCC	40 / 60	3	0	0	3	3
2	23BTT602	Bioprocess Engineering	PCC	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		Open Elective I	OEC	40 / 60	3	0	0	3	3

6		Mandatory Course II	MNC	100	3	0	0	3	0
PRACTICALS									
7	23BTP601	Bioinformatics Lab	PCC	60 /40	0	0	3	3	1.5
8	23BTP602	Bioprocess Laboratory	PCC	60 /40	0	0	3	3	1.5
9	23BTP603	Mini Project	EEC	60 /40	0	0	4	4	2
TOTAL				-	18	0	10	28	20

SEMESTER VII

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1	23BTT701	Downstream Processing	PCC	40 / 60	3	0	0	3	3
2	23GET701	Human Values and Ethics	HSMC	40 / 60	2	0	0	2	2
3		Professional Elective - VI	PEC	40 / 60	3	0	0	3	3
4		Open Elective II	OEC	40 / 60	3	0	0	3	3
5		Open Elective III	OEC	40 / 60	3	0	0	3	3
PRACTICALS									
6	23BTP701	Downstream Laboratory	PCC	60 /40	0	0	4	4	2
7	23BTP702	Project Work – Part I	EEC	60 /40	0	0	8	8	4
8	23BTP703	Industrial training / Internship - II	EEC	100	0	0	0	2 weeks	2
TOTAL				-	14	0	12	26 + 2 weeks	22

SEMESTER VIII

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
THEORY									
1		Elective - Management	HSMC	40 / 60	3	0	0	3	3
2		Open Elective IV	OEC	40 / 60	3	0	0	3	3
PRACTICALS									
3		Project Work – Part 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		
1	23GE3751	Principles of Management	HSMC	40 / 60	3	0	0	3	3
2	23GE3752	Total Quality Management	HSMC	40 / 60	3	0	0	3	3
3	23GE3753	Engineering Economics and Financial Accounting	HSMC	40 / 60	3	0	0	3	3
4	23GE3754	Human Resource Management	HSMC	40 / 60	3	0	0	3	3
5	23GE3755	Knowledge Management	HSMC	40 / 60	3	0	0	3	3
6	23GE3792	Industrial Management	HSMC	40 / 60	3	0	0	3	3

MANDATORY COURSES I

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

MANDATORY COURSES II

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23MCT005	Well Being with Traditional Practices - Yoga, Ayurveda and Siddha	MNC	100	3	0	0	3	0
2	23MCT006	History of Science and Technology in India	MNC	100	3	0	0	3	0
3	23MCT007	Political and Economic Thought for a Humane Society	MNC	100	3	0	0	3	0
4	23MCT008	State, Nation Building and Politics in India	MNC	100	3	0	0	3	0
5	23MCT009	Industrial Safety	MNC	100	3	0	0	3	0

PROFESSIONAL ELECTIVE COURSES

PROFESSIONAL ELECTIVE – I: BIOPROCESS TECHNOLOGY

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE001	Bioprocess Control and Instrumentation	40/60	PEC	3	0	0	3	3
2	23BTE002	Modern Bioanalytical Techniques	40/60	PEC	3	0	0	3	3
3	23BTE003	Food Processing and Technology	40/60	PEC	3	0	0	3	3
4	23BTE004	Biopharmaceuticals and Biosimilars	40/60	PEC	3	0	0	3	3
5	23BTE005	Bioprocess Modelling and Simulation	40/60	PEC	3	0	0	3	3
6	23BTE006	Bioreactor consideration for Recombinant Products	40/60	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE – II: BIOSCIENCES

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE007	Biosensors	40/60	PEC	3	0	0	3	3
2	23BTE008	Bio-Nanotechnology	40/60	PEC	3	0	0	3	3
3	23BTE009	Stem Cell Technology	40/60	PEC	3	0	0	3	3
4	23BTE010	Biomaterials	40/60	PEC	3	0	0	3	3
5	23BTE011	Protein Engineering	40/60	PEC	3	0	0	3	3
6	23BTE012	Tissue Engineering	40/60	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE – III: BIO CHEMICAL ENGINEERING

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE013	Mass Transfer operations	40/60	PEC	3	0	0	3	3
2	23BTE014	Transport Phenomena in Biological Systems	40/60	PEC	3	0	0	3	3
3	23BTE015	Bioenergy and Biofuels	40/60	PEC	3	0	0	3	3
4	23BTE016	Environmental Biotechnology	40/60	PEC	3	0	0	3	3

5	23BTE017	Applied Chemical Reaction Engineering	40/60	PEC	3	0	0	3	3
6	23BTE018	Biotechnological approach in crop improvement	40/60	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE – IV: ANIMAL BIOTECHNOLOGY

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE019	Fundamentals of Animal Biotechnology	40/60	PEC	3	0	0	3	3
2	23BTE020	Animal Health and Nutrition	40/60	PEC	3	0	0	3	3
3	23BTE021	Animal Physiology and Metabolism	40/60	PEC	3	0	0	3	3
4	23BTE022	Animal Cell Culture Technology	40/60	PEC	3	0	0	3	3
5	23BTE023	Advances in Animal Biotechnology	40/60	PEC	3	0	0	3	3
6	23BTE024	Biotechniques in Animal Breeding	40/60	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE – V: COMPUTATIONAL BIOTECHNOLOGY

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE025	Programming for Bioinformatics Applications	40/60	PEC	3	0	0	3	3
2	23BTE026	Fundamentals of Algorithms for Bioinformatics	40/60	PEC	3	0	0	3	3
3	23BTE027	Molecular Modelling	40/60	PEC	3	0	0	3	3
4	23BTE028	Computer-Aided Drug Design	40/60	PEC	3	0	0	3	3
5	23BTE029	Metabolomics and Metabolic Engineering	40/60	PEC	3	0	0	3	3
6	23BTE030	Data Mining and Machine Learning Techniques For Bioinformatics	40/60	PEC	3	0	0	3	3

PROFESSIONAL ELECTIVE – VI: AGRO BIOTECHNOLOGY

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23BTE031	Plant anatomy	40/60	PEC	3	0	0	3	3
2	23BTE032	Therapeutic application of phytochemicals	40/60	PEC	3	0	0	3	3
3	23BTE033	Bio-fertilizer production & mushroom cultivation	40/60	PEC	3	0	0	3	3
4	23BTE034	Phytotherapeutics	40/60	PEC	3	0	0	3	3
5	23BTE035	Advance techniques in agro forestry	40/60	PEC	3	0	0	3	3
6	23BTE036	Plant tissue culture & transformation techniques	40/60	PEC	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 & II

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23CSO001	Artificial Intelligence and Machine Learning Fundamentals	40/60	OEC	2	0	2	4	3
2	23CSO002	IoT Concepts and Applications	40/60	OEC	2	0	2	4	3
3	23CSO003	Data Science Fundamentals	40/60	OEC	2	0	2	4	3
4	23CSO004	Augmented and Virtual Reality	40/60	OEC	2	0	2	4	3

OPEN ELECTIVE - III

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23HSO001	English for Competitive Examinations	40/60	OEC	3	0	0	3	3
2	23CEO001	Lean Concepts, Tools And Practices	40/60	OEC	3	0	0	3	3
3	23MGO001	NGOs and Sustainable Development	40/60	OEC	3	0	0	3	3
4	23MGO002	Democracy and Good Governance	40/60	OEC	3	0	0	3	3
5	23EEO001	Renewable Energy Technologies	40/60	OEC	3	0	0	3	3
6	23MEO001	Applied DesignThinking	40/60	OEC	2	0	2	4	3
7	23MEO002	Reverse Engineering	40/60	OEC	3	0	0	3	3
8	23MEO003	Sustainable Manufacturing	40/60	OEC	3	0	0	3	3
9	23EEO002	Electric and Hybrid Vehicle	40/60	OEC	3	0	0	3	3
10	23ECO002	Space Engineering	40/60	OEC	3	0	0	3	3
11	23MGO004	Industrial Management	40/60	OEC	3	0	0	3	3

12	23MGO003	Quality Engineering	40/60	OEC	3	0	0	3	3
13	23CHO001	Fire Safety Engineering	40/60	OEC	3	0	0	3	3
14	23CEO001	Introduction to non-destructive testing	40/60	OEC	3	0	0	3	3
15	23MEO004	Mechatronics	40/60	OEC	3	0	0	3	3
16	23MEO005	Foundation of Robotics	40/60	OEC	3	0	0	3	3
17	23MEO006	Fundamentals of Aeronautical engineering	40/60	OEC	3	0	0	3	3
18	23CEO002	Remote Sensing Concepts	40/60	OEC	3	0	0	3	3
19	23CEO003	Urban Agriculture	40/60	OEC	3	0	0	3	3
20	23CEO004	Drinking Water Supply and Treatment	40/60	OEC	3	0	0	3	3
21	23EEO003	Electric Vehicle technology	40/60	OEC	3	0	0	3	3
22	23EEO004	Introduction to PLC Programming	40/60	OEC	3	0	0	3	3
23	23CHO002	Nano Technology	40/60	OEC	3	0	0	3	3
24	23MEO007	Functional Materials	40/60	OEC	3	0	0	3	3
25	23BTO003	IPR for Pharma Industry	40/60	OEC	3	0	0	3	3
26	23CHO003	Basics of Textile Finishing	40/60	OEC	3	0	0	3	3
27	23CHO004	Industrial Engineering for Garment Industry	40/60	OEC	3	0	0	3	3
28	23CHO005	Basics of Textile Manufacture	40/60	OEC	3	0	0	3	3
29	23CHO006	Introduction to Petroleum Refining and Petrochemicals	40/60	OEC	3	0	0	3	3
30	23EEO005	Energy Conservation and Management	40/60	OEC	3	0	0	3	3
31	23CHO007	Basics of Plastics Processing	40/60	OEC	3	0	0	3	3
32	23ECO003	Signals and Systems	40/60	OEC	3	0	0	3	3

33	23ECO004	Fundamentals of Electronic Devices and Circuits	40/60	OEC	3	0	0	3	3
34	23MEO008	Foundation Skills in integrated Product Development	40/60	OEC	3	0	0	3	3
35	23BMO002	Assistive Technology	40/60	OEC	3	0	0	3	3
36	23MAO001	Operations Research	40/60	OEC	3	0	0	3	3
37	23MAO002	Algebra and Number Theory	40/60	OEC	3	0	0	3	3
38	23MAO003	Linear Algebra	40/60	OEC	3	0	0	3	3

OPEN ELECTIVE - IV

S. No	Course Code	Course Title	Category	Internal / External	Periods per Week			Total Contacts Period	Credits
					L	T	P		
1	23HSO002	Project Report Writing	40/60	OEC	3	0	0	3	3
2	23CEO008	Basics of Integrated Water Resources Management	40/60	OEC	3	0	0	3	3
3	23MAO004	Advanced Numerical Methods	40/60	OEC	3	0	0	3	3
4	23MAO005	Random Processes	40/60	OEC	3	0	0	3	3
5	23MAO006	Queuing and Reliability Modelling	40/60	OEC	3	0	0	3	3
6	23MGO004	Production and Operations Management for Entrepreneurs	40/60	OEC	3	0	0	3	3
7	23MGO005	Multivariate Data Analysis	40/60	OEC	3	0	0	3	3
8	23MEO009	Additive Manufacturing	40/60	OEC	3	0	0	3	3
9	23MEO010	New Product Development	40/60	OEC	3	0	0	3	3
10	23MEO011	Industrial Design & Rapid Prototyping Techniques	40/60	OEC	2	0	2	4	3
11	23MEO012	Micro and Precision Engineering	40/60	OEC	3	0	0	3	3
12	23MEO013	Cost Management of Engineering Projects	40/60	OEC	3	0	0	3	3

13	23EEO011	Batteries and Management system	40/60	OEC	3	0	0	3	3
14	23EEO006	Sensors and Actuators	40/60	OEC	3	0	0	3	3
15	23ECO005	Space Vehicles	40/60	OEC	3	0	0	3	3
16	23MGO006	Management Science	40/60	OEC	3	0	0	3	3
17	23MEO014	Production Planning and Control	40/60	OEC	3	0	0	3	3
18	23MGO007	Operations Management	40/60	OEC	3	0	0	3	3
19	23BMO003	Industrial Hygiene	40/60	OEC	3	0	0	3	3
20	23CHO008	Chemical Process Safety	40/60	OEC	3	0	0	3	3
21	23EEO007	Electrical, Electronic and Magnetic materials	40/60	OEC	3	0	0	3	3
22	23CHO009	Nanomaterials and applications	40/60	OEC	3	0	0	3	3
23	23EEO008	Sensors	40/60	OEC	3	0	0	3	3
24	23ECO006	Concepts in Mobile Robotics	40/60	OEC	3	0	0	3	3
25	23MEO015	Marine Propulsion	40/60	OEC	3	0	0	3	3
26	23MEO016	Marine Merchant Vehicles	40/60	OEC	3	0	0	3	3
27	23MEO017	Elements of Marine Engineering	40/60	OEC	3	0	0	3	3
28	23ECO007	Drone Technologies	40/60	OEC	3	0	0	3	3
29	23CEO005	Geographical Information System	40/60	OEC	3	0	0	3	3
30	23CEO006	Agriculture Entrepreneurship Development	40/60	OEC	3	0	0	3	3
31	23EEO009	Introduction to control Systems	40/60	OEC	3	0	0	3	3
32	23EEO010	Energy Technology	40/60	OEC	3	0	0	3	3
33	23MEO021	Introduction to Industrial Automation Systems	40/60	OEC	3	0	0	3	3
34	23CHO010	Basics of Dyeing and Printing	40/60	OEC	3	0	0	3	3

35	23CHO011	Fibre Science	40/60	OEC	3	0	0	3	3
36	23CHO012	Garment Manufacturing Technology	40/60	OEC	3	0	0	3	3
37	23CEO009	Industrial safety	40/60	OEC	3	0	0	3	3
38	23CHO013	Unit Operations inPetro Chemical Industries	40/60	OEC	3	0	0	3	3
39	23MEO018	Plastic Materials for Engineers	40/60	OEC	3	0	0	3	3
40	23MEO019	Properties and Testing of Plastics	40/60	OEC	3	0	0	3	3
41	23ECO008	VLSI Design	40/60	OEC	3	0	0	3	3
42	23ECO009	Wearable devices	40/60	OEC	3	0	0	3	3
43	23BMO004	Medical Informatics	40/60	OEC	3	0	0	3	3

SUMMARY

Name of the Programme: B.Tech BIOTECHNOLOGY										
S.No	Subject Area	Credits per Semester								Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	HSMC	4	1	-	-	-	-	2	3	10
2	BSC	12	9	4	2	-	-	-	-	27
3	ESC	6	8	-	3	-	-	-	-	17
4	PCC	-	5	18	15	12	9	5	-	64
5	PEC	-	-	-	-	9	6	3	-	18
6	OEC	-	-	-	-	-	3	6	3	12
7	EEC	1	2	1	-	2	2	6	6	20
8	Non-Credit (Mandatory)	-	-	-	-	✓	✓	-	-	-
Total		23	25	23	20	23	20	22	12	168

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

- A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor degree.
- For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.
- For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.
- Complete details are available in clause 4.10 of Regulations 2023.

VERTICALS FOR MINOR DEGREE

(In addition to all the verticals of other programmes)

Vertical I Fintech and Block chain	Vertical II Entrepreneurship	Vertical III Public Administratio n	Vertical IV Business Data Analytics	Vertical V 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	Datamining 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 Block chain 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 Entrepreneurship	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

Vertical II : Entrepreneurship

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 Management for Business	PEC	40/60	3	0	0	3	3
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 Entrepreneurship	PEC	40/60	3	0	0	3	3
6	23CMG012	Financing New Business Ventures	PEC	40/60	3	0	0	3	3

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

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	Data mining 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

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

SEMESTER I

23IP101	INDUCTION PROGRAMME
Prerequisites	
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: “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 a 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.” “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.” 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. The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program. (i) Physical Activity This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc. (ii) 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 every day 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. (iii) 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, make 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 don'ts, 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. (iv) Literary Activity Literary activity would encompass reading, writing and possibly, debating, enacting a play etc. (v) Proficiency Modules This would address some lacunas that students might have, for example, English, computer familiarity etc.	

(vi) 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.

(vii) 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 underprivileged.

(viii) 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.

(ix) 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.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

23HST101	PROFESSIONAL ENGLISH I	Category: HSMC			
		L	T	P	C
		3	0	0	3
Prerequisites					
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 EFFECTIVE COMMUNICATION INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION				18
What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?					
Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Wh/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).					
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 etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and repositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.					
Unit III	DESCRIPTION OF A PROCESS / PRODUCT				9
Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - 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) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.					
Unit V	EXPRESSION				9
Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and 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. 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 Lakshminarayanan, 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, RS Salaria, Khanna Publishing House. |
| 5.Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003. |

Course Outcomes: At the end of the course, learners will be able	Blooms Taxonomy
CO 1: To use appropriate words in a professional context	K3
CO2: To gain understanding of basic grammatic structures and use them in right context.	K1
CO3: To read and infer the denotative and connotative meanings of technical texts	K2
CO4: To write definitions, descriptions, narrations and essays on various topics	K4
CO5: Comprehend and analyze editorials and opinion blogs effectively, identifying the writer’s viewpoint, arguments, and persuasive techniques.	K4

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	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	-	-	-

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

23MAT101	MATRICES AND CALCULUS	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites					
Course Objectives: - To develop the use of matrix algebra techniques that are 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 acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.					
Unit I	MATRICES				9 + 3
Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – 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: Stretching of an elastic membrane.					
Unit II	DIFFERENTIAL CALCULUS				9 + 3
Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications: Maxima and Minima of functions of one variable.					
Unit III	FUNCTIONS OF SEVERAL VARIABLES				9 + 3
Partial differentiation – Homogeneous functions and Euler’s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor’s series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange’s method of undetermined multipliers.					
Unit IV	INTEGRAL CALCULUS				9 + 3
Definite and Indefinite integrals - Substitution rule - Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Applications: Hydrostatic force and pressure, moments and centres of mass.					
Unit V	MULTIPLE INTEGRALS				9 + 3
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.					
Total Periods: 60					
Text Books:					
1. Kreyszig, E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.					
2. Grewal, B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44th Edition, 2018.					
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].					
References:					
1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016					
2. Bali. N., Goyal. M. and Watkins. C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.), New Delhi, 7th Edition, 2009.					
3. Jain . R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.					
4. Narayanan. S. and Manicavachagom Pillai. T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.					
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.					
6. Srimantha Pal and Bhunia. S.C, “Engineering Mathematics" Oxford University Press, 2015.					
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.					
Course Outcomes:					Blooms Taxonomy

CO 1: Use the matrix algebra methods for solving practical problems.													K3		
CO2: Apply differential calculus tools in solving various application problems.													K3		
CO3: Able to use differential calculus ideas on several variable functions.													K4		
CO4: Apply different methods of integration in solving practical problems.													K3		
CO5: Apply multiple integral ideas in solving areas, volumes and other practical problems.													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	-	-	-	-	2	-	2	3	-	-	-
CO2	3	3	1	1	-	-	-	-	2	-	2	3	-	-	-
CO3	3	3	1	1	-	-	-	-	2	-	2	3	-	-	-
CO4	3	3	1	1	-	-	-	-	2	-	2	3	-	-	-
CO5	3	3	1	1	-	-	-	-	2	-	2	3	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23PHT101	ENGINEERING PHYSICS	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites					
•					
Course Objectives:					
- To make the students effectively 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 successfully understand the importance of quantum physics. - To motivate the students towards the applications of quantum mechanics..					
Unit I	MECHANICS				9
Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the 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, CO2 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 and the 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. McGraw 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, McGrawHill (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
CO 1: Understand the importance of mechanics.					K1
CO2: Express their knowledge in electromagnetic waves.					K2
CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.					K3
CO4: Understand the importance of quantum physics.					K1

CO5: Comprehend and apply quantum mechanical principles towards the formation of energy bands.													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	1	1	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	1	2	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	2	2	1	-	-	-	-	-	1	-	-	-
CO4	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
CO5	3	3	1	1	2	1	-	-	-	-	-	-	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CYT101	ENGINEERING CHEMISTRY	Category: BSC			
		L	T	P	C
		3	0	0	3
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.					
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 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. 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, Dhanpat Rai,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 AnalyticalChemistry, Cengage Learning..					
References:					
1.O.G. Palanna, “Engineering Chemistry” McGraw Hill Education (India) Private Limited,2 nd Edition, 2017					
2.Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, NewDelhi, 2014					
3.Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, CambridgeUniversity 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 Delhi2014					
Course Outcomes:					Blooms Taxonomy

CO 1: To know well about water quality parameters and corrosion nature.													K1		
CO2: To differentiate easily absorption, adsorption and also phases.													K4		
CO3: To use alloys in day to day life and also batteries.													K4		
CO4: To distinguish polymers in regular use and clearly mention about advanced energies.													K3		
CO5: To calibrate chemical composition and use of shock wave in real life.													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	-	-	-
CO2	2	-	-	1	-	2	2	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	1	1	-	-	1	2	-	-	-	-	-	-	-	-
CO5	3	1	2	1	-	2	2	-	-	-	-	-	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23GET101	PROGRAMMING IN C												Category: ESC			
													L	T	P	C
													3	0	0	3
Prerequisites																
Course Objectives: - To understand the constructs of C 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 binary search.																
Unit III	FUNCTIONS AND POINTERS												9			
Modular programming - Function prototype, function definition, function call, Built-in functions (string functions, math functions) – 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, “Programming in C”, Oxford University Press, Second Edition, 2016.																
2. Kernighan, B.W and 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, Let us 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.													K2			
CO2: Develop simple applications in C using basic constructs and design and implement applications using arrays and strings.													K4			
CO3: Develop and implement modular applications in C using functions.													K4			
CO4: Develop applications in C using structures and pointers.													K4			
CO5: Design applications using sequential and random access file processing.													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	2	2	-	
CO2	1	-	2	1	3	-	-	-	-	-	-	1	3	1	-	
CO3	2	1	1	1	2	-	-	-	-	-	-	-	2	-	-	

CO4	1	-	2	2	2	-	-	-	-	-	-	2	3	1	-
CO5	2	1	1	1	3	-	-	-	-	-	-	-	1	2	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23GET102	தமிழர்களின் பாரம்பரியம்		Category: HSMC			
			L	T	P	C
			1	0	0	1
Prerequisites						
• -						
அலகு I		மொழியும் இலக்கியமும்				3
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – சிறப்பு மொழியாகத் தமிழ் – தமிழின் சங்ககால இலக்கியங்கள் – சங்க இலக்கியத்தின் மதச்சார்பின்மை – சங்க இலக்கியத்தில் பகிர்ந்தளிக்கும் நீதிக் கூறு – திருக்குறளில் மேலாண்மை கொள்கைகள் – தமிழ் காவியங்கள் மற்றும் தமிழகத்தில் பௌத்தம், ஜைன மதங்களின் தாக்கம் – பக்தி இலக்கியம் : ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கிய வகைகள் – தமிழில் நவீன இலக்கிய வளர்ச்சி – பாரதியார், பாரதிதாசன் ஆகியோரின் பங்களிப்பு						
அலகு II		பாரம்பரியம் – பாறை ஓவியங்களிலிருந்து நவீனக் கலை வரை – சிலைப்பண்கலை				3
வீரக்கல் முதல் நவீனச் சிலைக்கலை வரை – வெண்கலச் சின்னங்கள் – பழங்குடியினரும் அவர்கள் செய்யும் கைத்தொழில்களும் – கோயில் தேர் தயாரிப்பு கலை – மகத்தான டெராக்காட்டா (மண்) சிலைகள், கிராமத் தெய்வங்கள், கன்யாகுமரியில் திருவள்ளுவர் சிலை – இசைக்கருவிகள் தயாரித்தல்: மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக மற்றும் பொருளாதார வாழ்வில் கோயில்களின் பங்கு.						
அலகு III		ஜனகலைகளும் போர்க்கலைகளும்				3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கனியன் கூத்து, ஓயிலாட்டம், தோல் மரப்பட்டி (தோல்பாவைக் கூத்து), சிலம்பாட்டம், வளைரி, புலி நடனம் – தமிழர்களின் விளையாட்டுகள் மற்றும் போட்டிகள்.						
அலகு IV		தமிழர்களின் திணை கருத்து				3
தமிழர்களின் தாவர மற்றும் விலங்கியல் – தொல்காப்பியம் மற்றும் சங்க இலக்கியம் கூறும் அக-புறம் கருத்து – தமிழர்களின் அறம் கோட்பாடு – சங்ககால கல்வி மற்றும் எழுத்தறிவு – சங்ககால நகரங்கள் மற்றும் துறைமுகங்கள் – சங்ககால ஏற்றுமதி மற்றும் இறக்குமதி – சோழர்களின் கடல் கடந்த இராணுவ விரிவாக்கங்கள்.						
அலகு V		இந்திய தேசிய இயக்கத்திற்கும் இந்திய கலாசாரத்திற்கும் தமிழர்களின் பங்களிப்பு				3
இந்திய விடுதலைப் போராட்டத்தில் தமிழர்களின் பங்களிப்பு – இந்தியாவின் பிற பகுதிகளில் தமிழர்களின் கலாச்சாரத் தாக்கம் – சுயமரியாதை இயக்கம் – மரபுவழி மருத்துவ முறைகளில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள் மற்றும் கருவேலைச் சுவடிகள் – தமிழ் நூல்களின் அச்ச வரலாறு.						
Total Periods : 15						
TEXT-CUM-REFERENCE BOOKS:						
1. தமிழர்களின் சமூக வாழ்க்கை (டாக்டர் கே. கே. பிள்ளை) – TNTB & ESC மற்றும் RMRL ஆகியவற்றின் கூட்டு வெளியீடு – (அச்சிடப்பட்டுக் கொண்டிருக்கிறது)						
2. தமிழர்களின் சமூக வாழ்க்கை – சங்ககாலம் (டாக்டர் எஸ். சிங்காரவேலு) (வெளியீடு: சர்வதேசத் தமிழ் ஆய்வு நிறுவனம்)						
3. தமிழர்களின் வரலாற்றுப் பாரம்பரியம் (டா. எஸ். வி. சுப்பிரமணியன், டா. கே. டி. திருநாவுக்கரசு) (வெளியீடு: சர்வதேசத் தமிழ் ஆய்வு நிறுவனம்). இந்திய கலாசாரத்திற்கு தமிழர்களின் பங்களிப்புகள் (டா. எம். வள்ளர்மதி) (வெளியீடு: சர்வதேசத் தமிழ் ஆய்வு நிறுவனம்).						
4. கீழாடி – 'வைகை நதிக் கரையில் அமைந்த சங்க கால நகர நாகரிகம்' (வெளியீடு: தொல்பொருள் துறை & தமிழ்நாடு பாடநூல் மற்றும் கல்விச்சேவை கழகம் – கூட்டு வெளியீடு)						

5. இந்திய வரலாற்றில் ஆய்வுகள் – குறிப்பாக தமிழ்நாட்டைச் சார்ந்தவை (டாக்டர் கே. கே. பிள்ளை) (வெளியீடு: எழுத்தாளர் தாமே)
6. பொருளை நாகரிகம் (வெளியீடு: தொல்பொருள் துறை & தமிழ்நாடு பாடநூல் மற்றும் கல்விச்சேவை கழகம் – கூட்டு வெளியீடு)
7.நாகரிகப் பயணம்: இந்தஸ் முதல் வைகை வரை (ஆர். பாலகிருஷ்ணன்) (வெளியீடு: RMRL) – குறிப்பு நூல்

23GET102	HERITAGE OF TAMILS		Category: BSC			
			L	T	P	C
			1	0	0	1
Prerequisites						
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-CUM-REFERENCE BOOKS:						
1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கெ. கெ. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்விச்சேவை கழகம்).						
2. கணினித் தமிழ் – மாணவர் இ. சுந்தரம் (விகடன் பிரசுரம்).						
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு).						
4. பொருநை – ஆற்றங்கரைய 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 C ivilization 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) (Publishedby: 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.						

SEMESTER II

23HST201	PROFESSIONAL ENGLISH - II												Category: HSMC			
													L	T	P	C
													2	0	0	2
Prerequisites																
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 contexts. - To demonstrate an understanding of job applications and interviews for internship and placements.																
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	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	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	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	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.																
1. 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. 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, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.																
Course Outcomes:At the end of the course, learners will be able													Blooms Taxonomy			
CO 1:To compare and contrast products and ideas in technical texts.													K3			
CO2:To identify and report cause and effects in events, industrial processes through technical texts.													K3			
CO3:To analyse problems in order to arrive at feasible solutions and communicate them in the written format.													K4			
CO4:To present their ideas and opinions in a planned and logical manner.													K3			
CO5:To draft effective resumes in the context of job search.													K3			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	1	3	3	3	3	3	3	3	2	3	3	3	-	-	-	
CO2	2	3	3	3	3	3	3	3	2	3	3	3	-	-	-	

[illegible]

23MAT201	COMPUTATIONAL METHODS	Category: BSC			
		L	T	P	C
		3	1	0	4
Prerequisites					
Course Objectives:					
- To introduce the basic concepts of solving algebraic and transcendental equations. - To introduce the various numerical techniques for interpolation, differentiation and Integration, which 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 – Pivoting - 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	MATLAB 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 2 MATLAB (Only 2x2 matrix).					
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: At the end of the course, learners will be able to					Blooms Taxonomy
CO 1: Understand the basic concepts and techniques of solving algebraic and transcendental equations.					K2
CO2: Appreciate the numerical techniques of interpolation, differentiation and integration for engineering problems.					K3
CO3: Understand the knowledge of various techniques and methods for solving first and					K2

secondorder ordinary differential equations.													K3		
CO4: Solve the partial and ordinary differential equations with initial and boundary conditions byusing certain techniques with engineering applications.															
CO5: Understand the basic concepts of MATLAB for Computational Methods.													K2		
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	0	0	0	2	0	2	3	-	-	-
CO2	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO3	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO4	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
CO5	3	3	1	1	1	0	0	0	2	0	2	3	-	-	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23PHT206	MATERIALS SCIENCE FOR BIOTECHNOLOGISTS		Category: BSC			
			L	T	P	C
			3	0	0	3
Prerequisites Basic Science Knowledge						
Course Objectives: - To understand the knowledge of basic crystal structure and terms. - To get knowledge on various strengthening methods of materials, and also various mechanical properties and their measurement. - To impart knowledge on the basics of phase diagram and their applications. - To learn about iron-carbon system, and about various ferrous and non-ferrous alloys. - To introduce different types of biomaterials and their applications.						
UNIT I		CRYSTALLOGRAPHY				9
Crystallographic directions and planes – metallic crystal structures: BCC, FCC and HCP – linear and planar densities – crystal imperfections- edge and screw dislocations, Burgers vector and elastic strain energy- surface imperfections – grain and twin boundaries – Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation						
UNIT II		MECHANICAL PROPERTIES				
Tensile test – Plastic deformation by slip – slip systems – Mechanisms of strengthening in metals: strain hardening, grain size reduction, solid solution strengthening, precipitation hardening – Creep: creep curves, stress and temperature effects, mechanisms of creep, creep-resistant materials – Fracture: ductile and brittle fractures – The Griffith criterion – Fracture toughness – Fatigue failure: the S-N curve – Factors that affect fatigue life – Hardness: Rockwell and Brinell hardness tests, Knoop and Vickers microhardness tests.						
UNIT III		PHASE DIAGRAMS				9
Basic concepts – Gibbs phase rule – Unary phase diagram (iron) – Binary phase diagrams: isomorphous systems (Cu-Ni) – Determination of phase composition and phase amounts – Tie line and Lever rule – Binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – Eutectoid and peritectic reactions – Other invariant reactions – Microstructural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions.						
UNIT IV		FERROUS AND NON FERROUS ALLOYS				9
The Fe-Fe ₃ C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypoeutectoid and hypereutectoid alloys – Influence of other alloying elements in the FeC system – Phase transformations – Isothermal transformation diagram for eutectoid iron-carbon alloy – microstructures: pearlite, bainite, spheroidite and martensite – Steels, stainless steels and cast irons – Copper alloys – Aluminum alloys – Titanium alloys.						
UNIT V		MATERIALS FOR BIOLOGICAL APPLICATIONS				9
Biocompatibility – Host response – Materials response – Metallic implants: Titanium and its alloys, stainless steel – Cobalt-Chromium alloys – Tantalum – Nitinol – Magnesium based biodegradable alloys. Bioceramics: Alumina, Zirconia, Hydroxyapatite, Tricalcium phosphate, Bioactive glasses, pyrolytic carbon, graphite, graphene. Polymeric implant materials: Polyethylene, polypropylene, polyacrylates – Soft and hard tissue replacement materials.						
Total periods: 45 PERIODS						
Text Books:						
1. R. Balasubramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.						
2. V. Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.						
3. Raghavan, V. "Physical Metallurgy: Principles and Practice". PHI Learning, 2015.						

4. Joon Park and R.S.Lakes, Biomaterials: An Introduction, Springer, 2007.															
REFERENCE BOOKS:															
1. J. F. Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.															
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.															
3. J. C. Anderson, K. D. Leaver, P. Leever and R.D. Rawlings, Materials Science for Engineers, CRC Press, 2003.															
4. Jean P. Mercier, G. Zambelli and W. Kurz, Introduction to Materials Science, Elsevier, 2002.															
5. Sujata V. Bhat, Biomaterials, Narosa Publishers, 2002.															
6. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”, Narosa Publishing House, 2009.															
Course Outcomes:													Blooms Taxonomy		
Understand the basic crystal structure and its importance in materials properties.													Understanding		
Understand the significance of dislocations, strengthening mechanisms, and tensile, creep,hardness and fracture behaviour of materials.													Remembering		
Gain knowledge on binary phase diagrams, and also will be able to determine the phasecomposition and phase amount.													Understanding		
Understand about the Fe–C system and various microstructures in it, and also about variousferrous and non–ferrous alloys.													Understanding		
Get adequate understanding on metallic, ceramic and polymeric biomaterials and theirapplications.													Applying		
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	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	1	-	-	-	-	-	-	-	-	-
CO4	3	-	2	-	2	2	2	-	-	-	-	1	-	-	-
CO5	3	-	2	-	2	2	2	-	-	-	-	-	-	-	-
AVG	3	2	1.8	2	1.6	1.4	2	-	-	-	-	1	-	-	-

23EET203	BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY		Category: ESC			
			L	T	P	C
			3	0	0	3
Prerequisites						
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
Introduction to DC Circuits and Components: Conductor, Resistor, Inductor, Capacitor – Ohm’s Law - Kirchhoff’s Laws, Nodal Analysis, Mesh analysis with Independent sources only (Steady state Analysis only) - Simple problems only. 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.						
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 only. Domestic wiring, types of wires and cables, earthing, protective devices- switches- fuse unit- Miniature circuit breaker- (Qualitative analysis only), 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. (Qualitative analysis only)- Working Principle of DC motors, Torque Equation, Types and Applications (Qualitative analysis only). Working Principle of single phase induction motor- Single phase Transformer. - Construction, Working principle and Applications.(Qualitative analysis only)						
Unit IV	ANALOG ELECTRONICS					9
Semiconductor Materials: P Type and N Type Semiconductors – PN Junction Diodes, Zener Diode –Characteristics Applications – BJTs– Biasing of PNP and NPN Transistors, SCR,MOSFET,IGBT – V-I Characteristics and Applications, Rectifier and Inverters, harmonics (Qualitative analysis only)						
Unit V	SENSORS AND TRANSDUCERS					9
Sensors - solenoids, mechatronics, electro-pneumatic systems, limit switches, proximity sensors, piezoelectricsensor,and photo sensors, Transducers - Strain gauge, LVDT, differential pressure transducer,opticaltransducers, digital transducers, andSmart sensors.(Qualitative analysis only)						
Total Periods: 45						
Text Books:						
1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, Second Edition, McGraw Hill Education, 2020.						
2. S.K.Bhattacharya “Basic Electrical and Electronics Engineering”, Pearson Education, Second Edition, 2017.						
3. James A .Svoboda, Richard C. Dorf, “Dorf’s Introduction to Electric Circuits”, Wiley, 2018.						
4. A.K. Sawhney, Puneet Sawhney ‘A Course in Electrical & Electronic Measurements & Instrumentation’, Dhanpat Rai and Co, 2015.						
References:						
1. Thomas L. Floyd, ‘Digital Fundamentals’, 11th Edition, Pearson Education, 2017.						
2. Albert Malvino, David Bates, ‘Electronic Principles, McGraw Hill Education; 7th edition, 2017.						
3.John Bird, “Electrical Circuit theory and technology”, Routledge; 2017.						
4.H.S. Kalsi, ‘Electronic Instrumentation’, Tata McGraw-Hill, New Delhi, 2010 .						
Course Outcomes:						Blooms Taxonomy
CO 1: Compute the electric circuit parameters for simple problems						K3
CO2: Explain the concepts of domestics wiring and protective devices						K3
CO3: Explain the working principle and applications of electrical machines						K3
CO4: Analyze the characteristics of analog electronic devices						K1
CO5: Explain the types and operating principles of sensors and transducers						K1
CO - PO & PSO Mapping						

[illegible]

23GET201	ENGINEERING GRAPHICS	Category: ESC			
		L	T	P	C
		2	0	4	4
Prerequisites					
Course Objectives: The main learning objective of this course is to prepare the students for: • Drawing engineering curves. • Drawing a freehand sketch of simple objects. • Drawing orthographic projection of solids and section of solids. • Drawing development of solids • Drawing isometric and perspective projections of simple solids.					
CONCEPTS AND CONVENTIONS (Not for Examination)					
Importance of graphics in engineering applications — Use of drafting instruments — BIS conventions and specifications — Size, layout and folding of drawing sheets — Lettering and dimensioning.					
Unit I	PLANE CURVES AND FREEHAND SKETCHING				6+12
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+12
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+12
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+12
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+12
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 :(L=30+P=60) 90					
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. Parthasarathy N. S. and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.					
5. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India, 2nd Edition, 2009.					

Course Outcomes:	Blooms Taxonomy
CO 1: Use BIS conventions and specifications for engineering drawing.	K2
CO2: Construct the conic curves, involutes and cycloid.	K4
CO3: Solve practical problems involving projection of lines.	K3
CO4: Draw the orthographic, isometric and perspective projections of simple solids.	K1
CO5: Draw the development of simple solids.	K1

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

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

23GET202	TAMILS AND TECHNOLOGY	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites					
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 beats - 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-CUM-REFERENCE BOOKS					
1.தமிழக வரலாறு – மக்களும் பண்பாடும் – க. கி. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)					
2.கணினித் தமிழ் – முனைவர் இள. 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)(Publishedby: The Author)					
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu TextBookand Educational Services Corporation, Tamil Nadu)					
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.					

23GET202	தமிழரும் தொழில்நுட்பமும்	Category: HSMC			
		L	T	P	C
		1	0	0	1
Prerequisites					
-					
அலகு I	நெய்தல் மற்றும் செராமிக் தொழில்நுட்பம்				3
சங்ககாலத்தில் நெசவுத் தொழில் – செராமிக் தொழில்நுட்பம் – கருப்பு-சிவப்பு பாண்டங்கள் (BRW) – பாண்டங்களில் காணப்படும் குறியீட்டு எழுத்துகள் (கிராஃபிட்டி).					
அலகு II	வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம்				3
சங்ககாலத்தில் வீடுகளின் வடிவமைப்பும் கட்டிடக் கட்டுமான தொழில்நுட்பமும் – சங்ககால கட்டிடப் பொருட்கள் மற்றும் வீரக்கற்கள் – சிலப்பதிகாரத்தில் மேடை அமைப்புகள் பற்றிய விவரங்கள் – மாமல்லபுரத்தின் சிற்பங்களும் கோவில்களும் – சோழர்களின் மகத்தான கோவில்கள் மற்றும் பிற வழிபாட்டு தலங்கள் – நாயக்கர் கால கோவில்கள் – வகை ஆய்வு (மதுரை மீனாட்சி அம்மன் கோவில்) – திருமலை நாயக்கர் மகால் – செட்டிநாடு வீடுகள் – பிரிட்டிஷ் காலத்தில் மதராசில் உருவான இந்தோ-சராசினிக் கட்டிடக்கலை.					
அலகு III	உற்பத்தி தொழில்நுட்பம்				3
கப்பல் கட்டும் கலை – உலோக அறிவியல் ஆய்வுகள் – இரும்புத் தொழில் – இரும்புக் கரைப்பு, எஃகு தயாரித்தல் – வரலாற்று ஆதாரங்களாகப் பயன்படும் செம்பு மற்றும் பொற்காசுகள் – நாணய உற்பத்தி (மின்டிங்) – மணிகள் தயாரிக்கும் தொழில்கள்: கல் மணிகள், கண்ணாடி மணிகள், டெராக் கோட்டா மணிகள், சிப்பி/எலும்பு மணிகள் – தொல்பொருள் ஆதாரங்கள் – சிலப்பதிகாரம் குறிப்பிடும் ரத்தினக் கற்களின் வகைகள்.					
அலகு IV	வேளாண்மை மற்றும் பாசன தொழில்நுட்பம்				3
அணை, குளம், குண்டங்கள், கலங்கரை (sluice), சோழர் காலத்தின் குமிழித் தூம்பின் முக்கியத்துவம், கால்நடைப் பராமரிப்பு – மாடுகளுக்கான தனி வடிவமைப்புப் போக்குகள் கொண்ட கிணறுகள் – விவசாயமும் வேளாண் செயலாக்கமும் – கடல் அறிவு – மீன்வளம் – முத்து – சங்கு மூழ்குதல் – கடல் தொடர்பான பண்டைய அறிவு – அறிவு சார்ந்த சமூக அமைப்பு.					
அலகு V	அறிவியல் தமிழ் மற்றும் தமிழ் கணினி				3
அறிவியல் தமிழின் வளர்ச்சி – தமிழ் கணினி பயன்பாடுகள் – தமிழ் நூல்களின் மின்னாக்கம் – தமிழ் மென்பொருள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் இணைய நூலகம் – இணையத் தமிழ் அகராதிகள் – சொற்குவை திட்டம்.					
Total Periods:15					
TEXT-CUM-REFERENCE BOOKS					
1.தமிழக வரலாறு – மக்களும் பண்பாடும் – க. கி. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)					
2.கணினித் தமிழ் – முனைவர் இள. சுந்தரம் (விகடன் பிரசுரம்)					
3.கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)					
4.பொருணை – 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)(Publishedby: The Author)
12. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu TextBookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

SEMESTER III

23MAT301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	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 PERIODS					
Text Books:					
1. Grewal B.S., “Higher Engineering Mathematics" 44 th 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		
CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.													Applying		
CO3: Apply the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.													Applying		
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.													Analyzing		
CO5: Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.													Understanding		
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	-	-	-
AVG	3	3	3	3	-	1	-	-	-	-	-	1	-	-	-

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

23BTT301	BIOCHEMISTRY			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23CYT101 - ENGINEERING CHEMISTRY ➤ 23BTT201 – BIOORGANIC CHEMISTRY							
COURSE OBJECTIVES:							
1.	To give the details and fundamentals of organic chemistry along with the role of carbohydrates in biological cells.						
2.	To know the structure and properties of biomolecules.						
3.	To exploit the benefits of metabolism concepts and carbohydrate metabolism concepts.						
4.	To provide the basics of intermediary metabolism and regulations						
5.	To know different mechanisms involved in the transport and degradation.						
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, glycosaminoglycans. hyaluronic acid, chondroitin sulfate							
UNIT II		STRUCTURE AND PROPERTIES OF OTHER BIOMOLECULES					9
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: 45 PERIODS							
COURSE OUTCOMES:			BTL	POs	PSOs		
CO1:	The students have a strong foundation in the structure and reactions of biomolecules- carbohydrates		K1	1,2,3,4,5,6,7,8, 9,10,11,12	1,2,3		

CO2:	The students have a strong foundation in the structure and reactions of biomolecules- proteins, lipids and nucleic acid	K2	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3
CO3:	The students have the knowledge about metabolism concepts and carbohydrate metabolism concepts	K4	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3
CO4:	The students have the knowledge about intermediary metabolisms and regulation.	K4	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3
CO5:	The students have a strong foundation in the protein targeting, transportation and degradation.	K3	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3

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.

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", 31 st Edition, McGraw-Hill, 2018.
3.	Voet, D. and Voet, J.G., "Biochemistry", 4th Edition, John Wiley & Sons Inc., 2010

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2	PSO3
1	3	2	1	2	2	1	2	1	2	3	1	2	2	2	2
2	3	2	2	3	2	2	3	2	1	2	3	1	3	2	2
3	3	2	2	2	1	2	1	3	3	1	2	2	2	2	2
4	2	2	1	2	2	1	2	2	1	1	2	1	2	2	2
5	1	2	2	2	1	1	1	2	2	1	3	1	2	2	2
AVG	2.4	2	1.6	2.2	1.6	1.4	1.8	2	1.8	1.6	2.2	1.6	2.2	2	2

23BTT302	CELL BIOLOGY			L	T	P	C
				3	0	0	3
PREREQUISITES: No prerequisites							
COURSE OBJECTIVES:							
1.	To gain knowledge on cell Structure and its function.						
2.	To acquire knowledge on Cell division , cell cycle, cell culture and its applications						
3.	To know about the transport across then cell membrane via types of transport active and passive , pumps, channels in the cell						
4.	To know about signal transduction by receptor and its models						
5.	To gain knowledge in techniques used to study cell nature.						
UNIT I		CELL STRUCTURE AND FUNCTION OF THE ORGANELLES					9
Prokaryotic, Eukaryotic cells, Sub-cellular organelles and functions. Principles of membrane organization,membrane proteins,cytoskeletal proteins.Extracellular matrix,cell-cell junctions.							
UNIT II		CELL DIVISION,CANCER,APOPTOSIS AND IMMORTALIZATION OF CELLS					9
Cell cycle – Mitosis, Meiosis, Molecules controlling cell cycle, cancer, role of Ras and Raf in oncogenesis and apoptosis. Stem cells, Cell culture and immortalization of cells and its applications.							
UNIT III		TRANSPORT ACROSS CELL MEMBRANE					9
Passive and Active Transport, Permeases, Ion channels, ATP pumps. Na ⁺ / K ⁺ /Ca ²⁺ pumps,uniport,symport antiporters system.Ligand gated/voltage gated channels,Agonists and Antagonists.							
UNIT IV		SIGNAL TRANSDUCTION					9
Receptors–extracellular signaling,Cell surface/cytosolic receptors and examples,Different classes of receptors autocrine / paracrine / endocrine models, Secondary messengers molecules.							
UNIT V		TECHNIQUES USED TO STUDY CELLS					9
Cell fractionation and flow cytometry,Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy. Localization of proteins in cells–Immunostaining.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BTL	POs	PSOs	
CO1:	Gain knowledge on cell Structure and its function.			K2	1,2,3,4,5,9	1,2,3	
CO2:	Acquire knowledge on Cell division , cell cycle, cell culture and its applications.			K2	1,3,5,9,12	1	
CO3:	Know about the transport across then cell membrane via types of transport active and passive , pumps, channels in the cell			K2	1,2,3,4,7	1	
CO4:	Know about signal transduction by receptor and its models			K3	1,2,3,4,5,7,9	1	
CO5:	Gain knowledge in techniques used to study cell nature.			K3	1,2,3	1	
TEXT BOOKS:							
1.	Lodish,Harvey et al.,“Molecular Cell Biology”,7 th Edition,W.H.Freeman,2013.						

2.	Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 8 th Edition, Oxford University Press, 2018.
3.	Alberts, Bruce et al., "Molecular Biology of the Cell", 6 th Edition, W.W. Norton, 2014.
4.	Sadava, D.E. "Cell Biology: Organelle Structure and Function", Panima Publishing, 2004
5.	Rastogi, S.C. "Cell Biology" 2 nd Edition, New Age International, 2017

REFERENCES:

1.	Becker, W.M. et al., "The World of the Cell", 9 th Edition, Pearson Education, 2003.
2.	Campbell, N.A., J.B. Reece and E.J. Simon "Essential Biology", VII th Edition, Pearson International, 2007.
3.	Alberts, Bruce et al., "Essential Cell Biology", 4 th Edition, W.W. Norton, 2013.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PSO 3
1	3	1	3	3	3	2	2	2	3	-	-	1	3	3	3
2	3	2	3	2	3	-	1	1	3	-	2	3	3	-	1
3	2	3	3	2	1	-	2	-	2	-	1	1	2	3	-
4	2	1	3	2	3	1	2	1	3	-	-	3	3	2	-
5	3	3	3	1	-	-	-	2	2	-	2	2	3	2	2
AV G	2.6	2	3	2	2.5	1.5	1.8	1.5	2.6	-	1.7	2	2.8	2.5	2

23BTT303	MICROBIOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES: No prerequisites								
COURSE OBJECTIVES:								
1.	To introduce students the principles of Microbiology.							
2.	To emphasize structure and biochemical aspects of various microbes.							
3.	To acquire a comprehensive understanding of bacterial nutritional requirements, culture media, growth dynamics and quantification methods.							
4.	To impart knowledge to the students to solve the problems in microbial infection and their control.							
5.	To develop knowledge on the industrial and environmental applications of microorganisms.							
UNIT I		INTRODUCTION						9
Basics of microbial existence; history of microbiology, classification and nomenclature of microorganisms, microscopic examination of microorganisms, light and electron microscopy; principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining.								
UNIT II		MICROBES- STRUCTURE AND MULTIPLICATION						9
Structural organization and multiplication of bacteria, viruses, algae and fungi, with special mention of life history of actinomycetes, yeast, mycoplasma and bacteriophages.								
UNIT III		MICROBIAL NUTRITION, GROWTH AND METABOLISM						9
Nutritional requirements of bacteria; different media used for bacterial culture; growth curve and different methods to quantify bacterial growth; aerobic and anaerobic bioenergetics and utilization of energy for biosynthesis of important molecules.								
UNIT IV		CONTROL OF MICROORGANISMS						9
Physical and chemical control of microorganisms; host-microbe interactions; anti-bacterial, anti- fungal and anti-viral agents; mode of action and resistance to antibiotics; clinically important microorganisms.								
UNIT V		INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY						9
Primary metabolites; secondary metabolites and their applications; preservation of food;production of penicillin, alcohol, vitamin B-12; biogas; bioremediation; leaching of ores by microorganisms; biofertilizers and biopesticides; microorganisms and pollution control; biosensors								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:			BTL	POs		PSOs		
CO1:	Microorganisms and examination of microorganisms			K2	1,2,3,4,5,7,12		1,2	
CO2:	Structural organization of microorganisms			K2	1,3,4,7		2	
CO3:	Nutritional requirements of microorganisms, their growth and metabolism			K3	1,2,3,4,5		3	
CO4:	Control of microorganisms			K4	1,2,3,4,5,7,9		1,2	
CO5:	Metabolites, bioremediation, biofertilizers, biopesticides and biosensors			K3	1,2,3,4,5,11,12		3	

TEXT BOOKS:															
1.	Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi,India,2009														
2.	Prescott L.M., Harley J.P., Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers,1996.														
REFERENCES:															
1.	Black, Text book of microbiology. Freeman Publishers,2016														
2.	Talaron K, Talaron A, Casita, Pelczar and Reid. Foundations in Microbiology, W.C. BrownPublishers, 1993.														
3.	Ananthanarayan, CK Jayaram Panikars. Text book of Microbiology, 2005, Orient BlackswanPublishers.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PSO 3
1	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2
2	3	3	2	3	2	2	3	2	2	3	2	2	3	3	2
3	3	3	2	3	3	2	3	2	2	3	2	2	3	2	3
4	3	3	3	3	3	2	2	2	2	2	3	3	3	2	3
5	3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
AV G	3	2.8	2.6	2.8	2.6	2	2.6	2	2	2.4	2.2	2.2	2.8	2.2	2.6

23BTT304	BIOCHEMICAL THERMODYNAMICS				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23CYT101 - ENGINEERING CHEMISTRY								
➤ 23PHT206 - MATERIALS SCIENCE FOR BIOTECHNOLOGISTS								
COURSE OBJECTIVES:								
1.	To enable the students to learn about basic concepts of classical and statistical Thermodynamics							
2.	Apply the knowledge on Phase equilibrium and chemical reaction equilibrium							
UNIT I		THERMODYNAMIC LAW AND PROPERTIES OF FLUIDS						9
First Law of thermodynamics, a generalized balance equation and conserved quantities, Volumetric properties of fluids exhibiting non ideal behavior; residual properties; estimation of thermodynamic properties using equations of state; calculations involving actual property exchanges; Maxwell's relations and applications								
UNIT II		SOLUTION THERMODYNAMICS						9
Partial molar properties; concepts of chemical potential and fugacity; ideal and non-ideal solutions; concepts and applications of excess properties of mixtures; activity coefficient; composition models; Gibbs Duhem equation								
UNIT III		PHASE EQUILIBRIA						9
Criteria for phase equilibria; VLE calculations for binary and multi component systems; liquid-liquid equilibria and solid-solid equilibria								
UNIT IV		CHEMICAL REACTION EQUILIBRIA						9
Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; calculation of equilibrium conversion and yields for single and multiple reactions								
UNIT V		THERMODYNAMIC DESCRIPTION OF MICROBIAL GROWTH AND PRODUCT FORMATION						9
Thermodynamics of microbial growth stoichiometry thermodynamics of maintenance, Calculation of the Operational Stoichiometry of a growth process at Different growth rates, Including Heat using the Herbert –Pirt Relation for Electron Donor, thermodynamics and stoichiometry of Product Formation								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	To explain the theoretical concepts of thermodynamics and how it applies to energy Conversion			K1	1,3,5,7,8		1,2,3	
CO2:	To demonstrate the capability to analyse the energy conversion performance in a variety of modern applications in biological systems			K2	1,3,5,7,8		1,2,3	
CO3:	To design and carry out bioprocess engineering experiments, and analyse and interpret fundamental data to do the design and operation of bioprocesses			K2	1,3,5,7,8		1,2,3	
CO4:	To describe the criteria when two phases coexist in equilibrium and the vapour liquid equilibrium calculations			K2	1,3,5,7,8		1,2,3	
CO5:	To understand microbial growth and product formation and its kinetics and to explore the thermodynamic concepts in bio-chemical engineering			K2	1,3,5,7,8		1,2,3	

TEXT BOOKS:															
1.	Smith J.M., Van Ness H.C., and Abbot M.M. “Introduction to Chemical Engineering Thermodynamics”, VIth Edition. Tata McGraw-Hill, 2003														
2.	Narayanan K.V. “A Textbook of Chemical Engineering Thermodynamics”, PHI, 2003														
3.	Christiana D. Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010														
REFERENCES:															
1.	Sandler S.I. “Chemical and Engineering Thermodynamics”, John Wiley,1989														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	-	-	2	2	-	3	2	-	-	2	-	3	-	-
2	3	-	3	2	3	-	2	3	-	-	3	-	2	2	-
3	3	-	3	-	3	-	2	2	-	-	2	2	3	2	2
4	3	-	3	-	2	-	2	3	-	-	2	1	2	2	2
5	3	-	3	-	3	-	3	2	-	-	2	2	2	2	-
AV G	3	-	3	2	2.6	-	2.4	2.4	-	-	2.2	1.7	2.4	2	2

23BTT305	BASIC INDUSTRIAL BIOTECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT201 – BIOORGANIC CHEMISTRY								
➤ 23BTT301 - BIOCHEMISTRY								
COURSE OBJECTIVES:								
1.	To make the students aware of the overall industrial bioprocess so as to help them to manipulate the process to the requirement of the industrial needs							
2.	The course prepares the students for the bulk production of commercially important modern Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures							
UNIT I		INTRODUCTION TO INDUSTRIAL BIOPROCESS						9
Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation								
UNIT II		PRODUCTION OF PRIMARY METABOLITES						9
Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols								
UNIT III		PRODUCTION OF SECONDARY METABOLITES						9
Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids								
UNIT IV		PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS						9
Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation								
UNIT V		PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS						9
Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs	PSOs		
CO1:	To explain the steps involved in the production of bio products and methods to improve modern biotechnology			K1	1,2,3,5,9	1,2		
CO2:	To apply basic biotechnological principles, methods and models to solve biotechnological tasks			K2	1,2,3,5,9	1,2		
CO3:	To identify and debate the ethical, legal, professional, and social issues in the field of biotechnology			K2	1,2,3,5,9	1,2		
CO4:	To design and deliver useful modern biotechnology products to the Society			K2	1,2,3,5,9	1,2		
CO5:	To recognize the concepts of industrial biotechnology and apply biotechnological concept and principles in bioprocesses			K2	1,2,3,5,9	1,2		
TEXT BOOKS:								
1.	Satyanarayana, U. “Biotechnology” Books & Allied (P) Ltd., 2005							

2.	Kumar, H.D. “A Textbook on Biotechnology” IInd Edition. Affiliated East West Press Pvt.Ltd., 1998
3.	Balasubramanian, D. etal., “Concepts in Biotechnology” Universities Press Pvt. Ltd., 2004
4.	Ratledge, Colin and Bjorn Kristiansen “Basic Biotechnology” IInd Edition Cambridge University Press, 2001
5.	Dubey, R.C. “A Textbook of Biotechnology” S.Chand & Co. Ltd., 2006

REFERENCES:

1.	Casida, L.E. “Industrial Microbiology”, New Age International (P) Ltd, 1968
2.	Presscott, S.C. and Cecil G. Dunn, “Industrial Microbiology”, Agrobios (India), 2005
3.	Cruger, Wulf and Anneliese Crueger, “Biotechnology: A Textbook of Industrial Microbiology”, II nd Edition, Panima Publishing, 2000
4.	Moo-Young, Murrey, “Comprehensive Biotechnology”, 4 Vols. Pergamon Press, (An Imprint of Elsevier) 2004
5.	Stanbury, P.F., A. Whitaker and S.J. Hall “Principles of Fermentation Technology”, IInd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995
6.	C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999
7.	K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications

CO's – PO's & PSO's Mapping:

CO	PO1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PS O3
1	3	-	-	3	3	2	2	-	3	-	-	1	3	3	3
2	3	2	3	2	3	-	1	1	3	-	2	3	3	-	-
3	2	3	3	2	1	-	2	-	2	-	1	1	2	3	-
4	2	1	3	2	3	1	-	1	3	-	-	3	3	2	1
5	3	3	2	1	2	-	2	2	2	-	2	2	3	2	2
AV G	2.6	2.3	2.8	2	2.4	1.5	1.8	1.3	2.6	-	1.7	2	3	2.5	2

SEMESTER IV

23BTT401	MOLECULAR BIOLOGY			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23BTT302 – CELL BIOLOGY ➤ 23BTT303 - MICROBIOLOGY							
COURSE OBJECTIVES:							
1.	Understand basic principles of molecular biology such as role of nucleic acids and proteins and how these molecules interact at intracellular level to regulate growth, division and development.						
2.	By doing this course students will acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells						
3.	This course will emphasize the molecular mechanism of DNA replication, repair, transcription. This course will emphasize the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.						
4.	Apply/relate such principles to manipulate the organisms appropriately for valuable outcome in the area of science and technology.						
5.	This will be needed for any project work in modern biotechnology						
UNIT I		CHEMISTRY OF NUCLEIC ACIDS					9
Introduction to nucleic acids: Nucleic acids as genetic material, Structure and physicochemical properties of elements in DNA and RNA, Biological significance of differences in DNA and RNA. Primary structure of DNA: Chemical and structural qualities of 3',5'-Phosphodiester bond. Secondary Structure of DNA: Watson & Crick model, Chargaff's rule, X-ray diffraction analysis of DNA, Forces stabilizes DNA structure, Conformational variants of double helical DNA, Hogsteen base pairing, Triple helix, Quadruple helix, Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling.							
UNIT II		DNA REPLICATION & REPAIR					9
Overview of Central dogma. Organization of prokaryotic and eukaryotic chromosomes. DNA replication: Meselson & Stahl experiment, bi-directional DNA replication, Okazaki fragments, Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication, Overview of differences in prokaryotic and eukaryotic DNA replication, Telomere replication in eukaryotes. D-loop and rolling circle mode of replication. Mutagens, DNA mutations and their mechanism, various types of repair mechanisms.							
UNIT III		TRANSCRIPTION					9
Structure and function of mRNA, rRNA and tRNA. Characteristics of promoter and enhancer sequences. RNA synthesis: Initiation, elongation and termination of RNA synthesis, Proteins of RNA synthesis, Fidelity of RNA synthesis, Inhibitors of transcription, Differences in prokaryotic and eukaryotic transcription. Basic concepts in RNA world: Ribozymes, RNA processing: 5'-Capping, Splicing-Alternative splicing, Poly 'A' tail addition and base modification.							
UNIT IV		TRANSLATION					9
Introduction to Genetic code: Elucidation of genetic code, Codon degeneracy, Wobble hypothesis and its importance, Prokaryotic and eukaryotic ribosomes. Steps in translation: Initiation, Elongation and termination of protein synthesis. Inhibitors of protein synthesis. Posttranslational modifications and its importance. Regulation of gene expression: lac- and trp-operon.							
UNIT V		CELL DIVISION & CELL CYCLE					9
Cell division: Mitosis, Meiosis and Cytokinesis. Cell cycle: Methods in cell cycle analysis. Regulation of cell cycle – Cell cycle check points, molecules and mechanisms of cell cycle regulation. Cell cycle modulators.							

TOTAL: 45 PERIODS															
COURSE OUTCOMES:							BTL	POs				PSOs			
CO1:	Describe the basic structure and biochemistry of nucleic acids and proteins and discriminate between them						K1	1,2,7,11,12				1,2,3			
CO2:	Identify the principles of DNA replication, transcription and translation and explain how they relate to each other.						K2	1,2,4,6,8,11,12				1,2,3			
CO3:	Discuss clearly about gene organization and mechanisms of control the gene expression in various organisms.						K4	1,2,4,6,7,8,11,12				1,2,3			
CO4:	Discuss clearly about gene mechanisms of control the gene expression.						K3	1,2,3,4,6,7,8,11,12				1,2,3			
CO5:	Articulate applications of molecular biology in the modern world						K5	1,2,4,6,7,8,11,12				1,2,3			
TEXT BOOKS:															
1.	Friefelder, David. “Molecular Biology.” Narosa Publications, 1999														
2.	Weaver, Robert F. “Molecular Biology” IInd Edition, Tata McGraw-Hill, 2003.														
3.	Karp, Gerald “Cell and Molecular Biology : Concepts and Experiments” IVth Edition, John Wiley, 2005.														
4.	Friefelder, David and George M. Malacinski “Essentials of Molecular Biology” IInd Edition,Panima Publishing, 1993.														
REFERENCES:															
1.	Cooper GM, Hausman RE. The Cell: A Molecular approach. 7th Edition, 2015.														
2.	Krebs JE, Goldstein ES, Kilpatrick ST. Lewin’s Essential GENES XII,12 th edition 2017														
3.	Nelson DL, Cox MM. Lehninger Principles of Biochemistry. 6th Edition, 2012.														
4.	Alberts B, Johnson A, Lewis J, Morgan D, Raff M, Roberts K, Walter P. Molecular Biology of the cell, 6th Edition, 2014.														
5.	Lodish H, Berk A, MatsudairaP,Kaiser CA, Krieger M, Schot MP, Zipursky L, Darnell J. Molecular Cell Biology, 6th Edition, 2007.														
6.	Tropp, Burton E. “ Molecular Biology : Genes to Proteins”. IIIrd Edition. Jones and Bartlett, 2008.														
7.	Glick , B.R. and J.J. Pasternak. “Molecular Biotechnology : Principles and Applications of Recombinant DNA” 4th Edition. ASM, 2010.														
CO’s – PO’s & PSO’s Mapping:															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2	PSO3
1	3	2	-	-	-	-	1	-	-	-	1	2	2	2	2
2	2	2	-	2	-	1	-	2	-	-	1	-	3	2	2
3	3	2	-	3	-	1	1	1	-	-	2	-	2	2	2
4	2	2	-	3	-	1	1	2	-	-	2	1	2	2	2
5	3	2	2	1	-	2	1	1	-	-	1	1	2	2	2
AVG	2.6	2	2	1.8	-	1	1	1.2	-	-	1.4	0.4	2.2	2	2

23BTT402	FLUID FLOW AND HEAT TRANSFER OPERATIONS	L	T	P	C
		3	0	0	3
PREREQUISITES: ➤ 23BTT304 – BIOCHEMICAL THERMODYNAMICS					
COURSE OBJECTIVES:					
1.	To introduce the students the mechanics of fluids through a thorough understanding of the properties of the fluids, behaviour of fluids under static conditions. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy				
2.	To expose to the applications of the conservation laws to a) flow measurements b) flow through pipes (both laminar and turbulent) and c) forces on vanes				
UNIT I	FLUID PROPERTIES & FLUID MECHANICS				9
Fluid definition- compressible, incompressible fluids – coefficient of isothermal compressibility, Density, specific gravity, specific weight, surface tension, vapour pressure, viscosity. Newtonian and Non-newtonian fluids. Fluid statics – Barometric equation – application for incompressible and compressible fluids. Pressure changes in atmospheric air – Gauge and absolute pressure – pressure measurement with Bourdon gauge & manometers. Centre of pressure concept. Fluid Dynamics – equation of continuity – Bernoulli’s equation – pressure loss in straight pipes – in fittings – expansion and contraction losses (applied to Newtonian Fluids only) Fluid flow measurement, Orifice, venturi & Rotameter for Newtonian fluids					
UNIT II	FLOW OF FLUID THROUGH PACKINGS				9
Fluidization, Fluid transport Industrial application of fluid flow through packing-characteristics of packed bed-Bed surface area-void fraction-Laminar flow through packed bed and turbulent flow- pressure drop experienced by the fluid-equations and application problems. Fluidization phenomena-Industrial application - minimum fluidization velocities. Industrial pipes and fittings- Fluid moving machinery-pumps centrifugal, Reciprocating-gear, Peristaltic pumps, Introduction to gas moving machinery-Fans, blowers, compressors.					
UNIT III	CONDUCTION HEAT TRANSFER				9
Heat transfer phenomena-thermodynamics & heat transfer. Heat conduction – Fourier’s equation– steady state conduction in planar and radial systems – Resistance concept – series and resistance in conduction –and parallel resistance in conduction – unsteady state conduction – lumped capacity model – extended surfaces (Fins) –combined conduction & convection – 2 dimensional conduction					
UNIT IV	CONVECTION HEAT TRANSFER				9
Forced and natural convection – Dimensional analysis, Dimensional numbers, Convection heat transfer coefficient, Correlations for flow over plate, through tubes, over spheres and cylinders, Agitated systems, Packed columns, condensation phenomena, Film and drop wise condensation over tubes. Boiling phenomena, heat transfer coefficient.					
UNIT V	RADIATION HEAT TRANSFER AND HEAT TRANSFER EQUIPMENTS				9
Electromagnetic waves, energy of radiation, Planck’s equation-Blackbody, Radiation exchange. Kirchhoff’s law, Stefan Boltzmann equation of radiant energy – Wien’s law, Radiation exchange between surfaces – black, gray bodies, view factors-sample problems. Concept of overall heat transfer coefficient, Heat exchangers, types, boilers, Kettles, Heat exchanger Design concept. NTU concept					
TOTAL: 45 PERIODS					
COURSE OUTCOMES:			BTL	POs	PSOs

CO1:	Understand the basic knowledge of dimensional analysis & agitation process of Current Biotech Industries	K2	1,2,3,4,5	1,2,3
CO2:	Acquire knowledge on the steady, unsteady and combined resistances of conduction and convection	K1	1,2,3,4,5	1,2,3
CO3:	Familiar with radiation, boiling and condensation process of heat transfer	K2	1,2,3,4,5	1,2,3
CO4:	Analyse the design of various industrial heat exchangers, the concept of NTU for higher education in the field of Biotechnology	K4	1,2,3,4,5	1,2,3
CO5:	Learn fundamentals of three heat transfer modes, and have hands-on experience on heat transfer equipment's	K3	1,2,3,4,5	1,2,3

TEXT BOOKS:

1.	R.K. Bansal A Textbook of Fluid Mechanics, Laxmi Publications; Second edition, 2020
2.	Heat & Mass Transfer by P. K. Nag, Tata McGraw Hill – IIIrd Edition 2003

REFERENCES:

1.	K.A.Gavhane, Fluid flow Operations, Nirali publishers, 1st Edition, 2018
2.	R.K.Rajput A text Book of Heat & Mass Transfer SI Units , S.Chand publisher, 2018
3.	Geankoplis. C.J "Transport Process & separation Process Principles" IVth Edition Prentice Hall of India 2013.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
1	3	3	2	2	2	2	1	1	1	1	1	2	3	2	2
2	3	2	2	2	2	1	1	1	1	1	1	2	3	2	2
3	3	2	2	2	2	1	1	1	1	1	1	2	3	2	2
4	3	3	3	3	3	2	2	1	1	2	2	2	3	3	3
5	3	2	2	2	3	2	2	1	1	2	1	2	3	3	2
AVG	3.0	2.4	2.2	2.2	2.4	1.6	1.4	1.0	1.0	1.4	1.2	2.0	3.0	2.4	2.2

23BTT403	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY		L	T	P	C
			3	0	0	3
PREREQUISITES: ➤ 23BTT301 – BIOCHEMISTRY						
COURSE OBJECTIVES:						
1.	To have a fundamental knowledge about the Light spectrum, Absorption, Fluorescence, NMR, Mass spectroscopy					
2.	To acquire knowledge on the different chromatographic methods for separation of biological products					
UNIT I		INTRODUCTION TO SPECTROMETRY				9
Properties of electromagnetic radiation- wave properties – components of optical instruments – Sources of radiation – wavelength selectors – sample containers – radiation transducers – Signal process and read outs – signal to noise ratio - sources of noise – Enhancement of signal to noise - types of optical instruments – Principle of Fourier Transform optical Measurements						
UNIT II		MOLECULAR SPECTROSCOPY				9
Molecular absorption spectrometry – Measurement of Transmittance and Absorbance – Beer’s law– Instrumentation - Applications -Theory of fluorescence and Phosphorescence – Instrumentation– Applications – Theory of Infrared absorption spectrometry – IR instrumentation – Applications – Theory of Raman spectroscopy – Instrumentation – applications						
UNIT III		MAGNETIC RESONANCE SPECTROSCOPY AND MASS SPECTROMETRY				9
Theory of NMR – environmental effects on NMR spectra – chemical shift- NMR-spectrometers – applications of ¹ H and ¹³ C NMR- Molecular mass spectra – ion sources – Mass spectrometer. Applications of molecular mass - Electron paramagnetic resonance- g values –instrumentation						
UNIT IV		SEPARATION METHODS				9
General description of chromatography – Band broadening and optimization of column performance- Liquid chromatography – Partition chromatography – Adsorption chromatography – Ion exchange chromatography -size exclusion chromatography- Affinity chromatography- principles of GC and applications – HPLC- Capillary electrophoresis – Applications						
UNIT V		ELECTRO ANALYSIS AND SURFACE MICROSCOPY				9
Electrochemical cells- Electrode potential cell potentials – potentiometry- reference electrode – ion selective and molecular selective electrodes – Instrument for potentiometric studies – Voltametry – Cyclic and pulse voltametry- Applications of voltametry . Study of surfaces – Scanning probe microscopes – AFM and STM						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BTL	POs	PSOs	
CO1:	Understand the principles and components of optical instruments and spectrometers		K1	1,2,3,5,12	1,2,3	
CO2:	Explain molecular spectroscopy techniques including UV-Vis, IR, fluorescence and Raman		K2	1,2,3,5,12	1,2,3	
CO3:	Describe NMR, Mass spectrometry and their applications in biotechnology		K2	1,2,3,5,12	1,2,3	
CO4:	Understand various chromatographic and electrophoretic techniques for biomolecular separation		K2	1,2,3,5,12	1,2,3	

CO5:	Understand electrochemical analysis techniques and surface imaging technologies (AFM, STM)										K2	1,2,3,5,12	1,2,3		
TEXT BOOKS:															
1.	Skoog, D.A. F. James Holler, and Stanky, R.Crouch “Instrumental Methods of Analysis”.CengageLearning , 2007														
2.	Willard, Hobart, etal., “Instrumental Methods of Analysis”. VIIth Edition, CBS, 1986.														
3.	Fifield F.W., . Principles and Practice of Analytical Chemistry. Blackwell, Scientific Publishers,2016														
REFERENCES:															
1.	Sharma, B.K. “Instrumental Methods of Chemical Analysis: Analytical Chemistry”, Krishna Prakashan Media (P) Ltd, 2014														
2.	Haven, Mary C., etal., “Laboratory Instrumentation “. 4th Edition, Wiley India Pvt Ltd, 2010														
3.	Philopose P.M.Analytical Biotechnology. Domihant Publishers &distributors, New Delhi, 2016.														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	2	1	2	1	1	1	1	1	1	2	2	2	1
2	3	3	2	2	2	1	1	1	1	1	1	2	3	2	1
3	3	3	2	2	3	1	1	1	1	1	1	2	3	2	1
4	3	3	3	2	3	1	1	1	2	2	2	2	3	3	2
5	3	3	2	2	3	2	1	1	2	2	2	2	3	3	2
AV G	3.0	2.8	2.2	1.8	2.6	1.2	1.0	1.0	1.4	1.4	1.4	2.0	2.8	2.4	1.4

23BTT404	CHEMICAL PROCESS CALCULATIONS IN BIOTECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT304 – BIOCHEMICAL THERMODYNAMICS								
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY								
COURSE OBJECTIVES:								
1.	To enable the students to learn about basic concepts of chemical process and calculations							
2.	The course aims to develop skills of the students in the area of Chemical Engineering with emphasis in process calculations and fluid mechanics							
3.	The course will enable the students to perform calculations pertaining to processes and operations							
UNIT I		BASIC CHEMICAL CALCULATIONS						9
Dimension – Systems of units esp. engineering FPS, Engineering MKS & SI systems – Conversion from one system to the other – composition of mixtures and solutions – mass fraction, mass %, mole fraction, mole %, mass ratios, molarity, molality, normality, ppm, composition by density								
UNIT II		IDEAL AND ACTUAL GAS EQUATIONS						9
Ideal and actual gas equations, Vander Walls, compressibility factor equations, Application to pure gas & gas mixtures – partial pressures, partial volumes – Air-water vapour systems, Humidity, Molar Humidity, Relative Humidity, % Saturation, humid Volume – Humidity chart – wet, Dry bulb, Dew point temperatures, pH of solutions, Vapour pressure								
UNIT III		MATERIAL BALANCE						9
Material balance concept – overall & component – material balance applications for evaporator, gas absorber without reaction, Distillation (Binary system), Liquid extraction, solid-liquid extraction, drying, crystallization, Humidification, Reverse Osmosis separation and Mixing Recycle and Bypass illustration								
UNIT IV		ENERGY BALANCE						9
General energy balance equation for open systems, closed system sensible heat calculation, Heat required for phase change thermo chemistry, application of steam tables, Saturated and superheated steam application in bioprocess								
UNIT V		CHEMICAL REACTION						9
Chemical Reaction-Limiting, excess component, Fractional conversion, Percent conversion, Fractional yield in multiple reactions. Simple problems, Combustion Reactions								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Understand basic unit conversions and solution concentration expressions			K1	1,2,3,4,5		1,2	
CO2:	Explain gas laws, vapour pressure, humidity and related gas-vapour systems			K2	1,2,3,4,5		1,2	
CO3:	Apply material balance principles to unit operations like evaporation, drying, extraction etc.			K2	1,2,3,4,5		1,2	
CO4:	Understand energy balance and steam table applications in process calculations			K2	1,2,3,4,5		1,2	
CO5:	Explain reaction stoichiometry, limiting/excess components, conversion and yield			K2	1,2,3,4,5		1,2	

TEXT BOOKS:															
1.	Bhatt B.I & SB Thakore, Stoichiometry - Fifth edition Tata McGraw Hill 2017														
2.	K.A.Kavhane, Introduction to Process calculations,Nirali Publishers,1st Edition,2016														
3.	Himmelblau D.M “Basic principles & Calculations in Chemical Engineering” 8th edn PHI 2014														
REFERENCES:															
1.	McCabe W.L & J.C.Smith & P.Harriot “Unit operations of chemical Engineering” 7thEdn McGraw Hill 2017														
2.	S. Pushpavanam, Introduction to Chemical Engineering, PHI Learning Pvt. Ltd.,2012														
3.	Geankoplis C.J. “Transport process & Separation process Principles 4th edition-PHI 2006														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	2	1	2	1	1	1	1	1	1	2	3	2	1
2	3	2	2	2	3	1	1	1	1	1	1	2	3	2	2
3	3	3	3	2	3	1	1	1	1	2	1	2	3	3	2
4	3	2	3	2	2	1	1	1	1	1	1	2	3	2	2
5	3	2	3	2	2	1	1	1	1	2	1	2	3	2	2
AV G	3.0	2.2	2.6	1.8	2.4	1.0	1.0	1.0	1.0	1.4	1.0	2.0	3.0	2.2	1.8

23BTT405	INDUSTRIAL ENZYMOLOGY			L	T	P	C
				3	0	0	3
PREREQUISITES:							
➤ 23BTT301 – BIOCHEMISTRY							
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY							
COURSE OBJECTIVES:							
1.	To gain comprehensive knowledge of enzyme nomenclature, classification, structural features, catalytic mechanisms.						
2.	To emphasize the methodologies for isolating, purifying, and characterizing enzymes from various sources.						
3.	To acquire a comprehensive understanding of enhancing enzyme properties through mutagenesis and protein engineering						
4.	To acquire a foundational knowledge of biotransformation reactions facilitated by enzymes, including the phases of biotransformation.						
5.	To understand the practical applications of enzymes in various industries.						
UNIT I		INTRODUCTION TO ENZYMES					9
Classification of enzymes. Mechanisms of enzyme action; concept of active site and energetics of enzyme substrate complex formation; specificity of enzyme action; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.							
UNIT II		KINETICS OF ENZYME ACTION					9
Kinetics of single substrate reactions; estimation of Michelis – Menten parameters, multisubstrate reactions - mechanisms and kinetics; turnover number; types of inhibition & models –substrate, product. Allosteric regulation of enzymes, Monod Changeux Wyman model, pH and temperature effect on enzymes & deactivation kinetics.							
UNIT III		ENZYME IMMOBILIZATION AND BIOSENSORS					9
Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages, design of enzyme electrodes and their application as biosensors in industry, healthcare and environment.							
UNIT IV		PURIFICATION AND CHARACTERIZATION OF ENZYMES FROM NATURAL SOURCES					9
Production and purification of crude enzyme extracts from plant, animal and microbial sources; methods of characterization of enzymes; development of enzymatic assays.							
UNIT V		BIOTRANSFORMATION APPLICATIONS OF ENZYMES					9
Hydrolytic- Ester bond, Amide, Epoxides, Nitriles, Reduction reactions –aldehydes, Ketones, C=C, Oxidation reactions – Alkanes, Aromatic, Baeyer-Villiger, Enzymes in organic synthesis – esters, amide,peptide , Modified and Artificial Enzymes , Catalytic antibodies							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BTL	POs	PSOs	
CO1:	On enzyme and enzyme reactions will be the key step in to proceed towards various concepts in biotechnology.			K3	1,2,3,4,5,7	1	
CO2:	Theoretical and practical aspects of kinetics will provide the importance and utility of enzymekinetcs towards research.			K3	1,3,4,7,10	2,3	
CO3:	Process of immobilization has been increased steadily in food, pharmaceutical and chemicalindustries and thus this			K4	1,2,3,4,5,11	3	

	study will provide simple and easy method of implementation.			
CO4:	Ideas on Processing, Production and Purification of enzymes at an industrial scale will be helpful to work technologically.	K4	1,2,3,4,5,7,9	1,2
CO5:	Biotransformation applications of enzymes encompass hydrolytic reactions	K3	1,2,3,4,5,11	3

TEXT BOOKS:

1.	Trevor Palmer , 5th edition Enzymes Horwood Publishing Ltd, 2001
2.	Faber K, Biotransformations in Organic Chemistry, 2nd Edition, Springer

REFERENCES:

1.	Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, 2nd Edition, CRC Press, 1997
2.	James M. Lee, Biochemical Engineering, PHI, USA.
3.	James. E. Bailey & David F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, McGraw Hill Education; 2017.
4.	Wiseman, Enzyme Biotechnology, Ellis Horwood Pub. Volume 4, 1980

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PS O3
1	3	-	1	-	2	1	-	2	1	1	-	-	2	1	1
2	3	3	2	3	2	2	2	2	1	-	1	1	3	2	2
3	2	1	3	2	2	2	2	3	2	2	2	3	3	3	3
4	3	3	3	3	3	2	3	3	2	2	2	3	3	3	3
5	3	2	2	2	2	2	3	2	2	2	1	-	2	2	1
AV G	2.8	2.2	2.2	2.4	2.2	1.8	2.5	2.4	1.6	1.75	1.5	2.3	2.6	2.2	2

23GET401	ENVIRONMENTAL SCIENCE AND ENGINEERING	Category: BSC			
		L	T	P	C
		2	0	0	2
Prerequisites NIL					
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', 3 rd edition, Tata McGraw-Hill, New Delhi, 2017															
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2 nd edition, Pearson Education, 2004															
3. Anubha Kaushik and C.P. Kaushiks, 'Perspectives in Environmental Studies, 6 th 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, 3 rd 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.													K1		
CO2: Know well about the effects of environmental pollutions													K1		
CO3: Inculcate the basic knowledge of renewable energy resources													K1		
CO4: Differentiate various social problems.													K2		
CO5: Describe the importance/impacts of population growth.													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	-	-	-

SEMESTER V

23BTT501	BIOPROCESS PRINCIPLES				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY								
➤ 23BTT405 – INDUSTRIAL ENZYMOLOGY								
COURSE OBJECTIVES:								
1.	To impart knowledge on design and operation of fermentation processes with all itsprerequisites							
2.	To endow the students with the basics of microbial kinetics, metabolic stoichiometry and energetic							
UNIT I		OVERVIEW OF FERMENTATION PROCESSES						9
Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermentor (CSTR) and ancillaries, main parameters to be monitored and controlled in fermentation processes								
UNIT II		RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS						9
Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen, minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization methods								
UNIT III		STERILIZATION KINETICS						9
Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of sterilization equipment - batch and continuous.								
UNIT IV		METABOLIC STOICHIOMETRY AND ENERGETICS						9
Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield coefficients of biomass and product formation, maintenance coefficients energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth								
UNIT V		KINETICS OF MICROBIAL GROWTH AND PRODUCT FORMATION						9
Batch cultivation and continuous cultivation. Simple unstructured models for microbial growth, Monod model, growth of filamentous organisms, product formation kinetics - Leudeking- Piret models, substrate and product inhibition on cell growth and product formation. Biomass estimation–Direct and Indirect methods								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Identify suitable process instrumentation for monitoring and control of fermentor			K2	1,2,3,4,5,12		1,2,3	
CO2:	Formulate the fermentation medium to facilitate improved product production			K3	1,2,3,4,5,12		1,2,3	
CO3:	Select and apply the sterilization techniques in bioprocessing			K3	1,2,3,4,5,12		1,2,3	
CO4:	Interpret the metabolic stoichiometry in microbial processes			K3	1,2,3,4,5,12		1,2,3	

CO5:	Analyze the kinetics of microorganisms during fermentation processes	K4	1,2,3,4,5,12	1,2,3											
TEXT BOOKS:															
1.	Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3rd Edition ,2016														
2.	Pauline M. Doran, Bioprocess Engineering Principles, Elsevier, 2nd Edition,2012														
REFERENCES:															
1.	Michael L. Shuler, Fikret Kargi, Matthew De Lisa , Bioprocess Engineering , Prentice Hall,3rd Edition, 2017														
2.	Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, 2ndEdition. McGraw Hill , 1986														
3.	Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, CRC Press; 2nd Edition1997														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	2	2	3	1	1	1	1	1	1	2	3	2	1
2	3	3	2	2	3	1	1	1	2	1	1	2	3	3	2
3	3	3	3	2	3	1	1	1	1	1	1	2	3	3	2
4	3	3	3	3	3	1	1	1	1	1	2	2	3	3	2
5	3	3	3	3	3	1	1	1	2	2	2	2	3	3	3
AV G	3.0	2.8	2.6	2.4	3.0	1.0	1.0	1.0	1.4	1.2	1.4	2.0	3.0	2.8	2.0

23BTT502	IMMUNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT302 – CELL BIOLOGY								
➤ 23BTT303 - MICROBIOLOGY								
COURSE OBJECTIVES:								
1.	To discuss the structure, function and integration of immune system.							
2.	To understand the antigen-antibody interactions and how the immune system is protecting the body from foreign pathogens.							
3.	To explain various techniques of monoclonal and engineered antibodies (important therapeutic molecules) production, for treating most of the human diseases.							
4.	To discuss the immune deficiencies and their diagnostic methods.							
5.	To understand the applications of vaccine development using Ab and immunosuppressant drugs for the body.							
UNIT I		INTRODUCTION TO IMMUNE SYSTEM						9
Organisation and classification of immune system – immune cells and organs; innate and acquired immunity; Toll receptors and responses, classification of antigens – chemical and molecular nature; haptens, adjuvants; cytokines; complement pathway, antigen presenting cells; major histocompatibility complex								
UNIT II		HUMORAL AND CELLULAR IMMUNITY						9
Development, maturation, activation, regulation, differentiation and classification of T-cells and B-cells, antigen processing and presentation, theory of clonal selection, TCR; antibodies: structure and functions; antibodies: genes and generation of diversity; antigen-antibody reactions								
UNIT III		IMMUNITY AGAINST PATHOGENS AND TUMORS						9
Inflammation; protective immune responses to virus, bacteria, fungi and parasites; tumor antigens, tumor immune response, tumor diagnosis, tumor immunotherapy								
UNIT IV		IMMUNE TOLERANCE AND HYPERSENSITIVITY						9
Immune tolerance, Immune deficiencies; Transplantation – genetics of transplantation; laws of transplantation; Allergy and hypersensitivity – Types of hypersensitivity, Autoimmunity, Auto immune disorders and diagnosis								
UNIT V		APPLIED IMMUNOLOGY						9
Monoclonal antibodies, engineering of antibodies; T- Cell cloning - Classification of Vaccines, methods of vaccine development, immunodiagnostic methods (Immune diffusion ELISA, FACS), immune modulatory drugs								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Understand the structure, functions and integration of immune system.			K3	4, 12		1, 3	
CO2:	Understand the antigen-antibody interactions that offers defence mechanism.			K2	1, 2, 3, 4,		1, 2	
CO3:	Gain knowledge in importance of learning immunoregulation in Immunity development			K4	1, 2, 3, 5, 7, 12		1	
CO4:	Understand the importance of various techniques of therapeutically significant monoclonal and engineered antibodies production			K3	2, 3, 5, 6		1, 2	

CO5:	Aware of the concepts and mechanism behind tumour development, allergy and hypersensitivity reactions.										K3	1, 4, 6, 8, 12		1, 2, 3	
TEXT BOOKS:															
1.	Peter J Delves, Seamus J Martin, Dennis R Burtn and Ivan M Roitt., Roitts Essential Immunology, 13th Edition, Wiley –Blackwell, 2016.														
2.	Judith a Owen, Jenni Punt and Sharon A Stranford, Kuby Immunology, Macmillan														
3.	Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 2006.														
REFERENCES:															
1.	Coico, Richard “Immunology: A Short Course” VIth Edition. John Wiley, 2008.														
2.	Khan, Fahim Halim “Elements of Immunology” Pearson Education, 2009.														
3.	Robert R Rich, Thomas A Fleisher, William T Shearer, Harry Schroeder, Anthony J Frew, and Cornelia M Weyand, Clinical Immunology – Principles and Practive, Elsevier, 4 th Edition, 2013.														
4.	Maurice R, G O`Gorman, and Albert D Donnnenberg, Handbook of human Immunology, Second edition, CRC Press, 2008														
5.	Gerd – Rudiger Burmester, , Antonio Pezzutto and Jurgen Wirth, Colour Atlas of Immunology, Thieme Medical Publishers, 1st Edition, 2003.														
CO’s – PO’s & PSO’s Mapping:															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
1	2	0	0	0	1	0	0	0	2	0	2	2	3	0	2
2	2	1	0	2	2	0	0	2	2	0	2	2	2	2	2
3	1	0	2	1	0	0	0	1	2	0	0	2	3	1	2
4	2	2	2	2	0	2	3	0	3	0	2	3	2	2	3
5	2	1	3	2	3	1	2	3	2	1	3	3	3	1	2
AVG	1.8	0.8	0.8	1.4	0.7	0.6	0.8	1.2	2.2	0.2	1.8	2.4	2.6	1.2	2.2

23BTT503	GENETIC ENGINEERING			L	T	P	C
				3	0	0	3
PREREQUISITES:							
➤ 23BTT302 – CELL BIOLOGY							
➤ 23BTT401 – MOLECULAR BIOLOGY							
COURSE OBJECTIVES:							
1.	To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics						
2.	To explain the heterologous expression of cloned genes in different hosts						
UNIT I		BASICS OF RECOMBINANT DNA TECHNOLOGY					9
Manipulation of DNA – Restriction and Modification enzymes, Design of linkers and adaptors. Characteristics of cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Prokaryotic and eukaryotic host systems, Introduction of recombinant DNA in to host cells and selection methods							
UNIT II		DNA LIBRARIES					9
Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Chromosomal walking, Screening of DNA libraries using nucleic acid probes and antisera							
UNIT III		SEQUENCING AND AMPLIFICATION OF DNA					9
Maxam Gilbert’s and Sanger’s methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP- PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis							
UNIT IV		ORGANIZATION AND STRUCTURE OF GENOMES					9
Organization and structure of genomes, Genome sequencing methods, Conventional and shotgun genome sequencing methods, Next generation sequencing technologies , Ordering the genome sequence, Genetic maps and Physical maps, STS content based mapping, Restriction Enzyme Finger Printing, Hybridization mapping, Radiation Hybrid Maps, Optical mapping. ORF finding and functional annotation							
UNIT V		CURRENT STATUS OF GENOME SEQUENCING PROJECTS					9
Current status of genome sequencing projects, Introduction to Functional genomics, Microarrays, Serial Analysis of Gene expression (SAGE), Subtractive hybridization, DIGE, TOGA, Yeast Two hybrid System, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BTL	POs	PSOs	
CO1:	To clone commercially important genes			K3	1,2,3,4,5,12	1,2,3	
CO2:	To produce the commercially important recombinant proteins			K3	1,2,3,4,5,12	1,2,3	
CO3:	To be aware of gene and genome sequencing techniques			K2	1,2,3,4,5,12	1,2,3	
CO4:	To design modern tools and techniques for manipulation and analysis of genomic sequences			K4	1,2,3,4,5,12	1,2,3	

CO5:	To develop skills in microarrays, analysis of gene expression and proteomics and to strategize research methodologies employing genetic engineering techniques										K4	1,2,3,4,5,12		1,2,3	
TEXT BOOKS:															
1.	Old RW, Primrose SB, “Principles Of Gene Manipulation, An Introduction To GeneticEngineering “, Blackwell Science Publications, 1993														
2.	Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd EdWiley- Blackwell 2002														
REFERENCES:															
1.	Ansubel FM, Brent R, Kingston RE, Moore DD, “Current Protocols In Molecular Biology“Greene Publishing Associates, NY, 1988.														
2.	Berger Sl, Kimmer AR, “Methods In Enzymology”, Vol 152, Academic Press														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	3	3	2	2	1	1	1	1	1	1	2	3	3	2
2	3	3	3	2	3	1	1	1	1	1	1	2	3	3	3
3	3	3	2	2	2	1	1	1	1	1	1	2	3	2	2
4	3	3	3	3	3	1	1	1	2	1	1	2	3	3	3
5	3	3	3	3	3	1	1	1	2	2	1	2	3	3	3
AV G	3.0	3.0	2.8	2.4	2.6	1.0	1.0	1.0	1.4	1.2	1.0	2.0	3.0	2.8	2.6

SEMESTER VI

23BTT601	BIOINFORMATICS				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT401 – MOLECULAR BIOLOGY								
➤ 23BTT503 – GENETIC ENGINEERING								
COURSE OBJECTIVES:								
1.	To launch the Bioinformatics core concepts to students.							
2.	To provide knowledge on Biological databases, sequence analysis, evolutionary analysis and applications of Bioinformatics.							
UNIT I		BIOLOGICAL DATABASES						9
Introduction to Bioinformatics and Computational Biology, Biological sequences, Classification of biological databases - Sequence Databases, Structure Databases, Genome specific databases, Special Databases and applications- Microarray, Metabolic pathway, motif, and domain databases, Data file formats.								
UNIT II		SEQUENCE ANALYSIS						9
Sequence Alignment- Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment, Global alignment, Local alignment, Dotplot, Alignment algorithms- Needleman Wunsch and Smith and Waterman algorithm, Substitution matrices- PAM, BLOSUM. Multiple Sequence Alignment- Application of multiple alignments, Viewing and editing of MSA and Scoring function. Database Similarity Searching- Basic Local Alignment Search Tool (BLAST), FASTA, PHI BLAST, PSI BLAST, BLAST algorithm.								
UNIT III		MOLECULAR PHYLOGENY						9
Phylogenetics Basics, Molecular clock theory, Ultrametric trees, Distance matrix methods UPGMA, NJ, Character based methods- Maximum Parsimony. Methods of evaluating phylogenetic methods- bootstrapping, jackknifing.								
UNIT IV		MACROMOLECULAR STRUCTURE ANALYSIS						9
Gene prediction, Conserved domain analysis, Protein structure visualization, Prediction of protein secondary structure, Tertiary structure prediction- Homology modeling, Threading, Ab-initio prediction. Validation of the predicted structure using Ramachandran plot, stereochemical properties, Structure- structure alignment.								
UNIT V		APPLICATIONS						9
Introduction to Systems Biology and Synthetic Biology, Microarray data analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of Bioinformatics in genomics and proteomics- Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Use and describe bioinformatics data and information resources			K2	1,2,3,4,5,12		1,2,3	
CO2:	Apply computational based solutions for biological perspectives			K3	1,2,3,4,5,12		1,2,3	
CO3:	Analyze the evolutionary relationship between the organisms			K4	1,2,3,4,5,12		1,2,3	

CO4:	Understand the macromolecules structure prediction methods and relate how bioinformatics methods can be used in sequence to structure and function analysis	K3	1,2,3,4,5,12	1,2,3
CO5:	Learn the applications of bioinformatics approach for drug discovery, genomics and proteomics	K3	1,2,3,4,5,12	1,2,3

TEXT BOOKS:

1.	Lesk, A. K., “Introduction to Bioinformatics” 3rd Edition, Oxford University Press, 2013
2.	Dan Gusfield, “Algorithms on Strings, Trees and Sequences: Computer Science and Computational Biology
3.	Durbin, R., Eddy, S., Krogh, A., and Mitchison, G., “Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids” Cambridge, UK: Cambridge University Press, 1998
4.	Mount, D.W., “Bioinformatics Sequence and Genome Analysis” 2nd Edition, Cold Spring Harbor Laboratory Press, 2004
5.	Tindall, J., “Beginning Perl for Bioinformatics: An introduction to Perl for Biologists” 1st Edition, O’Reilly Media, 2001

REFERENCES:

1.	Baldi, P. and Brunak, S., “Bioinformatics: The Machine Learning Approach” 2nd Edition, MIT Press, 2001
2.	Jin Xiong, Essential Bioinformatics, Cambridge University Press, 2007
3.	B.Bergeron, Bioinformatics computing , PHI , 2002

CO’s – PO’s & PSO’s Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	3	2	2	3	1	1	1	1	1	1	2	3	2	2
2	3	3	3	3	3	1	1	1	2	1	1	2	3	3	2
3	3	3	3	3	3	1	1	1	2	2	1	2	3	3	3
4	3	3	3	3	3	1	1	1	2	2	1	2	3	3	3
5	3	3	3	3	3	1	1	1	2	2	1	2	3	3	3
AV G	3.0	3.0	2.8	2.8	3.0	1.0	1.0	1.0	1.8	1.6	1.0	2.0	3.0	2.8	2.6

23BTT602	BIOPROCESS ENGINEERING				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY								
➤ 23BTT405 – INDUSTRIAL ENZYMOLOGY								
➤ 23BTT501 – BIOPROCESS PRINCIPLES								
COURSE OBJECTIVES:								
1.	To able to describe various bioreactor configurations and operation modes.							
2.	To able to apply the knowledge of bioreactor scale up on the basis of rule of thumbs							
3.	To able to define kinetic parameters and apply the bioreactor considerations for immobilized enzymes systems.							
4.	To able to utilize modelling approaches and simulation concepts for bioprocess estimations.							
5.	To able to apply bioreactor considerations for the development of recombinant products.							
UNIT I		CONFIGURATION OF BIOREACTORS						9
Ideal reactors and its characteristics Fed batch cultivation, Cell recycle cultivation, Cell recycle cultivation in waste water treatment, two stage cultivation Packed bed reactor, airlift reactor, introduction to fluidized bed reactor bubble column reactors.								
UNIT II		BIOREACTOR SCALE – UP						9
Regime analysis of bioreactor processes, oxygen mass transfer in bioreactors – microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed.								
UNIT III		BIOREACTOR CONSIDERATION IN ENZYME SYSTEMS						9
Analysis of film and pore diffusion effects on kinetics of immobilized enzyme reactions; formulation of dimensionless groups and calculation of effectiveness factors. Design of immobilized enzyme reactors – packed bed, fluidized bed and membrane reactors								
UNIT IV		MODELLING AND SIMULATION OF BIOPROCESSES						9
Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.								
UNIT V		RECOMBINANT CELL CULTIVATION						9
Different host vector system for recombinant cell cultivation strategies and advantages. E.coli, yeast Pichia pastoris/ Saccharomyces cerevisiae, Animal cell cultivation, plant cell cultivation, Insect cell cultivation. High cell density cultivation, process strategies, reactor considerations in the above system								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs	PSOs		
CO1:	Able to describe various bioreactor configurations and operation modes.			K2	1,2,3,4,5,9	1,2,3		
CO2:	Able to apply the knowledge of bioreactor scale up on the basis of rule of thumb			K2	1,3,5,9,12	1		
CO3:	Able to define kinetic parameters and apply the bioreactor considerations for immobilized enzymes systems.			K3	1,2,3,4,7	1		
CO4:	Able to utilize modelling approaches and simulation concepts for bioprocess estimations.			K4	1,2,3,4,5,7,9	1		

CO5:	Able to apply bioreactor considerations for the development of recombinant products.										K3	1,2,3			1	
TEXT BOOKS:																
1.	Michael L. Shuler, Fikret Kargi, Matthew De Lisa,.Bioprocess Engineering, 3rdEdition,Prentice Hal, 2017															
2.	Pauline Doran, Bioprocess Engineering Calculation, 2nd Edition, Blackwell Scientific Publications,2012.															
3.	Sarfaraz K. Niazi, Justin L. Brown , Fundamentals of Modern Bioprocessing, Taylor & Francis,2017 99															
REFERENCES:																
1.	Anton Moser,”Bioprocess Technology ,Kinetics and reactors”,,Springer Verlag2012.															
2.	James E.Bailey &David F Olis, Biochemical Engineering fundamentals,McGraw Hill,1986															
3.	James M.Lee,Biochemical Engineering,PHI, USA,1992.															
CO’s – PO’s & PSO’s Mapping:																
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3	
1	3	3	2	3	1	-	1	-	2	2	2	3	3	3	3	
2	3	3	3	3	2	1	3	2	1	-	1	2	3	3	3	
3	3	3	3	2	2	-	-	-	1	1	1	2	3	3	3	
4	3	3	3	3	2	1	3	1	2	2	1	1	3	1	2	
5	3	2	3	2	2	3	3	3	2	1	2	2	3	3	3	
AV G	3	2.8	2.8	2.6	1.8	1	2	1.2	1.6	1.2	1.4	2	3	2.6	2.8	

SEMESTER VII

23BTT701	DOWNSTREAM PROCESSING			L	T	P	C
				3	0	0	3
PREREQUISITES:							
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY							
➤ 23BTT501 – BIOPROCESS PRINCIPLES							
➤ 23BTT602 – BIOPROCESS ENGINEERING							
COURSE OBJECTIVES:							
1.	To understand various methods to isolate and purify proteins and enzymes, ensuring their suitability for research and therapeutic applications.						
2.	To gain in-depth knowledge of downstream processing steps, including centrifugation, chromatography, and filtration, essential for biopharmaceutical manufacturing.						
3.	To cultivate the ability to analyse complex manufacturing scenarios and devise logical solutions for efficient product development.						
4.	To bridge the gap between theoretical concepts and hands-on experience in downstream processes within a multifactorial manufacturing environment.						
5.	To students will be able to build competencies in product development research, focusing on the refinement and optimization of bioproducts through structured methodologies.						
UNIT I		INTRODUCTION					9
Introduction to downstream processing, principles, characteristics of bio-molecules and bioprocesses. Cell disruption for product release – mechanical, enzymatic and chemical methods. Pre treatment and stabilisation of bio-products.							
UNIT II		PHYSICAL METHODS OF SEPARATION					9
Unit operations for solid-liquid separation - filtration and centrifugation.							
UNIT III		ISOLATION OF PRODUCTS					9
Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation – ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.							
UNIT IV		PRODUCT PURIFICATION					9
Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques.							
UNIT V		FINAL PRODUCT FORMULATION AND FINISHING OPERATIONS					9
Crystallization, drying and lyophilization in final product formulation							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BT L	POs	PSOs	
CO1:	Define the fundamentals of downstream processing for product recovery			K3	1,2,3,4,5,7	1,2	
CO2:	Understand the requirements for successful operations of downstream processing			K2	1,3,4,7,12	2	
CO3:	Describe the components of downstream equipment and explain the purpose of each			K4	1,2,3,4,7,11	3	
CO4:	Apply principles of various unit operations used in downstream processing and enhance problem solving techniques			K3	1,2,3,4,5	1,2	

CO5:	Apply the principles of crystallization, drying, and lyophilization to design and optimize final product formulations, ensuring enhanced stability, efficacy, and quality in pharmaceutical manufacturing processes.	K3	1,2,3,5,11,12	3

TEXT BOOKS:

1.	Belter, P.A., E.L. Cussler and Wei-Houhu “Bioseparations – Downstream Processing for Biotechnology”, John Wiley, 1988.
2.	Nooralabettu Krishna Prasad., Downstream Process Technology: A New Horizon in Biotechnology, Prentice Hall India, 2010.
3.	Sivasankar, B. “Bioseparations: Principles and Techniques”. PHI, 2006.

REFERENCES:

1.	Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006
2.	Michael R.Ladisch Bioseparations Engineering: Principles, practice and Economics, Wiley- Interscience, 1 st Edition, 2001.
3.	Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23GET701	HUMAN VALUES AND ETHICS				L	T	P	C
					2	0	0	2
PREREQUISITES: No prerequisites								
COURSE OBJECTIVES:								
1.	To identify the importance of democratic values in the harmonious functioning of social life							
2.	To practice democratic and scientific values in both their personal and professional life.							
3.	To find rational solutions to social problems.							
4.	To behave in an ethical manner in society							
5.	To practice critical thinking and the pursuit of truth.							
UNIT I		DEMOCRATICVALUES						6
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. ReadingText:ExcerptsfromJohnStuartMills’ <i>OnLiberty</i>								
UNIT II		SECULARVALUES						6
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices. ReadingText:Excerptfrom <i>SecularisminIndia: ConceptandPractice</i> byRamPuniyani								
UNIT III		SCIENTIFICVALUES						6
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. ReadingText:Excerptfrom <i>TheScientificTemper</i> byAntonyMichaelisR								
UNIT IV		SOCIALETHICS						6
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices. ReadingText:Excerptfrom <i>21Lessonsforthe21stCentury</i> byYuvalNoahHarari								
UNIT V		SCIENTIFICETHICS						6
TransparencyandFairnessinscientificpursuits–Scientificinventionsforthebetterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modernsociety. ReadingText:Excerptfrom <i>AmericanPrometheus:TheTriumphandTragedyofJ.Robert Oppenheimer</i> by Kai Bird and Martin J. Sherwin.								
TOTAL: 30 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Identifytheimportanceof democraticvaluesinharmoniousfunctioning of social life			K2	1,2,3,4,5,8,10		1,2,3	
CO2:	Practicedemocraticandscientificvaluesinboththeirpersonal andprofessionallife.			K3	1,3,5,8,9,12		1,3	
CO3:	Find rational solutions to social problems.			K4	1,2,3,4,7,8,12		1,2	

CO4:	Behave in an ethical manner in society	K4	1,2,3,4,5,7,8,12	1,2,3
CO5:	Practice critical thinking and the pursuit of truth.	K3	1,2,3,8,10,11,12	1,2

TEXT BOOKS:

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.

REFERENCES:

1.	The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
2.	The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
3.	Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	1	3	3	3	2	2	3	3	-	-	1	3	3	3
2	3	2	3	2	3	-	1	3	3	-	-	3	3	-	1
3	2	3	3	2	1	-	2	3	2	3	1	1	2	3	-
4	2	1	3	2	3	1	2	3	3	3	-	3	3	2	-
5	3	3	3	1	-	-	-	3	2	-	2	2	3	2	2
AVG	2.6	2	3	2	2.5	1.5	1.8	1.5	2.6	-	1.7	2	2.8	2.5	2

SEMESTER VIII

23GET801	TOTAL QUALITY MANAGEMENT				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23GET701 – HUMAN VALUES AND ETHICS								
COURSE OBJECTIVES:								
1.	Teach the need for quality, its evolution, basic concepts, contribution of quality gurus, TQM framework, Barriers and Benefits of TQM.							
2.	Explain the TQM Principles for application.							
3.	Define the basics of Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.							
4.	Describe Taguchi's Quality Loss Function, Performance Measures and apply Techniques like QFD, TPM, COQ and BPR.							
5.	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, 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: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Ability to apply TQM concepts in a selected enterprise.			K3	1,2,3,4,5,6,12		1	
CO2:	Ability to apply TQM principles in a selected enterprise			K3	1,2,3,4,5,6,12		1	

CO3:	Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA	K3	1,2,3,4,5,6,12	1
CO4:	Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR	K4	1,2,3,4,5,6,12	1
CO5:	Ability to apply QMS and EMS in any organization	K3	1,2,3,4,5,6,12	1

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.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	3	2	2	2	3	2	2	2	2	1	3	2	1	1
2	3	3	3	3	2	3	2	2	2	2	1	3	2	2	1
3	3	3	3	3	3	3	2	2	2	2	2	3	2	2	2
4	3	3	3	3	3	3	2	2	2	2	2	3	2	2	2
5	3	3	3	2	2	3	2	2	2	2	2	3	2	2	2
AV G	3.0	3.0	2.8	2.6	2.4	3.0	2.0	2.0	2.0	2.0	1.6	3.0	2.0	1.8	1.6

SEMESTER I

23GEP101	PROGRAMMING IN C LABORATORY											Category: ESC			
												L	T	P	C
												0	0	4	2
Prerequisites No Prerequisites															
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 in C 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: 1D and 2D, 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, processor directives.														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016															
2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition,Pearson Education, 2015															
3. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018															
4. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020															
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996															
6. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013															
7. 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													K2		
CO2: Develop programs in C using basic constructs													K3		
CO3: Develop programs in C using arrays													K3		
CO4: Develop applications in C using strings, pointers, functions													K3		
CO5: Develop applications in C using structures and file processing													K3		
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	-

23BSP101	PHYSICS LABORATORY												Category: ESC			
													L	T	P	C
													0	0	2	2
Prerequisites																
•																
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			
• CO2: Use graphical models to analyze laboratory data.													Understanding			
• CO3: Use mathematical models as a medium for quantitative reasoning and describing physical reality.													Remembering			
• CO4: Access, process and analyze scientific information.													Analyzing			
• CO5: Solve problems individually and collaboratively.													Applying			
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	-	-	-	-	-	-	-	-	-	-	
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation																

23BSP101	CHEMISTRY LABORATORY												Category: ESC			
													L	T	P	C
													0	0	2	2
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													CO	PO/PSO		
1	Determination of total, temporary & permanent hardness of water by EDTA method												CO1	1,2,6,7,9,1,12		
2	Determination of chloride content of water sample by Argentometric method												CO1	1,2,6,7,9,1,12		
3	Determination of types and amount of alkalinity in water sample												CO2	1,6,7,9,12		
4	Determination of DO content of water sample by Winkler's method												CO2	1,6,7,9,12		
5	Determination of strength of acids in a mixture of acids using conductivity meter.												CO3	1,6,7,9,12		
6	Conductometric titration of barium chloride against sodium (precipitation titration).												CO4	1,6,7,9,12		
7	Estimation of iron content of the given solution using potentiometer.												CO5	1,6,7,9,12		
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													K4			
CO2: To analyze the quantity of alkalinity and DO in water sample													K4			
CO3: Using conductivity meter the strength and amount of acids are analyzed.													K4			
CO4:To Analyze quantitatively BaCl ₂ present in the given solution by conductivity meter.													K4			
CO5:To determine the amount of Fe content potentiometrically.													K4			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	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				
1 - Low, 2 - Medium, 3 - High , '-' No correlation																

23HSP102	English Laboratory	Category: ESC			
		L	T	P	C
		0	0	2	1
Prerequisites					
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 .													RE		
CO2: To speak fluently and accurately in formal and informal communicative contexts													AP		
CO3: To express their opinions effectively in both oral and written medium of communication													UN		
CO4: Write critical reports to convey data and information with clarity and precision													AP		
CO5: Give appropriate instructions and recommendations for safe execution of tasks													AP		
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	1	0	2	2	2	3	2	3	0	0	0
CO2	1	0	0	0	1	0	2	2	2	3	2	3	0	0	0
CO3	1	0	0	0	1	0	2	2	2	3	2	3	0	0	0
CO4	1	0	0	0	1	0	2	2	2	3	2	3	0	0	0
CO5	1	0	0	0	1	0	2	2	2	3	2	3	0	0	0
1 - Low, 2 - Medium, 3 -High , ‘-‘ No correlation2															

SEMESTER II

23GEP201	ENGINEERING PRACTICES LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites No Prerequisites					
Course Objectives: - Drawing pipeline plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing, planning, and making joints in wood materials used in common household woodwork. - Wiring various electrical joints in common household electrical wire work - Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work - Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB					
LIST OF EXPERIMENTS					
GROUP – A (CIVIL & ELECTRICAL)					
PART I	CIVIL ENGINEERING PRACTICES				15
<u>PLUMBING WORK:</u> 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.					
<u>WOOD WORK:</u> a) Sawing, b) Planing c) Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.					
<u>Wood Work Study:</u> a) Studying joints in door panels and wooden furniture b) Studying common industrial trusses using models.					
PART II	ELECTRICAL ENGINEERING PRACTICES				15
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					
GROUP – B (MECHANICAL AND ELECTRONICS)					
PART III	MECHANICAL ENGINEERING PRACTICES				15
<u>WELDING WORK:</u> a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding. b) Practicing gas welding.					
<u>BASIC MACHINING WORK:</u> a) (simple)Turning. b) (simple)Drilling. c) (simple)Tapping.					
<u>ASSEMBLY WORK:</u> a) Assembling a centrifugal pump. b) Assembling a household mixer. c) Assembling an airconditioner.					
<u>SHEET METAL WORK:</u> a) Making of a square tray					

FOUNDRY WORK:															
a) Demonstrating basic foundry operations.															
PART IV		ELECTRONIC ENGINEERING PRACTICES												15	
SOLDERING WORK:															
a) Soldering simple electronic circuits and checking continuity.															
ELECTRONIC ASSEMBLY AND TESTING WORK:															
a) Assembling and testing electronic components on a small PCB.															
ELECTRONIC EQUIPMENT STUDY:															
a) Study an elements of smart phone.															
b) Assembly and dismantle of LED TV.															
c) Assembly and dismantle of computer/ laptop															
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. K.J. Reddy & T. Ranganathan, Standard Engineering Practice Manual, I.K. International, 2012															
2. S.C. Rangwala, Engineering Materials, Charotar Publishing House															
3. Bhattacharya, Electrical Wiring, Estimating & Costing, New Age International															
Course Outcomes:													Blooms Taxonomy		
CO1: Draw pipe layout and assemble wood joints used in household works													K3		
CO2: Perform household electrical wiring and safety device setup													K3		
CO3: Perform arc welding, basic machining, sheet metal work and mechanical assembly													K3		
CO4: Solder, assemble and test basic electronic circuits and components on PCB													K4		
CO5: Develop applications application skills in household works													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	1	1	2	1	1	2	1	1	2	2	1	1
CO2	2	2	3	1	2	2	1	1	2	1	1	2	2	2	1
CO3	3	3	3	2	2	2	1	1	2	2	1	2	2	2	2
CO4	3	3	3	2	2	2	1	1	2	2	1	2	2	2	2
CO5	2	2	2	1	1	2	1	1	2	1	1	2	2	1	1

23GEP202	COMMUNICATION LABORATORY	Category: ESC			
		L	T	P	C
		0	0	4	2
Prerequisites					
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 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

C01: Speak effectively in group discussions held in a formal/semi formal contexts.

RE

C02: Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

AP

CO3: Write emails, letters and effective job applications

UN

C04: Write critical reports to convey data and information with clarity and precision

AP

C05: Give appropriate instructions and recommendations for safe execution of tasks

AP

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	0	0	0
CO2	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0
CO3	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0
CO4	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0
CO5	1	0	0	0	0	0	2	2	2	3	2	3	0	0	0

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

23BTP201	BIOORGANIC CHEMISTRY LABORATORY											Category: PCC			
												L	T	P	C
												0	0	4	2
Prerequisites 23BTT201 – BIOORGANIC CHEMISTRY															
Course Objectives: - Make the students understand the mechanism of synthesis of different chemical moieties - Familiarize the students with the isolation of biomolecules from natural sources															
LIST OF EXPERIMENTS															
1	Synthesis of aspirin														
2	Hydrolysis of sucrose														
3	Preparation of pyruvic acid from tartaric acid														
4	Preparation of oleic acid from tartaric acid														
5	Preparation of alpha D- glucopyranose pentaacetate														
6	Preparation of 1,2,5,6 dicyclohexylnoine alpha d glucofuranose														
7	Isolation of lycopene from tomato paste														
8	Preparation of L-proline														
9	Preparation of L-cysteine from hair														
10	Preparation of S-ethylhydroxyl butonate from methylacetoacetate using yeast														
11	Resolution of S-ethyl hydroxyl butonate using 3,5 dinitro benzoate														
12	Preparation of 5,10,15,20-tetrakisphenylporphyrin														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Organic Chemistry, Francis A.Carey, VII Edition, Tata McGraw Hill, Fourth reprint 2009															
2. Organic and Bio-organic Mechanisms, M.I. Page and Andrew Williams. Pearson, First Impression, 2010															
Course Outcomes:													Blooms Taxonomy		
CO1: Comprehend the mechanism of reactions													K2		
CO2: Be able to synthesize various Bioorganic compounds													K3		
CO3: Be able to work independently for the experimentation													K4		
CO4: Understanding the biochemical mechanisms													K2		
CO5: Synthesize Biological compounds													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	1	1	1	1	1	2	3	2	1
CO2	3	3	3	2	2	1	1	1	2	2	1	2	3	2	2
CO3	3	3	3	3	2	1	1	1	2	2	1	2	3	2	2
CO4	3	2	2	2	1	1	1	1	1	1	1	2	3	2	1
CO5	3	3	3	2	2	1	1	1	2	2	1	2	3	2	2

SEMESTER III

23BTP301	BIOCHEMISTRY LABORATORY											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites 23BTT301 - BIOCHEMISTRY															
Course Objectives: - Learn fundamental approaches for experimentally investigating biochemical problems. - Able to extract living cell samples from plants and animals for genetic research															
LIST OF EXPERIMENTS															
1	General guidelines for working in biochemistry lab (theory)														
2	Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.														
3	Accuracy, precision, sensitivity and specificity (theory)														
4	Preparation of buffer –titration of a weak acid and a weak base.														
5	Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars and keto from aldo sugars														
6	Quantitative method for amino acid estimation using ninhydrin – distinguishing amino from imino acid														
7	Protein estimation by Biuret and Lowry’s methods														
8	Protein estimation by Bradford and spectroscopic methods														
9	Extraction of lipids and analysis by TLC.														
10	Estimation of nucleic acids by absorbance at 260 nm and hyperchromic effect (demo).														
11	Enzymatic assay: phosphatase from potato														
12	Enzymatic assay: estimation of glucose by GOD-POD method after hydrolysis of starch with acid and specificity of the enzymatic method														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Practical Biochemistry by R.C. Gupta and S. Bhargavan															
2. Introduction of Practical Biochemistry by David T. Phummer. (II Edition)															
3. Harpers Biochemistry Ed. R.K. Murray , D.K. Granner, P.A. Mayes and V.W.Rodwell, Appleton and Lange ,Stanford ,Conneticut															
4. Textbook of Biochemistry with clinical correlations. Ed. Thomas M. Devlin. Wiley Liss Publishers															
5. Experimental Biochemistry, A student Companion by Beedu Sashidhar Rao and Vijay Deshpande															
Course Outcomes:													Blooms Taxonomy		
CO1: Analyze biochemical & molecular techniques to plan and carryout experiments													K4		
CO2: Perform good biochemical lab practices. Adapt methods for biochemical analysis													K3		
CO3: Carry out experiments in biomolecular separations													K2		
CO4: Understand the principles of qualitative and quantitative estimation of biomolecules													K2		
CO5: Understand the applicability of biochemical methods to realistic solution													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	3	1	3	2	3	1	2	2	3	3	3
CO2	2	2	3	3	3	3	2	3	2	2	3	1	2	2	1
CO3	3	2	3	1	3	2	2	2	1	2	2	2	3	2	2
CO4	1	3	3	2	2	3	2	1	2	2	1	1	2	1	3
CO5	2	1	3	2	1	1	3	2	1	2	2	2	1	2	2

SEMESTER IV

23BTP401	CHEMICAL ENGINEERING LABORATORY FOR BIOTECHNOLOGISTS											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites • 23BTT402 – FLUID FLOW AND HEAT TRANSFER OPERATIONS • 23BTT404 – CHEMICAL PROCESS CALCULATIONS FOR BIOTECHNOLOGIST															
Course Objectives: • To provide basic understanding of chemical engineering principles and operations • Course will enable the students to apply the principles in other chemical engineering and biotechnology subjects offered in higher semesters															
LIST OF EXPERIMENTS															
1	Flow measurement - Orifice meter														
2	Flow measurement - Venturimeter														
3	Flow measurement - Rotameter														
4	Pressure drop in flow through pipes														
5	Pressure drop in flow through packed column														
6	Pressure drop in flow through fluidized beds														
7	Characteristics of centrifuge pump														
8	Filtration through plate and frame filter press														
9	Filtration in leaf filter														
10	Heat transfer characteristics in heat exchanger														
11	Simple and steam distillation														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Geankoplis, C.J., Transport Processes and Separation Process Principles, Prentice Hall, 4th Ed., 2013															
2. McCabe, W.L., Smith, J.C. & Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, 7th Ed., 2017															
3. Gavhane, K.A., Unit Operations I & II, Nirali Publications, 2018															
4. K.V. Narayanan & B. Lakshmikutty, Stoichiometry and Process Calculations, PHI, 2006															
5. Coulson & Richardson's, Chemical Engineering Vol. 1 & 2, Elsevier															
Course Outcomes:													Blooms Taxonomy		
CO1: Acquire knowledge on the basic concepts of chemical engineering													K1		
CO2: Develop the skill of material balance and energy balance in unit operations and unit process													K3		
CO3: Analyse the chemical engineering principles and their applications in chemical, mechanical and biological perspectives													K4		
CO4: Realize the design and working principles of fluid moving machinery and transport phenomena in biological systems													K3		
CO5: Select and apply appropriate techniques used for biological products and to recognize the need for instrumentation studies in technical environment													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	1	1	1	1	2	3	2	1
CO2	3	3	3	2	2	1	1	1	2	2	1	2	3	2	2
CO3	3	3	3	3	2	1	1	1	2	2	1	2	3	2	2
CO4	3	2	3	2	2	1	1	1	2	2	1	2	3	2	2
CO5	3	3	3	3	2	2	1	1	2	2	1	2	3	3	2

23BTP402	ANALYTICAL INSTRUMENTATION LABORATORY										Category: PCC				
											L	T	P	C	
											0	0	3	1.5	
Prerequisites															
• 23BTT403 – ANALYTICAL INSTRUMENTATION IN BIOTECHNOLOGY															
Course Objectives:															
• To have a practical hands on experience on Absorption Spectroscopic methods															
• To acquire experience in the purification by performing chromatography															
• To validate and analysis using spectrometric and microscopic techniques															
LIST OF EXPERIMENTS															
1	Precision and validity in an experiment using absorption spectroscopy														
2	Validating Lambert-Beer’s law using KMnO4														
3	Finding the molar absorbtivity and stoichiometry of the Fe (1,10 phenanthroline)3 using absorption spectrometry.														
4	Finding the pKa of 4-nitrophenol using absorption spectroscopy														
5	UV spectra of nucleic acids														
6	Chemical actinometry using potassium ferrioxolate														
7	Estimation of SO4-- by nephelometry														
8	Estimation of Al3+ by Flourimetry														
9	Limits of detection using aluminium alizarin complex														
10	Chromatography analysis using TLC														
11	Chromatography analysis using column chromatography														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Skoog, D.A. etal. “Principles of Instrumental Analysis”, Vth Edition, Thomson / Brooks – Cole,1998															
2. Braun, R.D. “Introduction to Instrumental Analysis”, Pharma Book Syndicate, 1987															
3. Willard, H.H. etal. “Instrumental Methods of Analysis”, VIth Edition, CBS, 1986.															
4. Ewing,G.W. “Instrumental Methods of Chemical Analysis”, Vth Edition, McGraw-Hill, 1985.															
Course Outcomes:													Blooms Taxonomy		
CO1: Demonstrate precision and accuracy in absorption spectroscopic measurements													K3		
CO2: Validate Lambert-Beer’s law and determine molar absorptivity													K4		
CO3: Analyze pKa, stoichiometry and structure of biomolecules using UV spectrometry													K4		
CO4: Estimate ions and compounds using nephelometry and fluorimetry													K4		
CO5: Apply chromatography techniques (TLC & Column) for analytical separation													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	2	1	1	1	1	1	1	2	3	2	2
CO2	3	3	3	3	2	1	1	1	1	1	1	2	3	2	2
CO3	3	3	3	3	2	1	1	1	2	2	1	2	3	2	2
CO4	3	3	3	3	2	1	1	1	2	2	1	2	3	2	2
CO5	3	2	3	2	2	1	1	1	2	2	1	2	3	2	2

SEMESTER V

23BTP501	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites 23BTT401 – MOLECULAR BIOLOGY 23BTT503 – GENETIC ENGINEERING															
Course Objectives: - Provide hands -on experience in performing basic molecular biology and Genetic Engineering techniques - Introduce the theory behind in each technique and to describe common applications of each methodology in biological research. This will facilitate the students to take up specialized project in Molecular biology and will be a pre-requisite for research work.															
LIST OF EXPERIMENTS															
1	Isolation of total DNA														
2	Isolation of Plasmid DNA														
3	Agarose gel electrophoresis														
4	Restriction enzyme digestion of DNA														
5	DNA Ligation														
6	Competent cell preparation & Transformation														
7	Blue-White screening														
8	Induction and Analysis of Gene expression														
9	PCR														
10	SDS-PAGE														
11	Western blot														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Sue Carson, Heather Miller, Melissa Srougi, D. Scott Witherow, “Molecular Biology Techniques: A Classroom Laboratory Manual”, Fourth Edition, Academic Press, Elsevier, 2019															
2. Frank H. Stephenson, “Calculations for Molecular Biology and Biotechnology” Third Edition, Academic Press, Elsevier, 2016															
3. Michael R. Green and Joseph Sambrook, “Molecular Cloning: A Laboratory Manual”, Fourth Edition, Cold Spring Laboratory Press, 2012															
4. Keith Wilson and John Walker, “Principles and Techniques of Biochemistry and Molecular Biology” 8th Edition, Cambridge University Press, 2018															
5. Alan S. Gerstein, “Molecular Biology Problem Solver-A Laboratory Guide” Wiley-Liss, Inc., 2017															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand basic techniques of DNA isolation and manipulation.													K2		
CO2: Gain experience in selecting genetically transformed organisms ford own stream analysis													K3		
CO3: Aware basic techniques involved in analysis of gene expression at nucleic acids and proteins level													K3		
CO4: Establish the ability to carryout laboratory experiments and interpret the results													K4		
CO5: Apply practical knowledge to solve biotechnological problems.													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	2	2	1	1	2	1	1	2	3	2	2
CO2	3	3	3	2	2	2	1	1	2	1	1	2	3	2	2
CO3	3	3	3	2	2	2	1	1	2	2	1	2	3	3	2
CO4	3	3	3	3	3	2	1	1	2	2	1	2	3	3	2
CO5	3	3	3	3	3	2	1	1	2	2	1	2	3	3	2

23BTP502	IMMUNOLOGY LABORATORY											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites 23BTT502 – IMMUNOLOGY															
Course Objectives: - To give practical training in the functioning of immune system - To give laboratory training in different immunological and immunotechnological techniques															
LIST OF EXPERIMENTS															
1	Animal Handling – Immunization – Bleeding techniques by Virtual methods														
2	Identification of immune cells in a blood smear and Identification of blood group														
3	Isolation of serum and plasma														
4	Testing for typhoid antigens by Widal test														
5	Immunodiffusion – SRID and Ouchterlony Double Diffusion														
6	Immunoelectrophoresis – Classical, Counter Current and Rocket														
7	Immunoelectrophoresis Enzyme Linked ImmunoSorbent Assay (ELISA) - Types														
8	Isolation of peripheral blood mononuclear cells														
9	Isolation of monocytes from blood														
10	Lymphocyte migration assay														
11	Plaque forming cell assay														
12	Identification of T cells by T-cell rosetting using sheep RBC														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Roitt I, Male, Brostoff. Immunology, Mosby Publ., 2002															
2. Kuby J, Immunology, WH Freeman & Co., 2000.															
3. Ashim K. Chakravarthy, Immunology, Tata McGraw-Hill, 1998.															
Course Outcomes:													Blooms Taxonomy		
CO1: The students would be aware of immune system cells and tissues.													K2		
CO2: The students would have knowledge on immunological /clinical tests													K3		
CO3: The students would be able to isolate lymphocytes and monocytes													K3		
CO4: The students would be able to identify various immune system cells													K4		
CO5: The students would become familiar with the techniques involved in antigen-antibody reaction.													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	2	2	1	1	1	1	1	2	3	2	2
CO2	3	3	3	2	2	2	1	1	2	2	1	2	3	3	2
CO3	3	3	3	2	2	2	1	1	2	2	1	2	3	3	2
CO4	3	3	3	2	2	2	1	1	2	2	1	2	3	3	2
CO5	3	3	3	2	2	2	1	1	2	2	1	2	3	3	2

SEMESTER VI

23BTP601	BIOINFORMATICS LAB											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites 23BTT601 – BIOINFORMATICS															
Course Objectives: - To provide a practical exposure to the bioinformatics databases, tools and software. - To select and use functions in Perl for processing sequence data.															
LIST OF EXPERIMENTS															
1	Introduction to UNIX basic commands.														
2	Perl programming and applications to Bioinformatics. a) Basic scripting. b) Regular expression c) File i/o & control statement. d) Subroutines e) String specific functions.														
3	Biological data bases and their uses a) Sequence databases b) Structure data bases														
4	Sequence Analysis a) BLAST,FASTA b) Multiple sequence alignment c) ExPASy Tools d) DOTPLOT														
5	Phylo genetic tree prediction														
6	Protein secondary structure prediction														
7	Protein tertiary structure prediction – Homology modelling and any open-source software.														
8	Lead molecule search using databases														
9	Protein-Ligand docking														
10	Protein-Protein docking														
11	ADMET modeling														
12	Gene prediction tools.														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Mount, D.W. Bioinformatics: Sequence and Genome Analysis, 2nd Ed., Cold Spring Harbor															
2. Lesk, A.M. Introduction to Bioinformatics, Oxford University Press, 2013															
3. Xiong, J. Essential Bioinformatics, Cambridge University Press, 2006															
4. Tindall, J. Beginning Perl for Bioinformatics, O'Reilly, 2001															
5. Durbin, R. et al., Biological Sequence Analysis, Cambridge University Press															
6. Bergeron, B. Bioinformatics Computing, Prentice Hall															
Course Outcomes:													Blooms Taxonomy		
CO1: Understand basic commands UNIX OS.													K2		
CO2: Apply Perl programming to develop bioinformatics tools													K3		
CO3: Retrieve and analyze sequence and structure data													K3		
CO4: Access the databases and tools used for computer aided drug designing													K4		
CO5: Compare and analyze biological sequences.													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	1	1	1	1	1	2	3	2	2
CO2	3	3	3	2	2	1	1	1	2	2	1	2	3	3	2
CO3	3	3	3	3	3	1	1	1	2	2	1	2	3	3	2
CO4	3	3	3	3	3	1	1	1	2	2	1	2	3	3	3
CO5	3	3	3	3	2	1	1	1	2	2	1	2	3	3	2

23BTP602	BIOPROCESS LABORATORY											Category: PCC			
												L	T	P	C
												0	0	3	1.5
Prerequisites 23BTT405 – INDUSTRIAL ENZYMOLOGY 23BTT501 – BIOPROCESS PRINCIPLES 23BTT602 – BIOPROCESS ENGINEERING															
Course Objectives: - To understand enzyme kinetics, immobilization, and inhibition for process applications - To perform microbial growth kinetics and calculate fermentation parameters - To optimize bioprocess conditions using statistical methods - To design, conduct, and analyze bioreactor experiments safely - To determine key process parameters like KLa, Uoverall and mixing time - To enhance teamwork and lab safety awareness through collaborative experiments															
LIST OF EXPERIMENTS															
1	Enzyme kinetics–Determination of Michaelis-Menten parameters														
2	Enzyme activity–Effect of Temperature and Deactivation Kinetics														
3	Enzyme activity–Effect of pH														
4	Enzyme inhibition kinetics														
5	Enzyme immobilization– Gel Entrapment														
6	Enzyme immobilization–Cross-linking														
7	Enzymatic conversion in Packed bed Column														
8	Growth of Bacteria–Estimation of Biomass, Calculation of Specific Growth Rate, Yield Coefficient														
9	Optimization by Plackett Burman Design														
10	Optimization by Response Surface Methodology														
11	Estimation of KLa–Dynamic by different methods														
12	Estimation of Overall Heat Transfer Coefficient and mixing time in reactor														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Butterworth-Heinemann; 3rd Edition ,2016															
2. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier, 2nd Edition,2012															
3. Michael L. Shuler, Fikret Kargi, Matthew De Lisa , Bioprocess Engineering , Prentice Hall, 3rd Edition, 2017															
4. Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, 2ndEdition. McGraw Hill , 1986															
Course Outcomes:														Blooms Taxonomy	
CO1: Explain about Enzyme kinetics and characterization and how to use them for practical applications.														K3	
CO2: Evaluate the growth kinetics of microorganisms and														K4	
CO3: Become adept with medium optimization techniques														K4	
CO4: Determine an experimental objective, understand the theory behind the experiment, and operate the relevant equipment safely.														K4	
CO5: Demonstrate good lab citizenry and the ability to work in team														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	1	1	1	2	1	1	2	3	3	2
CO2	3	3	3	3	2	1	1	1	2	2	1	2	3	3	2
CO3	3	3	3	3	2	1	1	1	2	2	1	2	3	3	2
CO4	3	3	3	3	2	2	1	1	2	2	1	2	3	3	2
CO5	2	2	2	2	2	2	2	3	3	2	2	3	2	3	2

SEMESTER VII

23BTP701	DOWNSTREAM LABORATORY											Category: PCC			
												L	T	P	C
												0	0	4	2
Prerequisites 23BTT701 – DOWNSTREAM PROCESSING															
Course Objectives: - To provide hands-on training in Downstream processing through simple experimentations in the laboratory. This will be a prerequisite for project work. - The objectives of this course are to practice for the students - To understand the nature of the end product, its concentration, stability and degree of purification required - To design processes for the recovery and subsequent purification of target biological products															
LIST OF EXPERIMENTS															
1	Solid-liquid separation– centrifugation														
2	Solid-liquid separation– microfiltration														
3	Cell disruption–ultra sonication or bead milling														
4	Protein precipitation– ammonium sulfate precipitation														
5	Aqueous Two-Phase Extraction (ATPE)														
6	Simple Distillation for Solvent Recovery or Product Concentration														
7	Thin Layer Chromatography for Product Separation														
8	Column Chromatography-Product Purification														
9	Product drying–desiccation														
10	Product purification–dialysis														
11	Adsorption Chromatography Using Activated Charcoal														
12	Crystallization of Biomolecules														
Total periods: 60 Periods															
PRACTICAL MANUAL / REFERENCE BOOKS:															
1. P.A. Belter, E.L. Cussler And Wei-Houhu – Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).															
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High Resolution Methods And Applications, VCH Pub. 1989.															
3. Michael R.Ladisch Bioseparations Engineering: Principles, practice and Economics, Wiley- Interscience, 1st Edition, 2001															
4. Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series). Butterworth – Heinmann / Elsevier, 2004															
5. Raja Ghosh “Principles of Bioseparations Engineering”. World Scientific, 2006															
Course Outcomes:													Blooms Taxonomy		
CO1: Acquired knowledge for the separation of whole cells and other insoluble ingredients from the culture broth.													K2		
CO2: Learned cell disruption techniques to release intracellular products													K3		
CO3: Learned various techniques like evaporation, extraction, precipitation and membrane separation for concentrating biological products													K4		
CO4: Learned the basic principles and techniques of chromatography to purify the biological products													K4		
CO5: Formulate the products for different end uses.													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	2	2	1	1	1	2	1	1	2	3	3	2
CO2	3	3	3	2	2	1	1	1	2	1	1	2	3	3	2
CO3	3	3	3	3	2	1	1	1	2	2	1	2	3	3	2
CO4	3	3	3	3	3	1	1	1	2	2	1	2	3	3	2
CO5	3	3	3	3	3	1	1	1	2	2	1	2	3	3	2

23BTP702	PROJECT WORK – Part A										Category: PCC				
											L	T	P	C	
											0	0	4	2	
Prerequisites 23BTP501 – MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY 23BTP502 – IMMUNOLOGY LABORATORY 23BTP601 – BIOINFORMATICS 23BTP602 – BIOPROCESS LABORATORY 23BTP701 – DOWNSTREAM PROCESSING															
Course Objectives: - Identifying research or industrial problems and formulating a feasible methodology with innovation potential. - Undertaking extensive literature surveys and preparing a structured review article on the selected problem area. - Participating in hands-on workshops or training programs related to the chosen domain to enhance technical skills relevant to the project. - Developing a proof of concept or prototype and analyzing its novelty for patent filing. - Documenting the project works effectively with emphasis on intellectual property and scholarly writing.															
COURSE DESCRIPTION: The students shall individually or in groups undertake a preliminary project work on a topic approved by the Department, aligned with their specialization in the Biotechnology programme. The chosen topic must offer scope for literature exploration, innovation, and practical application. Students are required to conduct an in-depth literature survey to identify gaps and prepare a review article in a format suitable for academic publishing. They must also participate in hands-on training sessions or workshops relevant to the selected topic to strengthen their technical competencies. Based on the knowledge acquired, students should work toward developing an innovative idea or prototype, analyze its novelty, and initiate the patent filing process, if applicable. At the end of the semester, students must submit a technical report comprising the definition of the problem, objectives, detailed literature review, documentation of hands-on/workshop experience, initial methodology, patentability assessment (if any), and the review article. Evaluation will be based on periodic reviews, the quality of the review article, patent initiation steps, interim reports, and a viva-voce conducted by a panel of examiners as per University regulations															
Total periods: 60 Periods															
Course Outcomes:													Blooms Taxonomy		
CO1: Identify relevant research/industry problems and perform a comprehensive literature review to prepare a review article.													K2		
CO2: Apply theoretical knowledge through practical exposure gained via workshops or hands-on training sessions													K3		
CO3: Design and initiate a research methodology or technical approach for solving the identified problem													K4		
CO4: Draft a review article suitable for journal submission and initiate patent documentation for innovative ideas													K4		
CO5: Demonstrate improved research aptitude and communication skills through interim presentations and technical documentation.													K4		
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	As Per the Project done by Students														
CO2															
CO3															
CO4															
CO5															

SEMESTER VIII

23BTP801	INTERNSHIP# / PROJECT WORK – Part B										Category: PCC				
											L	T	P	C	
											0	0	20	8	
Prerequisites • 23BTP501 – MOLECULAR BIOLOGY AND GENETIC ENGINEERING LABORATORY • 23BTP502 – IMMUNOLOGY LABORATORY • 23BTP601 – BIOINFORMATICS • 23BTP602 – BIOPROCESS LABORATORY • 23BTP701 – DOWNSTREAM PROCESSING • 23BTP702 - PROJECT WORK – Part A															
Course Objectives: • 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.															
COURSE DESCRIPTION: 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: 300 Periods															
Course Outcomes:												Blooms Taxonomy			
CO1: Formulate and analyze problem / create a new product/ process												K6			
CO2: Design of experiments to find solutions.												K6			
CO3: Analyze the results and provide a solution for the identified problem.												K5			
CO4: Conduct Experiments to find best Suggestion for the identified problem.												K5			
CO5: Prepare project report and make presentation												K4			
CO – PO & PSO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	As Per the Project done by Students														
CO2															
CO3															
CO4															
CO5															

PROFESSIONAL ELECTIVE I
(BIOPROCESS TECHNOLOGY)

23BTE001	BIOPROCESS CONTROL AND INSTRUMENTATION			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23BTT403 – ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY							
COURSE OBJECTIVES:							
1.	To learn about key process parameters like pH, temperature, dissolved oxygen, and aeration, and how they are measured and controlled.						
2.	Students will explore the use of computers and digital control systems for automating and optimizing bioprocesses.						
3.	Students will gain knowledge of the various instruments used in bioprocesses, their operational modes, and how they contribute to process optimization.						
4.	To gain hands-on experience in setting up, calibrating, and troubleshooting instrumentation systems used in bioprocesses.						
5.	Students will delve into control techniques, including feedback and feedforward control, and their application in bioreactors						
UNIT I		BIOCHEMICAL PROCESS VARIABLES AND THEIR MEASUREMENTS					9
Temperature, flow measurement and control, Pressure measurement and control, shaft power, rate of stirring, detection and prevention of foam, measurement of cells, measurement and control of dissolved oxygen, inlet and outlet gas analysis, pH measurement and control							
UNIT II		OPEN LOOP SYSTEMS					9
Laplace transformation, application to solve ODEs. 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.							
UNIT III		CLOSED LOOP SYSTEMS					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							
UNIT IV		FREQUENCY RESPONSE					9
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings.							
UNIT V		ADVANCED PROCESS CONTROL AND BIOSENSORS					9
Introduction to advanced control systems, cascade control, feed forward control On-line analysis of process parameters; Introduction to biosensors; Transduction principles used in biosensors; Characteristics of biosensors; Biosensors based on amperometric, potentiometric, thermistor FET, fiber optics and bioluminescence; Microbial biosensors; Fundamentals of digital process control; Use of computer in control and optimization of microbiological processes. Artificial neural networking and use in prediction of bioprocess and control							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:			BTL	POs		PSOs	
CO1:	Apply knowledge on process control principles to real-world bioprocesses.		K1	1,2,7,11,12		1,2,3	
CO2:	Develop a comprehensive understanding of controlling bioprocess plants and operations.		K2	1,2,4,6,8,11,12		1,2,3	

CO3:	Develop mathematical models of bioprocess systems and their control.	K4	1,2,4,6,7,8,11,12	1,2,3
CO4:	Design and implement various instrumentation systems for bioprocess monitoring and control.	K3	1,2,3,4,6,7,8,11,12	1,2,3
CO5:	Apply engineering principles to systems containing biological catalysts to meet the needs of the society.	K5	1,2,4,6,7,8,11,12	1,2,3

TEXT BOOKS:

1.	Stephanopoulos, G., “Chemical Process Control“, Prentice Hall of India, 2003.
2.	Coughnowr, D., “ Process Systems Analysis and Control “,. 3rd ed., McGraw Hill, 2008.
3.	Sensors in Bioprocess Control (Biotechnology and Bioprocessing Series) by John Twork , 2020

REFERENCES:

1.	Process Control Instrumentation Technology (8th Edition) by Curtis Johnson ,2008
2.	Marlin, T. E., “ Process Control “, IInd Edn, McGraw Hill, New York, 2000.
3.	Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”,IInd Edn., John Wiley, New York, 1997.

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2	PSO3
1	3	3	2	3	2	1	3	2	-	-	-	1	3	2	3
2	2	1	3	2	2	2	2	1	-	-	-	-	2	2	1
3	2	2	3	2	3	-	3	2	-	-	-	2	1	2	3
4	1	2	1	1	2	1	3	-	-	-	-	1	1	1	2
5	-	3	2	2	2	-	2	1	-	-	-	-	2	1	2
AVG	2	2.2	2.2	2	2.2	1.3	2.6	1.5	-	-	-	1.3	1.8	1.6	2.2

23BTE002	MODERN BIOANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3
PREREQUISITES:					
➤ 23BTT403 – ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY					
COURSE OBJECTIVES:					
1.	To provide scientific understanding of analytical techniques and detail interpretation of results.				
2.	Extraction of drugs from biological samples.				
3.	Separation of drugs from biological samples using different techniques				
UNIT 1	SPECTROSCOPY STUDY OF CHEMICAL COMPOUNDS AND BIO-MOLECULES				9
Electromagnetic radiations and interactions with matters: Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Absorption of radiation, BeerLambert’s law, deviation of Beer-Lambert’s equation and its limitations. Principals, instrumentation, sampling and application of few spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy.					
UNIT 2	DIFFRACTION TECHNIQUE				9
Introduction to lattice and lattice systems, Bragg’s plane, miller indices, point groups and space groups Principle of diffraction and X-ray diffraction: X-rays production, X- ray spectra, Bragg’s law and intensity of X- rays, Mosley’s law, powdered XRD, percentage crystallinity, single crystal XRD, macromolecular XRD (protein crystallization, data collection and structure solution).					
UNIT 3	CHROMATOGRAPHY				9
Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography. Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography. Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors. Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.					
UNIT 4	MICROSCOPY				9
Microscopy with light and electrons – Electrons and their interaction with the specimen – Electron, diffraction – Instrument, specimen preparation and application of TEM and SEM – Fluorescence microscopy – Laser confocal microscopy – Phase contrast – Video microscopy – Scanning probe microscopy.					
UNIT 5	ELECTROPHORETIC TECHNIQUES				9
Principle, equipment and process, Agarose gel electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules.					
TOTAL: 45 PERIODS					
COURSE OUTCOMES:		BT L	POs		PSO s
CO1:	The students will be capable of handling different instruments in the laboratory.	K1	1,2,4,7,11		1

CO2:	They would be able to compare different separation techniques and use them effectively in research work	K1	1,2,3,5,7,8,11	1,2
CO3:	Apply the principles and procedures involved in the extraction of drugs and metabolites from biological matrices using various bioanalytical methods.	K4	1,2,3,5,7,8,11	1,2,3
CO4:	Familiarity with working principals, tools and techniques of analytical techniques.	K3	1,2,4,5,7,11	1,2
CO5:	To understand the strengths, limitations and creative use of techniques for problem-solving.	K5	1,2,4,5,7,11	1,2,3

TEXT BOOKS:

1.	D. Campbell, Biological spectroscopy (Benjamin/Cummings Pub. Co, Menlo Park, Calif, 1984), Biophysical techniques series. 2. K. Wilson, J. M. Walker, Eds., Principles and techniques of biochemistry and molecular biology (Cambridge University Press, Cambridge, UK : New York, 7th ed., 2009)
2.	R. F. Boyer, Biochemistry laboratory: modern theory and techniques (Prentice Hall, Boston, 2nd ed., 2012).
3.	R. Katoch, Analytical techniques in biochemistry and molecular biology (Springer, New York, 2011).
4.	D. L. Spector, R. D. Goldman, Eds., Basic methods in microscopy: protocols and concepts from cells: a laboratory manual (Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y, 2006).
5.	R. L. Switzer, Experimental biochemistry (W. H. Freeman and Co, New York, 3rd ed., 1999).
6.	Chandler, D. and Roberson, R.W., "Bioimaging: Current Techniques in Light & Electron Microscopy", Jones and Bartlett publishers, 2008.

REFERENCES:

1.	R. F. Boyer, Modern experimental biochemistry (Benjamin Cummings, San Francisco, 3rd ed., 2000).
2.	J. R. Lakowicz, Principles of fluorescence spectroscopy (Springer, New York, 2006;
3.	B. Fultz, Transmission electron microscopy and diffractometry of materials (Springer, Berlin ; New York, 2nd ed., 2002).
4.	D. B. Williams, C. B. Carter, Transmission electron microscopy a textbook for materials science (Springer, New York, 2009
5.	R. M. Silverstein, Spectrometric identification of organic compounds (John Wiley & Sons, Hoboken, NJ, 7th ed., 2005).
6.	D. Harvey, Modern analytical chemistry (McGraw-Hill, Boston, 2000).
7.	Pavia, D.L., Lampman, G.M., Kriz, G.S. and Vyvyan, J.R., "Introduction to Spectroscopy", 4th Edition, Brooks/Cole Cengage Learning, 2008.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO2	PSO3
1	2	1	-	2		-	3	2	-	-	2	-	3		-
2	2	2	3	-	3	-	2	3	-	-	3	-	2	2	-
3	2	3	3	-	3	-	2	2	-	-	2	-	3	2	2
4	2	1	3	-	2	-	2	-	-	-	2	1	2		-
5	2	-	3		3	-	3	2	-	-	2	-	2	2	-
AV G	2	1.7	3	2	2.7	-	2.4	2.2	-	-	2.2	1	2.4	2	2

23BTE003	FOOD PROCESSING AND TECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT301 - BIOCHEMISTRY ➤ 23BTT303 – MICROBIOLOGY								
COURSE OBJECTIVES:								
1.	To know about the constituents and organoleptic characters.							
2.	To learn about the food additives, colourants and flavours in the food processing.							
3.	To gain knowledge about the microorganisms associated to food and the production of single cell protein.							
4.	To understand the types of microorganisms which spoil food and food-borne diseases.							
5.	To know different techniques used for the preservation of foods.							
UNIT 1		FOOD ENERGY AND LAWS						9
Constituents of food –carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics. National food legislation, other food legislations/authorities and their role- essential commodities act, ISI mark of BIS and Agmark, Food and Agricultural organization (FAO), World Health Organization (WHO), codex joint FAO/WHO expert committee on food additives (JECFA), World Trade Organization (WTO), International standardization (ISO) Food safety and quality management systems.								
UNIT 2		FOOD ADDITIVES						9
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants-natural and artificial; food flavours; enzymes as food processing aids.								
UNIT 3		MICROORGANISMS ASSOCIATED WITH FOOD						9
Bacteria, yeasts and molds- sources, types and species of importance in food processing and preservation; fermented foods and food chemicals, single cell protein.								
UNIT 4		FOOD BORNE DISEASES						9
Classification - food infections-bacterial and other types; food intoxications and poisonings bacterial and non bacterial ; food spoilage- factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.								
UNIT 5		FOOD PRESERVATION						9
Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning, frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	To gain fundamental knowledge about the constituents of food and organoleptic properties of food and basic idea about food chemistry and their applications.			K1	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3	
CO2:	To demonstrate the importance of additives in food biotechnology.			K1	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3	
CO3:	To attain knowledge on food microbiology.			K4	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3	
CO4:	To elaborate the effect of food spoilage and food borne diseases.			K3	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3	

CO5:	To apply their knowledge in the field of preservation.										K5	1,2,3,4,5,6,7,8,9,10,11,12			1,2,3	
TEXT BOOKS:																
1.	B. Sivasanker-Food processing and preservation, Prentice-Hall of India Pvt. Ltd. New Delhi, 2002.															
2.	George JB. Basic Food Microbiology, CBS Publishers & Distributors, 1987.															
REFERENCES:																
1.	T.P. Coultate-Food-The Chemistry of its Components, 2nd edition. Royal society, London, 1992.															
2.	W.C. Frazier and D.C. Westhoff-Food Microbiology, 4th Ed., McGraw-Hill book Co., New York.															
3.	J.M. Jay-Modern Food Microbiology, CBS Pub. New Delhi, 1987.															
CO's – PO's & PSO's Mapping:																
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2	PSO3	
1	3	2	1	2	2	1	2	1	2	3	1	2	2	2	2	
2	3	2	2	3	1	2	3	2	1	2	1	1	3	2	2	
3	3	2	3	1	1	2	1	3	3	1	2	2	2	2	2	
4	2	2	1	2	2	1	2	2	1	1	2	1	2	2	2	
5	1	2	2	2	1	1	1	2	2	1	3	1	2	2	2	
AVG	2.4	2	1.8	2	1.4	1.4	1.8	2	1.8	1.6	1.8	1.6	2.2	2	2	

23BTE004	BIOPHARMACEUTICALS AND BIOSIMILARS		L	T	P	C
			3	0	0	3
PREREQUISITES:						
➤ 23BTT302 – CELL BIOLOGY						
➤ 23BTT405 – INDUSTRIAL ENZYMOLOGY						
COURSE OBJECTIVES:						
1.	To provide strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.					
2.	To impart the knowledge of the various dosage forms and its implications in pharmaceutical technology.					
UNIT 1		INTRODUCTION				9
Drug sources – Discovery and Development phases – Drugs and Cosmetics Act and regulatory aspects – Role of patents in the drug industry – Biopharmaceutical classification system – Drug Target – Drug metabolism – Pharmacokinetics – Pharmacodynamics – Bioavailability – Bioequivalence – Toxicity studies – Pharmacogenomics.						
UNIT 2		DOSAGE FORMS				9
Classification of dosage forms – Excipients – Formulation – Tablets, Capsules, Emulsion, Suspension, Lotion, Liniments, Ointments, Cream, Paste, Suppositories, Parenterals – Pressurized dosage forms – Packaging techniques.						
UNIT 3		ADVANCED DRUG DELIVERY SYSTEMS				9
Controlled release dosage forms – Rationale – Principle and factor influencing – Design and Fabrication – Microencapsulation – Liposomes – Niosomes – Transdermal drug delivery – Ocular, Vaginal and Uterine controlled release.						
UNIT 4		BIOSIMILARS				9
Biosimilar medicine – Importance – INN nomenclature system – Key trends in biosimilar product development – Production of biosimilar products – Difficulties with biosimilar drugs – Non clinical and clinical study – Regulation and approval process – Future prospects.						
UNIT 5		CASE STUDIES ON BIOPHARMACEUTICALS				9
Erythropoietin – Insulin – Somatotropin – Interleukin – Interferon – GMCSF – Blood clotting Factors – Tissue plasminogen activator – Monoclonal antibodies and engineered antibodies.						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BT L	POs		PSOs
CO1:	Comprehend the factors influencing the bioavailability and bioequivalence of drugs.		K1	1,4,11,12		1
CO2:	Grasp the current regulatory acts and safety norms of the modern pharmaceutical industries.		K3	3,4,5,6,7,8,9,11,12		1,3
CO3:	Recognize the formulation concepts and evaluate different dosage forms to meet out the compendial requirements.		K4	1,2,3,4,9,11,12		1,2
CO4:	Acquired knowledge on novel drug delivery systems and their applications in therapeutic fields.		K3	1,2,3,4,5,6,9,11,12		1,2
CO5:	Demonstrate knowledge and understanding of current topical and newly emerging aspects of biopharmaceuticals.		K5	1,2,3,4,5,6,9,11,12		1,2,3

TEXT BOOKS:

1.	Crommelin Dwan J.A., Robert D. Sindelar and Bernd Meibohm, “Pharmaceutical Biotechnology: Fundamentals and application”, Springer, 4th Edition, 2013.
2.	Gary Walsh, “Pharmaceutical Biotechnology-Concepts and Application”, John Wiley and Sons Publishers, 1st Edition, 2007.
3.	Shein-Chung Chow, “Biosimilars: Design and Analysis of Follow-on Biologics”, CRC Press, 3rd Edition, 2013.

REFERENCES:

1.	James Swarbrick, “Encyclopedia of Pharmaceutical Technology”, CRC Press, 4th Edition, 2013.
2.	Shayne Cox Gad, “Pharmaceutical Manufacturing Handbook: Production and Processes”, Wiley, 2nd Edition, 2011.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO2	PSO3
1	1	-	-	2	-	-	-	-	-	-	1	2	2	-	-
2	-	-	2	2	2	3	1	2	3	-	2	2	3	-	3
3	1	3	1	2	-	-	-	-	2	-	2	2	2	3	-
4	2	1	3	1	2	1	2	-	2	-	2	3	2	2	-
5	1	2	1	2	2	2	-	-	3	-	3	3	3	3	3
AVG	1.2	2	1.7	1.8	2	2	1.5	2	2.5	-	2	2.4	2.4	2.6	3

23BTE005	BIOPROCESS MODELLING AND SIMULATION		L	T	P	C
			3	0	0	3
PREREQUISITES:						
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY						
➤ 23BTT501 – BIOPROCESS PRINCIPLES						
COURSE OBJECTIVES:						
1.	To understand the mathematical models in Biochemical Engineering systems.					
2.	To learn about different aspects of modelling in Bioprocess system.					
3.	To learn various techniques to solve and simulate various bioprocess models.					
UNIT 1		BASIC MODELLING PRINCIPLES				9
Introduction, definition of Modelling and simulation, different types of models, application of mathematical modelling. Fundamental laws: continuity equation, energy equation, equation of motion, transport equation, equation of state, Phase and chemical equilibrium, chemical kinetics with examples.						
UNIT 2		MATHEMATICAL MODELS FOR BIOREACTOR SYSTEMS				9
Batch reactor, CSTR isothermal with cooling/heating jacket or coil, Fed Batch reactor.						
UNIT 3		MODELLING APPROACHES FOR BIOLOGICAL SYSTEMS				9
Growth kinetic Models – structured and unstructured systems; Compartment models; Cybernetic models; Genetically structured models, Single cell models, Morphologically structured models. Thermal death kinetics models, Stochastic Model for thermal sterilization of medium.						
UNIT 4		MODELLING APPROACHES FOR BIOLOGICAL PROCESSESS				9
Modelling for activated sludge process, Model for anaerobic digestion, Model for lactic acid fermentation, antibiotic production, Ethanol fermentation.						
UNIT 5		SIMULATION OF BIOPROCESSES				9
Software packages for simulation of bioprocesses – MATLAB-SIMULINK, Creating bioprocess models in MATLAB and Simulink environment. Linear and non-linear estimation of the kinetic parameters for types and models.						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BT L	POs		PSO s
CO1:	To understand the basic modelling principles in Biochemical Engineering systems.		K1	1,2,3,4,5,7,9,10,11,12		1,2,3
CO2:	Apply the knowledge of modeling concepts for bioreactor design.		K3	1,2,3,4,5,6,7,8,9,11,12		1,2,3
CO3:	To formulate model for biological System.		K4	1,2,3,4,5,9,10,11,12		1,2,3
CO4:	To utilize modelling approaches for various bioprocess estimation.		K4	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3
CO5:	To build kinetic simulation models of the cell growth and product formation.		K5	1,2,3,4,5,6,7,8,9,10,11,12		1,2,3
TEXT BOOKS:						
1.	Luyben W.L., “Process Modeling, Simulation and control for Chemical Engineers”, McGraw Hill, 2nd Edition, 2013.					

2.	Bailey J.A and Ollis D.F., “Biochemical Engineering Fundamentals”, McGraw Hill (New York), 2nd Edition, 2010.														
3.	T.K.Ghose., “Bioprocess Computations in Biotechnology-Vol.I”, Ellis Horwood Ltd. 1989														
REFERENCES:															
1.	Perry R H ,“Perry's Chemical Engineers' Handbook”, McGraw-Hill, 8th Edition, 2008														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO2	PSO3
1	3	3	2	3	1	-	1	-	2	2	2	3	3	3	3
2	3	3	3	3	2	1	3	2	1	-	1	2	3	3	3
3	3	3	2	2	2	-	-	-	1	1	1	2	2	3	2
4	2	3	3	3	2	1	3	1	2	2	1	1	3	1	3
5	3	2	3	2	2	3	3	3	2	1	2	2	3	3	3
AVG	2.8	2.8	2.6	2.6	1.8	1.6	2.5	2	1.6	15	1.4	2	2.8	2.6	2.8

23BTE006	BIOREACTOR CONSIDERATIONS FOR RECOMBINANT PRODUCTS		L	T	P	C
			3	0	0	3
PREREQUISITES:						
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY						
➤ 23BTT503 – GENETIC ENGINEERING						
COURSE OBJECTIVES:						
1.	To expose students to application of recombinant DNA technology in biotechnological research.					
2.	To train students in strategizing research methodologies employing genetic engineering techniques.					
UNIT 1		GENETICALLY ENGINEERED ORGANISMS				9
Different host vector systems, Guidelines for choosing Host Vector systems, Process constraints – Genetic instability, considerations in plasmid design, Regulatory constraints, principles and implementation of containment, good industrial large-scale practice (GILSP).						
UNIT 2		CONSIDERATIONS FOR ANIMAL CELL CULTURES				9
Structure and biochemistry of animal cells - Methods Used for the cultivation of animal cells - Bioreactor considerations for animal cell culture - Products of animal cell cultures, economics of animal cell tissue cultures.						
UNIT 3		CONSIDERATIONS FOR PLANT CELL CULTURES				9
Overview of plant cell cultures - Plant cells in culture compared to microbes - Bioreactor considerations for plant cell culture - Bioreactors for suspension cultures - Reactors using cell immobilization - Bioreactors for organized tissues, economics of plant cell tissue cultures.						
UNIT 4		DOWNSTREAM PROCESSING CONSIDERATIONS				9
Release of protein from Biological Host, genetic approaches to facilitate protein purification, Solid Liquid separation, extraction of Recombinant protein, Avoidance of proteolysis from extracts, membranes for protein isolation and purification, Chromatographic techniques, Removal of detergent from protein fractions, precipitation of proteins, protein crystallization for large scale bio separation.						
UNIT 5		SAFETY CONSIDERATIONS ASSOCIATED WITH AGRICULTURAL AND ENVIRONMENTAL APPLICATIONS				9
Risk assessment methods, safety considerations, Application of rDNA organism in the environment, Survival, multiplication and/or dissemination in the environment, Interactions with species or biological systems, effects on the environment, evaluating environmental risks of rDNA organisms released from industrial applications.						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BT L	POs		PSO s
CO1:	To acquire skills on techniques of isolation of gene of interest and construction of recombinant DNA.		K1	1,2,3,4,5,7,9,10,11,12		1,2,3
CO2:	To apply techniques for production of pharmaceuticals, growth hormones, vaccines, gene therapy in expression system.		K3	1,2,3,4,5,6,7,8,9,11,12		1,2,3
CO3:	To apply rDNA technology in evolving plants for resistance to pest and disease, tolerance to herbicides and abiotic factors.		K3	1,2,3,4,5,6,8,9,10,11,12		1,2,3

CO4:	To identify problems associated with production of recombinant proteins and protein purification and devising strategies to overcome problem.	K4	1,3,4,5,7,9,10,11,12	1,2,3											
CO5:	To acquire knowledge on environmental applications of genetic engineering through bioremediation.	K2	1,2,3,4,5,6,7,8,9,10,11,12	1,2,3											
TEXT BOOKS:															
1.	Michael L. Shuler, Fikret Kargi, Matthew De Lisa, Bioprocess Engineering, 3rd Edition, Prentice Hall, 2017														
2.	Bailey J.A and Ollis D.F., “Biochemical Engineering Fundamentals”, McGraw Hill (New York), 2nd Edition, 2010.														
3.	Cutler, P. ed., 2004. Protein purification protocols (Vol. 244). Springer Science & Business Media.														
4.	Perry R H , “Perry's Chemical Engineers' Handbook”, McGraw-Hill, 8th Edition, 2008.														
REFERENCES:															
1.	Pörtner, R. and Barradas, O.B.J.P., 2007. Animal cell biotechnology. Methods and Protocols, 2nd. Edition. Humana														
2.	Slater, A., Scott, N. and Fowler, M., 2008. Plant biotechnology: the genetic manipulation of plants. OUP Oxford.														
3.	Pörtner, R. and Barradas, O.B.J.P., 2007. Animal cell biotechnology. Methods and Protocols, 2nd. Edition. Humana.														
4.	Slater, A., Scott, N. and Fowler, M., 2008. Plant biotechnology: the genetic manipulation of plants. OUP Oxford.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO 12	PSO 1	PSO2	PSO3
1	3	3	2	3	1	-	1	-	2	2	2	2	3	3	3
2	3	3	2	3	2	1	3	1	1	-	1	3	2	2	3
3	3	3	3	2	2	1	-	2	1	2	1	1	3	3	2
4	2	2	3	3	2	-	3	-	2	1	1	2	3	2	3
5	3	3	3	2	2	1	3	3	3	1	2	3	3	3	2
AVG	2.8	2.8	2.6	2.6	1.8	1	2.5	2	1.8	1.5	1.4	2.2	2.8	2.6	2.6

**PROFESSIONAL ELECTIVE II
(BIOSCIENCES)**

23BTE007	BIOSENSORS				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT403 – ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY								
COURSE OBJECTIVES:								
1.	To describe how bio specific interaction is used for various applications.							
2.	To compare different techniques with emphasis on selectivity and sensitivity.							
3.	To demonstrate knowledge of the general principles of sampling and manipulation of data generated by biosensors.							
4.	To apply the knowledge to identify the various types of analytical methods.							
5.	To design a system component or process to meet desired needs within realistic constraints.							
UNIT I		FUNDAMENTALS OF BIOSENSOR						9
Biosensors as functional analogs of chemoreceptors, structure and function of transducers, qualitative and quantitative sensors, sensor parameters, transduction methods-optical, calorimetric, electrochemical and piezoelectric sensors Supports and support modifications-synthetic polymers,carbon material supports, metal supports, bifunctional crosslinkers.								
UNIT II		METABOLIC SENSORS						9
Methods of enzyme immobilization-adsorption, gel entrapment, covalent coupling, crosslinking immobilization effects in biosensors, characterisation of immobilized enzymes in biosensors, effectiveness factor, enzyme loading test, Metabolic sensors-glucose, ascorbic acid, lactate sensors, determination of alcohols, sensors for phenols and amines, coupled enzyme reactors, sequence electrodes for nucleic acid , enzyme sensor for inhibitors.								
UNIT III		AFFINITY SENSORS AND REAGENTLESS SENSORS						9
Affinity sensors based on small ligands, immunosensors, immunoassay-RIA, ELISA and TELISA, piezoelectric immunosensors, optical immunosensors, electrochemical immunoassay, Biocompatibility of sensors, biomimetic sensors, bioconjugated silica nanoparticles for bioanalysis.								
UNIT IV		NOVEL BIOSENSORS						9
Surface dielectric enhancement, gold nanoparticles enhanced surface plasmon resonance ,magnetic biosensors and biochips , Quantum Dot based Biosensor, DNA and Proteinconformational changes, optical and magnetic sensors, micro and nanocantilevers, electrochemical QCM,MEMS,PCR microchamber array chip system,Detection of target DNA on a single chip.								
UNIT V		APPLICATIONS OF BIOSENSORS						9
Biosensors and diabetes management, Microfabricated biosensors and point-of-care diagnostics systems, Noninvasive biosensors in clinical analysis; Surface plasmon resonance and evanescent wave biosensors, Biosensor in cancer and HIV early diagnosis.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	To describe how bio specific interaction is used for various applications.			K2	1,2,3,4,5,7		1,2,3	
CO2:	To compare different techniques with emphasis on selectivity and sensitivity.			K3	1,3,5,6,7,12		1,3	

CO3:	To demonstrate knowledge of the general principles of sampling and manipulation of data generated by biosensors.	K4	1,2,3,4,5,7	1,2
CO4:	To apply the knowledge to identify the various types of analytical methods.	K4	1,2,3,5	1,2,3
CO5:	To design a system component or process to meet desired needs within realistic constraints.	K3	2,3,4,5,7	1,2,3

TEXT BOOKS:

1.	Frieder Schelfer and Florian Schubert Biosensors Elsevier Science Publications 1992 2.
2.	Challa Kumar Nanomaterials for Biosensors Wiley-VCH Verlag GMBH, Germany 2007.
3.	Floriner-Gabriel Banica Chemical sensors and Biosensors-Fundamentals and Applications, John-Wiley & Sons Ltd, 2012.

REFERENCES:

1.	P. N. Bartlett (Ed.) Bioelectrochemistry- Fundamentals, Experimental techniques and applications, John Wiley & Sons, England 2008.
2.	Nalwa (Ed.) Encyclopedia of Nanoscience and Nanotechnology 1 Vol. 5, 2004.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3
1	3	3	2	3	2	-	3	-	-	-	1	1	3	2	3
2	2	1	3	2	3	2	2	1	-	-	-	-	2	2	1
3	2	2	3	3	3	-	3	2	-	-	-	2	3	2	2
4	1	2	2	1	2	1	1	-	-	-	-	-	1	1	2
5	-	3	2	2	2	-	2	1	-	-	-	-	2	-	3
AV G	3	3	3	2	3	1	2	-	-	-	-	-	2	3	3

23BTE008	BIO-NANOTECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT403 – ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY								
➤ 23BTT405 – INDUSTRIAL ENZYMOLOGY								
COURSE OBJECTIVES:								
1.	To recognize the nanoscale processes and nanomaterials							
2.	To relate the structural and functional principles							
3.	To develop the protein based nanomaterials							
4.	To construct the DNA based nanomaterials							
5.	To apply the theoretical knowledge for the development of nanomedicine and nanosensors							
UNIT I		NANOSCALE PROCESSES AND NANOMATERIALS						9
Overview of nanoscale processes and characterization of nanomaterials — Physicochemical properties of nanomaterials — Concepts in nanotechnology — Natural nanomaterials –Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Polymeric nanoparticles, Buckyballs, Nanotubes)–Synthesis and assembly of nanoparticles and nanostructures using bio- derived templates.								
UNIT II		STRUCTURAL AND FUNCTIONAL PRINCIPLES OF BIONANOTECHNOLOGY						9
Biomolecular structure and stability — Protein folding — Self-assembly — Self-organization — Information-Driven nanoassembly — Biomaterials — Biomolecular motors — Traffic across membranes – Biomolecular sensing – Self-replication – Machine-phase bionanotechnology.								
UNIT III		PROTEIN-BASED NANOTECHNOLOGY						9
Overview of protein nanotechnology — Nanotechnology with S-Layer protein — Engineered nanopores — Bacteriorhodopsin and its potential — Protein assisted synthesis of metal nanoparticles – Synthesis of protein-based nanoparticles – Protein nanoparticle-hybrids – Covalent and non-covalent protein nanoparticle conjugates – Protein-carbon nanotube conjugates.								
UNIT IV		DNA-BASED NANOTECHNOLOGY						9
DNA-based nanostructures — Biomimetic fabrication of DNA based metallic nanowires and networks — Self assembling DNA structures — DNA-nanoparticle conjugates — DNA-carbon nanotube conjugates — DNA templated electronics — DNA nanostructures for mechanics and computing – DNA nanomachine.								
UNIT V		APPLICATIONS OF NANOTECHNOLOGY						9
Promising nanobiotechnologies for applications in medicine –Liposomes in nanomedicine — Therapeutic applications of nanomedicine – Nano-Sized carriers for drug delivery and drug carrier systems – Protein and peptide nanoparticles, DNA based nanoparticles, Lipid matrix nanoparticles for drug delivery — Nanobiosensors for imaging and diagnosis.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	To recognize the nanoscale processes and nanomaterials			K2	1,2,3,4,5,9		1,2,3	
CO2:	To relate the structural and functional principles			K3	1,3,5,9,12		1	
CO3:	To develop the protein based nanomaterials			K4	1,2,3,4,5,6,7,8,9		1	

CO4:	To construct the DNA based nanomaterials									K3	1,2,3,4,5,7,9			1	
CO5:	To apply the theoretical knowledge for the development of nanomedicine and nanosensors									K2	1,2,3			1	
TEXT BOOKS:															
1.	Niemeyer, C.M. and Mirkin, C.A., “Nanobiotechnology: Concepts, Applications and Perspectives”, Wiley- VCH, 2006.														
2.	Goodsell, D.S., “Bionanotechnology”, John Wiley and Sons, 2004.														
REFERENCES:															
1.	Shoseyov, O. and Levy I., “Nanobiotechnology: Bioinspired Devices and Materials of the Future”, Humana Press, 2008.														
2.	Gazit, E., and Mitraki, A., “Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology”, Imperial College Press, 2013.														
3.	Jesus M. de la Fuente and Grazu, V., “Nanobiotechnology: Inorganic Nanoparticles Vs Organic Nanoparticles” Elsevier, 2012.														
CO’s – PO’s & PSO’s Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO 2	PSO 3
1	2	1	2	1	1	1	2	2	1	2	2	2	2	1	2
2	2	-	1	2	-	-	1	1	2	1	-	-	2	-	1
3	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
4	2	2	3	2	2	1	2	2	2	2	2	2	2	2	1
5	3	1	2	1	2	2	2	2	2	3	1	2	3	2	3
AVG	3	3	3	3	3	2	3	2	3	2	3	3	3	3	3

23BTE009	STEM CELL TECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT302 – CELL BIOLOGY								
➤ 23BTT401 – MOLECULAR BIOLOGY								
COURSE OBJECTIVES:								
1.	To differentiate different types of stem cells and to characterize them							
2.	To gain knowledge on animal and plant stem cells							
3.	To develop techniques to program stem cells into specific cell types							
4.	To determine the factors affecting stem cell differentiation							
5.	To understand the role of stem cells in tissue engineering and regenerative medicine							
UNIT I		INTRODUCTION TO STEM CELLS						9
Stem cell Classification, Sources and Properties –Types of stem cells: methods of isolation, study of stem cells and their viability IPSC, embryonic stem cells, cancer stem cells. — Preservations of Stem cell. Embryonic stem cell: Isolation, Culturing, Differentiation, Properties — Adult stem cell: Isolation, Culturing, Differentiation, Trans-differentiation, Plasticity, and Properties								
UNIT II		HUMAN EMBRYONIC AND ADULT STEM CELL						9
Stem cells and their developmental potential. In vitro fertilization-culturing of embryos - blastocyst- inner cell mass-isolation and growing ES cells in lab; Identification and characterization of human ES cells. Somatic stem cells-test for identification of adult stem cells-adult stem cell differentiation- trans differentiation-plasticity-different types of adult stem cells-liver stem cells-skeletal muscle stem cells-bone marrow derived stem cells.								
UNIT III		DIFFERENTIATION OF STEM CELLS INTO CELL TYPES						9
Factors influencing cell specialization – internal factors – asymmetric segregation, cell signaling mechanisms – diffusion, direct contact and gap junctions; environmental factors – temperature, drugs and injuries; mechanism of stem cell differentiation – errors in cell differentiation – anaplasia, dysplasia and metaplasia.								
UNIT IV		STEM CELLS IN TISSUE ENGINEERING						9
Haematopoietic Stem Cells-Growth factors and the regulation of haematopoietic stem cells, clinical applications of haematopoietic stem cells; HLA matching, patient selection, peripheral blood and bone marrow transplantation; Mesenchymal stem cells and their role in bone tissue engineering- bone repair; Stem cell based gene therapy and benefits to human. Techniques in stem cell technology - fluorescence activated cell sorting (FACS), time lapse video, green fluorescent protein tagging								
UNIT V		APPLICATION AND ETHICAL ISSUES						9
Therapeutic applications-Parkinsons disease, Cancer stem cell — Neural stem cell for central nervous system repair — Spinal cord injury — use of ESC to treat heart disease — Burns and skin ulcers— Orthopaedic applications of stem cell - Insulin-producing Cells Derived from Stem cells: A Potential Treatment for Diabetes; Stem cell policy and ethics, stem cell research: Hype, hope and controversy.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:					BTL	POs		PSOs
CO1:	Differentiate different types of stem cells and to characterize them				K3	1,2,3,4,5,6,8,9,10,11,12		1,2,3

CO2:	Gain knowledge on animal and plant stem cells	K2	1,2,3,4,5,6,8,9,10,11,12	1,2,3
CO3:	Develop techniques to program stem cells into specific cell types	K3	1,2,3,4,5,6,8,9,10,11,12	1,2,3
CO4:	Determine the factors affecting stem cell differentiation	K4	1,2,3,4,5,7,9,11,12	1,2,3
CO5:	Understand the role of stem cells in tissue engineering and regenerative medicine	K2	1,2,3,4,5,8,9,10,11,12	1,2,3

TEXT BOOKS:

1.	Stem cells by C.S Potten., Elsevier, 2006
2.	Essentials of Stem Cell Biology by Robert Lanza., fourth edition. Elsevier 2014.

REFERENCES:

1.	Stem cell biology and Gene Therapy by Peter Quesenberry., First Edition, Wiley-Liss, 1998.
2.	Embryonic Stem cells — Protocols by KursadTurksen., Second Edition Humana Press, 2002.
3.	Stem Cells: From Bench to Bedside by AriffBongso, EngHinLee., World Scientific Publishing Company,2005.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3
1	3	3	3	3	3	2	2	1	3	3	3	3	3	3	2
2	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3
3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
4	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3
5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
AV G	3	3	3	3	3	3	2	2	3	3	3	3	3	3	3

23BTE010	BIOMATERIALS			L	T	P	C
				3	0	0	3
PREREQUISITES:							
➤ 23PHT206 – MATERIAL SCIENCE FOR BIOTECHNOLOGIST							
COURSE OBJECTIVES:							
1.	To study the phenomena various metals used in implant applications						
2.	To acquire knowledge importance of ceramics and polymer used biomedical diagnostics						
3.	To obtain the concept of different types biomaterials applied in-vitro and in-vivo biomedical implants						
4.	To obtain the concept of different types biomaterials and ceramic materials						
5.	To gain the knowledge about biomaterials used in various biomedical implant application						
UNIT I		INTRODUCTION					9
Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.							
UNIT II		METALLAIC IMPLANT MATERIALS					9
Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.							
UNIT III		POLYMERIC IMPLANT MATERIALS					9
Polyolefin’s, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.							
UNIT IV		CERAMIC IMPLANT MATERIALS					9
Definition of bio ceramics. Common types of bioceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Polymers Filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.							
UNIT V		TESTING OF MATERIALS					9
Biocompatibility and Toxicological screening of biomaterials: Definition of biocompatibility blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity,intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:			BTL	POs		PSOs	
CO1:	Study the phenomena various metals used in implant applications			K3	1,2,3,5,6,8,		1,3

CO2:	Acquire knowledge importance of ceramics and polymer used biomedical diagnostics	K2	1,2,3,5,6,8,	1,2
CO3:	Obtain the concept of different types biomaterials applied in-vitro and in-vivo biomedical implants	K3	1,2,3,5,6,8,9	1,3
CO4:	Obtain the concept of different types biomaterials and ceramic materials	K4	1,2,3,7,9	1,3
CO5:	Gain the knowledge about biomaterials used in various biomedical implant application	K2	1,2,3,9	1,2,3

TEXT BOOKS:

1.	Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
2.	Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2003.

REFERENCES:

1.	J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
2.	Joon park, R.S Lakes, “Biomaterials an Introduction”Springer, 2007
3.	Larry L. Hench and Julian R. Jones, Biomaterials, artificial organs and tissue engineering, CRC Press 2010

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3
1	3	2	2	-	-	3	-	-	-	1	1	-	3	-	3
2	2	3	-	1	-	2	1	3	-	-	-	-	2	1	-
3	1	-	1	-	2	2	-	1	3	-	-	1	1	-	2
4	1	2	-	2	-	3	2	1	1	-	-	-	3	-	1
5	1	2	-	1	-	3	1	2	-	-	-	-	3	2	1
AV G	2	2	1	1	1	3	2	2	1	1	1	1	3	2	3

23BTE011	PROTEIN ENGINEERING				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT503 – GENETIC ENGINEERING								
COURSE OBJECTIVES:								
1.	To analyze the various interactions in protein makeup.							
2.	To be familiar with different levels of protein structure.							
3.	To know the role of functional proteins in various field of study.							
4.	To practice the latest application of protein science in their research.							
5.	To understand the major factors for protein folding. Understand the major factors for protein folding.							
UNIT I		BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS						9
Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X- ray) and elucidation of protein structure. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).								
UNIT II		PROTEIN ARCHITECTURE						9
Primary structure: peptide mapping, peptide sequencing - automated Edman method & massspec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine Super-secondary structure: Alpha-turn-alpha, beta-turnbeta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites.								
UNIT III		TERTIARY STRUCTURE						9
Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures. Quaternary structure: Modular nature, formation of complexes. Computer exercise on the above aspects								
UNIT IV		STRUCTURE-FUNCTION RELATIONSHIP						9
DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp Repressor, Eukaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers. Membrane proteins: General characteristics, Transmembrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications. Computer exercise on the above aspects								
UNIT V		PROTEOMICS						9
Introduction to the concept of proteome, components of proteomics, proteomic analysis, importance of proteomics in biological functions, protein-protein interactions and methods to study it: protein arrays, cross linking methods, affinity methods, yeast hybrid systems and protein arrays. Computer exercise on the above aspects								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Analyze the various interactions in protein makeup.			K2	1,2,,7		1,2,3	
CO2:	Familiar with different levels of protein structure.			K3	1,3,5,6,8,12		1,3	

CO3:	Know the role of functional proteins in various field of study.	K4	1,5,6,7	1,2
CO4:	Practice the latest application of protein science in their research.	K4	1,3,4,6	1,2,3
CO5:	Understand the major factors for protein folding. Understand the major factors for protein folding.	K3	2,3,6,8,11	1,2,3

TEXT BOOKS:

1.	Branden C. and Tooze J., “Introduction to Protein Structured” 2 nd Edition, Garland Publishing, 1999.
2.	Creighton T.E. “Proteins” 2 nd Edition. W.H. Freeman, 1993.
3.	Pennington, S.R and M.J. Dunn, “Proteomics: Protein Sequence to Function”. Viva Books, 2002.
4.	Liebler, “Introduction to Proteomics” Humana Press, 2002.

REFERENCES:

1.	Voet D. and Voet G., “Biochemistry”. 3 rd Edition. John Wiley and Sons, 2008.
2.	Haggerty, Lauren M. “Protein Structure: Protein Science and Engine. Nova Science Publications, 2011.
3.	Williamson, Mike “How Proteins Work”. Garland Science, 2012.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO 3
1	3	3	2	2	2	2	3	2	2	2	2	2	3	3	3
2	3	3	3	3	3	2	2	3	-	-	2	3	2	3	3
3	3	2	2	2	3	3	2	2	-	2	1	1	2	2	2
4	3	2	3	3	2	3	2	-	1	2	1	2	3	2	3
5	2	2	3	2	3	2	3	2	2	1	2	3	2	3	3
AV G	2	3	3	2	2	3	2	3	2	1	3	2	3	3	3

23BTE012	TISSUE ENGINEERING				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT302 – CELL BIOLOGY								
COURSE OBJECTIVES:								
1.	To understand the basics of cells and cells as a therapeutic agent for various treatments							
2.	To learn the fundamentals of tissue engineering and tissue repairing							
3.	To acquire knowledge on clinical applications of tissue engineering							
4.	To understand the basic concept behind tissue engineering focusing on the stem cells							
5.	To study the biomaterials and its applications							
UNIT I		INTRODUCTION						9
Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics ,appearance, cellular component, ECM component, mechanical measurements and physical properties								
UNIT II		TISSUE ARCHITECTURE						9
Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix& Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.								
UNIT III		BIOMATERIALS						9
Biomaterials: Properties of biomaterials ,Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials, Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology..								
UNIT IV		BASIC BIOLOGY OF STEM CELLS						9
Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation,Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pluripotent stem cells.								
UNIT V		CLINICAL APPLICATIONS						9
Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenerative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedicapplications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products, ethical issues.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs		PSOs	
CO1:	Ability to understand the therapeutic application of cells			K2	1,2,3,4,5,7		3	
CO2:	Ability to understand the components of the tissue architecture			K4	1,2,3,4		1,2	
CO3:	Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine			K4	1,2,3,4,5,7,1 1		1	

CO4:	Awareness about the properties and broad applications of biomaterials	K3	2,3,5,6	1,2
CO5:	Overall exposure to the role of tissue engineering and stem cell therapy	K3	1,4,6,8,12	1,2,3

TEXT BOOKS:

1.	Bernhard O.Palsson, Sangeeta N.Bhatia, "Tissue Engineering" Pearson Publishers 2009
2.	Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009.

REFERENCES:

1.	Bernard N. Kennedy (editor). Stem cell transplantation, Tissue engineering, and cancer applications, Nova Science Publishers, 2008.
2.	Raphael Gorodetsky, Richard Schäfer.Stem cell-based tissue repair. RSC Publishing, 2011
3.	R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, Handbook of Stem Cells, Two
4	Volume, Volume 1-2: Volume 1-Embryonic Stem Cells; Volume 2-Adult & Fetal Stem Cells, Academic Press, 2004.
5	R. Lanza, J. Gearhart, B. Hogan, D. Melton, R. Pedersen, E. .l Thomas, J. Thomson, I. W.Gearhart, Essential of Stem Cell Biology, Elsevier Academic Press, 2nd Edition , 2009.
6	J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine" Artech House, INC Publications, 2008.
7	Naggy N. Habib, M.Y. Levicar, , L. G. Jiao.,and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press, 2007.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	P O 11	PO 12	PSO 1	PSO2	PSO 3
1	1	1	2	3	-	2	-	-	-	-	-	3	3	1	3
2	3	3	3	3	2	2	-	2	-	-	-	2	3	3	2
3	3	3	3	2	3	2	3	2	-	-	-	3	3	2	1
4	2	3	3	2	3	3	2	2	1	-	-	2	3	3	1
5	3	1	2	3	1	3	1	3	-	-	2	3	3	3	3
AV G	2.4	2.2	2.6	2.6	1.8	2.4	1.2	1.8	0.2	0	0.4	2.6	3	2.4	2

**PROFESSIONAL ELECTIVE III
(BIOCHEMICAL ENGINEERING)**

23BTE013	MASS TRANSFER OPERATIONS				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT402 – FLUID FLOW AND HEAT TRANSFER OPERATIONS								
COURSE OBJECTIVES:								
1.	To define the principles of adsorption, absorption, leaching and drying extraction, distillation crystallization operations.							
2.	To begin the concept of membrane separation process and develop skills of the students in the area of mass transfer operations							
3.	To study the principles of mass transfer and their application to separation and purification processes.							
4.	To understand the principles and concepts of industrial distillation equipment's							
UNIT I		DIFFUSION AND MASS TRANSFER						9
Molecular diffusion in fluids and solids; Interphase Mass Transfer; Mass Transfer coefficients; Analogies in Transport Phenomenon.								
UNIT II		GAS LIQUID OPERATIONS						9
Principles of gas absorption; Single and Multi component absorption; Absorption with Chemical Reaction; Design principles of absorbers; Industrial absorbers; HTU, NTU concepts.								
UNIT III		VAPOUR LIQUID OPERATIONS						9
V-L Equilibria; Simple, Steam and Flash Distillation; Continuous distillation; McCABE-THIELE & ONCHON-SAVARIT Principles; Industrial distillation equipments, HETP, HTU and NTU concepts.								
UNIT IV		EXTRACTION OPERATIONS						9
L-L equilibria, Staged and continuous extraction, Solid-liquid equilibria, Leaching Principles.								
UNIT V		SOLID FLUID OPERATIONS						9
Adsorption equilibria – Batch and fixed bed adsorption; Drying-Mechanism-Drying curves- Time of Drying; Batch and continuous dryers.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	To recognize and apply analogies among momentum, heat and mass transfer in various types of mass transfer operations.			K3	1,4,7		1	
CO2:	To investigate gas -liquid, vapour-liquid, solid-liquid and liquid-liquid equilibrium in mass transfer operations			K2	3,5,8,11		1, 2	
CO3:	To employ the engineering correlations of diffusion and mass transfer coefficients to model a separation process			K4	1,5		1	
CO4:	To demonstrate a multi-stage equilibrium separation process.			K3	3		1	
CO5:	To apply the knowledge on downstream processing and attain the desired products by mass transfer operations			K5	3,7		2	
TEXT BOOKS:								
1.	Treybal R.E. Mass Transfer Operations.IIIrd edition. Mcgraw Hill, 2017.							

2.	Kiran D.Patil Principles of Mass transfer Operations , 6th edition, Nirali Prakashan publisher,2017														
REFERENCES:															
1.	Binay K. Dutta Principles of Mass Transfer and Separation Processes, rentice Hall India publisher,2006														
2.	Geankoplis C.J. Transport Processes and Unit Operations. III rd edition, Prentice Hall of India, 1993.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PS O3
1	2	-	-	2			3	2	-	1	2	-	3	-	-
2	2	-	3	-	3		-	3	-	-	3		2	2	
3	3	-	-	-	3	2	2	2	1	-	2		3	2	2
4	-	-	3	-	2		2	-	-	2		1	2		
5	2	-	3	-			3	2	-	-	2	2		2	
AV G	2. 25	-	3	2	2.6	2	2. 5	2.2 5	1	1.5	2.25	1.5	2.5	2	2

23BTE014	TRANSPORT PHENOMENA IN BIOLOGICAL SYSTEM				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT304 - BIOCHEMICAL THERMODYNAMICS ➤ 23BTT402 – FLUID FLOW AND HEAT TRANSFER OPERATIONS								
COURSE OBJECTIVES:								
1.	To understand the transport phenomena in biological system							
2.	To understand the fluid motion and momentum exchange between fluid particles and solid boundaries							
3.	To understand and quantify energy fluxes at surfaces for different heat sources							
4.	To understand the diffusion with homeogeneous and heterogenous chemical reaction							
5.	To gain indepth knowledge in transport principles in diverse applications of chemical, biological, and materials science and engineering.							
UNIT I		TRANSPORT PHENOMENA BY MOLECULAR MOTION						9
Vectors/Tensors, Newton’s law of viscosity, Newtonian & Non-Newtonian fluids, rheological models, Temperature, pressure and composition dependence of viscosity, Kinetic theory of viscosity, Fourier’s law of heat conduction, Temperature, pressure and composition dependence of thermal conductivity, Kinetic theory of thermal conductivity, Fick’s law of diffusion, Temperature, pressure and composition dependence of diffusivity, Kinetic theory of diffusivity..								
UNIT II		MOMENTUM TRANSPORT						9
Shell Momentum balances, boundary conditions, velocity profiles, average velocity, momentum flux at the surfaces, of Newtonian and non-Newtonian for flow of a falling film, flow through circular tube, slits, flow through an Annulus, Adjacent flow of two Immiscible fluids. Equations of Change (Isothermal), equation of continuity, equation of motion, equation of energy (isothermal) their applications in fluid flow problems.								
UNIT III		HEAT TRANSPORT						9
Shell energy balances, boundary conditions, temperature profiles, average temperature, energy fluxes at surfaces for different types of heat sources such as electrical, nuclear viscous and chemical, Equations ofchange (non-isothermal), equation of motion for forced and free convection, equationof energy (non-isothermal).								
UNIT IV		MASS TRANSPORT						9
Shell mass balances, boundary conditions, concentration profiles, average concentration, mass flux at surfaces for Diffusion through stagnant gas film, Diffusion with homogeneous and heterogeneous chemical reaction, Diffusion in to a falling liquid film, Diffusion and chemical reaction in porous catalystand the effectiveness factor, equation of continuity for binary mixtures, equation of change to set updiffusion problems for simultaneous heat and mass transfer.								
UNIT V		TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW						9
Turbulence phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow over flat								

surface. Introduction to macroscopic balances for isothermal flow systems, non isothermal systems and multi component systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:		BT L	POs	PSOs
CO1:	Employ shell balance equations to obtain desired profiles for velocity, temperature and concentration.	K3	1,4,7	1
CO2:	Reduce and solve the appropriate equations of change to obtain desired profiles for velocity, temperature and concentration.	K2	3,5,8,11	2
CO3:	Reduce and solve appropriate macroscopic balances for conservation of momentum, energy and mass.	K4	1,5	1
CO4:	Utilize information obtained from solutions of the balance equations to obtain engineering quantities of interest.	K4	3	1
CO5:	Recognize and apply analogies among momentum, heat and mass transfer.	K5	3,7	2

TEXT BOOKS:

1.	R. B. Bird, W.E. Stewart, E.W. Lightfoot, Transport Phenomena, Revised 2nd Edition, John Wiley, 2021
2.	Robert, S Brodkey, Harry C. Hershey, "Transport Phenomena A Unified Approach", Brodkey Publishing 2003.

REFERENCES:

1.	C. J. Geankoplis, Transport Processes and Separation Process Principles, Pearson publishers., 4th Edition, 2013
2.	C. O. Bennett, J. O. Myers, Momentum, Heat and Mass Transfer, 2nd International Student Edition Mc-Graw Hill, 1983.
3.	R. Welty, R.W. Wilson, and C.W. Wicks, Rorer G.E, Wilson R.W. "Fundamentals of Momentum Heat and Mass Transfer", 5th Edition, John Wiley, New York, 2007.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO 1	P S O 2	PSO3
0	2	-	-	2	-	-	3	2	-	1	2	-	3	-	-
2	2	-	3	-	3	-	-	3	-	-	3	-	2	2	-
3	3	-	-	-	3	2	2	2	1	-	2	-	3	2	2
4	-	-	3	-	2	-	2	-	-	2	-	1	2	-	-
5	2	-	3	-	-	-	3	2	-	-	2	2	-	2	-
AV G	2.3	-	3.0	2.0	2.7	2.0	2.5	2.3	1.0	1.5	2.3	1.5	2.5	2.0	2.0

23BTE015	BIOENERGY AND BIOFUEL				L	T	P	C
						3	0	0
PREREQUISITES:								
➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY								
COURSE OBJECTIVES:								
1.	To understand the concepts and importance of cellulosic biomass							
2.	To gain knowledge on production of bioethanol							
3.	To understand the chemistry and production process of biodiesel							
4.	To understand the production of other biofuels like biobutanol, biopropanol and bioglycerol							
5.	To gain knowledge on applications of biofuels							
UNIT I		INTRODUCTION					9	
Cellulosic Biomass availability and its contents. Lignocellulose as a chemical resource. Physical and chemical pretreatment of lignocellulosic biomass. Cellulases and lignin degrading enzymes.								
UNIT II		ETHANOL					9	
Ethanol as transportation fuel and additive; bioethanol production from carbohydrates; engineering strains for ethanol production from variety of carbon sources to improved productivity.								
UNIT III		BIODIESEL					9	
Chemistry and Production Processes; Vegetable oils and chemically processed biofuels; Biodiesel composition and production processes; Biodiesel economics; Energetics of biodiesel production and effects on greenhouse gas emissions Expanding biodiesel production.								
UNIT IV		OTHER BIOFUELS					9	
Biodiesel from microalgae and microbes; biohydrogen production; biorefinery concepts Biobutanol, Biopropanol, bioglycerol – Principles,materials and feedstocks-Process technologies and techniques-Advantages and Limitations.								
UNIT V		APPLICATIONS OF BIOFUELS					9	
Life cycle environmental impacts of biofuels and co products – Environmental sustainability of biofuels – Energy security and supply,Economic sustainability of biofuels.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:			BT L	POs	PSOs			
CO1:	Determine the important properties of biomass		K3	2,3,7	2			
CO2:	Produce solutions to real world problems related to bioenergy		K2	2,3,4,5	2			
CO3:	Analyse bioenergy systems and their potential in future energy supply.		K4	1,2,3,4,5	1,2			
CO4:	Use of biomass an inexpensive feedstock as sustainable and renewable energy.		K3	1	3			

CO5:	Replace fossil-based products with biodiesel.	K3	1,2,3	3

TEXT BOOKS:

1.	Gupta. V. K. and TUOHY. M. g. Biofuel Technologies, Springer, 2013.
2.	Luque, R., Campelo, J. and Clark, J. Handbook of biofuels production, Woodhead Publishing Limited 2011.
3.	Moheimani, N. R., Boer, M, P, M, K, Parisa A. and Bahri, Biofuel and Biorefinery Technologies, Volume 2, Springer, 2015.

REFERENCES:

1.	Lee, Sunggyu; Shah, Y.T. “Biofuels and Bioenergy”. CRC / Taylor & Francis, 2013.
2.	Eckert, C, A. and Trinh, C, T. Biotechnology for Biofuel Production and Optimization, Elsevier, 2016.
3.	Bernardes, M, A, D, S. Biofuel production – recent developments and prospects, InTech, 2011.

CO's – PO's & PSO's Mapping:

CO	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	PSO3
1	2	3	3	2	2	-	3	-	-	-	1	1	2	3	2
2	2	3	3	3	3	-	2	1	-	-	-	-	2	2	1
3	3	3	3	3	3	-	2	2	-	-	2	-	2	3	1
4	3	2	2	2	2	-	1	-	-	-	-	-	1	1	3
5	2	2	2	2	2	-	-	-	-	-	-	-	-	2	2
AVG	2.4	2.6	2.6	2.4	2.4	-	2	1.5	-	-	1.5	1	1.75	2.2	1.8

23BTE016	ENVIRONMENTAL BIOTECHNOLOGY			L	T	P	C
				3	0	3	9
PREREQUISITES:							
➤ 23GET401 – ENVIRONMENTAL SCIENCE AND SUSTAINABILITY							
COURSE OBJECTIVES:							
1.	To understand the various biodegradation processes.						
2.	To gain in-depth knowledge of microbial metabolism in wastewater treatment.						
3.	To cultivate the ability to analyse the overview of aerobic and anaerobic microorganisms						
4.	To understand the treatment strategies for air pollution and solid waste management						
5.	To students will learn about product development from various renewable sources						
UNIT I		BIODEGRADATION					9
Aerobic degradation of aliphatic and aromatic compounds – Co-metabolic degradation of organopollutants – Anaerobic degradation of aromatic compounds, halogenated organics and sulfonates – Biodegradation of herbicides and pesticides –Biodesulphurization of coal and oil – Bioleaching, bioprecipitation, bioaccumulation and biosorption of heavy metals							
UNIT II		MICROBIAL METABOLISM IN WASTEWATER TREATMENT					9
Decomposition of organic compounds in natural and manmade ecosystems – Mass and energy balance for aerobic and anaerobic reactions – Hydrolysis of biopolymers by aerobic and anaerobic microorganisms – Anaerobic degradation of carbohydrates, proteins, fats and lipids – Nitrogen removal – Ammonification, nitrification, denitrification, anaerobic ammonia oxidation – Enhanced biological phosphorus removal							
UNIT III		BIOLOGICAL TREATMENT OF WASTEWATER					9
Physico-chemical characteristics of wastewater – Overview of aerobic and anaerobic treatment processes – Process design of aerobic and anaerobic system – Activated sludge process – Trickling filter – Rotating biological contactors – Fluidized bed reactor – Upflow anaerobic sludge blanket reactor (UASB) – Membrane bioreactors – Algal photosynthesis in wastewater treatment							
UNIT IV		BIOTECHNOLOGY FOR AIR POLLUTION AND SOLID WASTE MANAGEMENT					9
Air pollution control and treatment strategies – Biotechnology for treating air pollutants – Biofilters and Bioscrubbers – Biotechnology for the management of agricultural, plastic, dairy, paper and pulp, textile, leather, hospital and pharmaceutical industrial wastes.							
UNIT V		BIOPRODUCTS FROM RENEWABLE SOURCES					9
Overview of renewable sources – Production of biocompost and vermicompost – Production of biofertilizers and biopesticides – Production of biomethane, bioethanol, biohydrogen, biodiesel – Production of bioplastics and biopolymers – Bioelectricity generation and value added products from renewable sources.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BT L	POs		PSOs
CO1:	To know the importance of biodegradation			K3	3,5		1,2
CO2:	To recognise the microbial processes for the treatment of wastewater development • Identify the pathways and therapeutic targets of cancer			K2	1,5,9		-

CO3:	To develop the various biological processes for wastewater treatment	K4	1,2,3,9	1,2
CO4:	To integrate the biotechnology concepts for the control of air pollution	K3	1,2,3,5	1
CO5:	To apply the knowledge for the development of bioproducts from renewable sources	K4	1,2,3,4,5,9,11, 12	1,2

TEXT BOOKS:

1.	Jordening, H.J. and Winter, J., “Environmental Biotechnology: Concepts and Application”, Wiley-VCH Verlag GmbH & Co., 2005.
2.	Evans, G.G. and Furlong, J., Environmental Biotechnology: Theory and Application, 2nd Edition, John Wiley & Sons, 2011.

REFERENCES:

1.	Henze, M., Harremoes, P., Jansen, J.C. and Arvin, E., “Wastewater Treatment: Biological and Chemical Processes”, 2nd Edition, Springer, 2013.
2.	Zarook, S. and Ajay, S., Biotechnology for Odor and Air Pollution Control, Springer, 2005.
3.	Wong J.W-C., Tyagi R.D., and Pandey. A., “Current Developments in Biotechnology and Bioengineering Solid waste” Elsevier, 2016.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PS O3
1	1	-	2	-	1	-	2	2	-	-	-	1	2	-	1
2	2	2	3	1	2	-	2	3	3	2	-	2	3	2	1
3	3	3	3	3	3	2	2	2	2	2	3	3	3	3	3
4	3	2	2	2	2	2	2	2	2	1	2	2	3	2	2
5	3	3	3	3	2	2	3	2	3	1	3	2	2	3	3
AV G	2.4	2.5	2.6	2.2	2	2	2.2	2.2	2.5	1.5	2.6	2	2.6	2.5	2

23BTE017	APPLIED CHEMICAL REACTION ENGINEERING			L	T	P	C
				3	0	0	3
PREREQUISITES:							
➤ 23BTT404 – CHEMICAL PROCESS CALCULATIONS IN BIOTECHNOLOGY							
COURSE OBJECTIVES:							
1.	To provide the basic concepts of types of reactions, variable affecting the rate of reaction, predicting the rate equations for different types of reactions.						
2.	To provide the information about different reactor systems, deriving the performance						
3.	Equations and predicting the rate equations in chemical reaction engineering system						
4.	To understand the process of gas-solid, gas-liquid reactions						
5.	To gain knowledge on fixed bed and fluid bed reactors						
UNIT I		SCOPE OF CHEMICAL KINETICS & CHEMICAL REACTION ENGINEERING					9
Broad outline of chemical reactors; rate equations; concentration and temperature dependence; development of rate equations for different homogeneous reactions. Industrial scale reactors							
UNIT II		IDEAL REACTORS					9
Isothermal batch, flow, semi-batch reactors; performance equations for single reactors; multiple reactor systems; multiple reactions.							
UNIT III		NON IDEAL REACTORS					9
RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow.							
UNIT IV		GAS-SOLID, GAS-LIQUID REACTIONS					9
Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.							
UNIT V		FIXED BED AND FLUID BED REACTORS					9
G/L reactions on solid catalysis; trickle bed, slurry reactors; three phase-fluidized beds; reactors for fluid-fluid reactions; tank reactors							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BT L	POs	PSOs	
CO1:	To design and conduct an experimental investigation in order to determine rate equations			K4	1,4,7	1	
CO2:	To demonstrate an ability to solve material and energy balances in order to analyze the performance of a reactor			K3	3,5,8	1,2	
CO3:	To demonstrate an experimental data using standard statistical methods to establish quantitative results.			K5	1,5	1,3	
CO4:	To design a reactor for biobased products to achieve production and yield specifications.			K4	3,5,7,10	2	
CO5:	To recognize and apply analogies among momentum, heat and mass transfer in various types of chemical reactions.			K4	1,4,7,11	2	
TEXT BOOKS:							
1.	Levenspiel O. Chemical Reaction Engineering. IIIrd Edition. John Wiley.2006.						
2.	Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002Fogler H.S. Elements Of Chemical Reaction Engineering. Prentice Hall India.2002						
REFERENCES:							

1.	K.A.Gavhane Chemical Reaction Engineering I, Nirali Publications 23rd Edition,2016
2.	K.A.Gavhane Chemical Reaction Engineering II, Nirali Publications 25rd Edition,2014
3.	Dawande, S.D., “Principles of Reaction Engineering”, Ist Edition, Central Techno Publications, 2001.
4.	Richardson, J.F. and Peacock, D.G., “Coulson Richardson - Chemical Engineering”, Vol.III, IIIrd Edition, Butterworth- Heinemann- Elsevier, 2006.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	-	-	2	-	-	3	2		1	2	-	3	-	-
2	2	-	3	-	3	-	-	3	-	-	3	-	2	2	-
3	3	-	-	-	3	2	2	2	1	-	2		3	2	2
4		-	3		2		2			2		1	2		
5	2		3				3	2			2	2		2	
AVG	2.25		3	2	2.6	2	2.5	2.2	1	1.5	2.2	1.5	2.5	2	2

23BTE018	BIOTECHNOLOGICAL APPROACH IN CROP IMPROVEMENT				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT401 – MOLECULAR BIOLOGY ➤ 23BTT503 – GENETIC ENGINEERING								
COURSE OBJECTIVES:								
1.	To understand the structure, function and evolutionary history of plant genomes.							
2.	To improve crop through genetic manipulation and other advanced techniques.							
3.	To gain in-depth knowledge of molecular markers and analyzing genetic diversity of crops							
4.	Molecular markers to identify and DNA variations to improve breeding strategies							
5.	To understand the production of transgenic plants in various field crops							
UNIT I		PLANT GENOME ORGANIZATION						9
Features of plant chromosomes: centromere, telomere, euchromatin, heterochromatin and nucleolus organizing region (NOR); karyotype (asymmetric and symmetric). C-value paradox, range of interspecific and intraspecific variation, origin of quantitative DNA variation. Estimation of various components of higher-plant genome: highly repetitive sequences, middle repetitive sequences, and unique DNA sequences. Rice and maize genome sequencing projects; cereal genome databases.								
UNIT II		BIOTECHNOLOGICAL APPROACH FOR CROP IMPROVEMENT						9
Biotechnological approaches for disease resistance, protection against fungal pathogens and drought tolerance. Modification of crop-plant nutritional content (vitamins, amino acids and lipids). Modification of crop-plant taste and appearance (sweetness, starch and preventing discoloration). Polyploidy: induction of polyploidy by artificial methods; role of polyploidy in crop improvement								
UNIT III		MOLECULAR MARKERS AND CROP IMPROVEMENT						9
Types of molecular markers used in analyzing genetic diversity for crop improvement; molecular mapping and tagging of agronomically important traits. Molecular cytogenetic markers: FISH and GISH, their application in crop improvement. Transposable elements: mechanism of action and their role in crop improvement. Quantitative trait loci (QTL) mapping: introduction, types of mapping populations; role in crop improvement								
UNIT IV		APPLICATION OF MOLECULAR MARKERS						9
Construction of molecular maps (using F2, DH, RILs); gene tagging using bulked segregant analysis (BSA) and near isogenic lines (NILs); QTL analysis; map-based cloning of genes; elementary idea of marker-assisted selection (MAS) in plant breeding								
UNIT V		PRODUCTION OF TRANSGENIC PLANTS IN VARIOUS FIELD CROPS						9
cotton, wheat, maize, rice, soybean, oilseeds, sugarcane etc. Commercial releases. Biotechnology applications in male sterility/hybrid breeding, molecularfarming. MOs and related issues (risk and regulations); GMO; International regulations, biosafety issues of GMOs; Regulatory procedures in major countries including India, ethical, legal and social issues; Intellectual property rights. Bioinformatics & Bioinformatics tools. Nanotechnology and its applications in crop improvement programmes.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs	PSOs		

CO1:	The crops produced need to increase with ever increasing population. Conventional methods for crop improvement are not able to deliver fully. Therefore, high use of throughput technologies is need of the hour.	K3	1,2,3,4	1,2
CO2:	This course is intended to give some idea to students how crop plants can be improved quantitatively and qualitatively using biotechnological approaches	K2	3,4	3
CO3:	Students are able to understand plant genome organization.	K4	2,3,4,7	1,2,3
CO4:	To acquaint students with recent techniques for crop improvement	K3	1,2,3,4	1,2
CO5:	Application of molecular markers for crop improvement	K3	1,3,5,11	3

TEXT BOOKS:

1.	Abelson, P. H. (1984). Biotechnology and Biological Frontiers. American Association for the Advancement of Science, Washington, U.S.A.
2.	Ammirato, P. V., Evans, P. V., Evans, D. A., Sharp, W. R. and Yamada, Y. (Eds.) (1984). Handbook of Plant Cell Culture. Vols. 1, 2 & 3. MacMillan Publish
3.	Dodds, J. H. and Roberts, L. W. (1985). Experiments in Plant Tissue Culture. Cambridge University Press, Camb
4.	Mantell, S. H. and Smith, H. (Eds.) (1983). Plant Biotechnology. Cambridge University Press, Cambridg
5.	Swaminathan, M. S. (1991). Biotechnology in Agriculture – A dialogue. MacMillan India, New D
6.	Gupta, P. K. (2004). Biotechnology and Genomics. Rastogi Publications, Meerut
7.	Kung, S. and Arntzen, C. J. (Eds.). (1989). Plant Biotechnology. Butterworth, Boston
8.	Grierson D (Ed.). (1991). Plant Genetic Engineering: Plant Biotechnology Series, Volume I. Block

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	P O 11	P O 12	PSO 1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AV G	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

**PROFESSIONAL ELECTIVE IV
(ANIMAL BIOTECHNOLOGY)**

23BTE019	FUNDAMENTALS OF ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3
PREREQUISITES:					
➤ 23BTT302 – CELL BIOLOGY					
➤ 23BTT303 – MICROBIOLOGY					
COURSE OBJECTIVES:					
1.	To provide the fundamentals of animal cell culture, details of the diseases and therapy.				
2.	To offer the knowledge about the in-vitro fertilization, reproduction micromanipulation and transgenic animals.				
3.	To explore and gain knowledge and hands-on experience in the genetic engineering and molecular techniques.				
4.	To development of transgenic animals and applications of genetically modified animal.				
5.	To students will be able to understand the research and development activity particularly focusing on the agriculture product, therapeutic protein production and disease prevention.				
UNIT I		ORIGIN AND EVOLUTION OF LIFE			9
Theories of the origin of life, early earth, modern self-assembly theories, Oparin Haldane theory of chemical evolution, The Miller Urey experiment, Organic evolution, Development of evolution theory, Darwin’s theory, Origin and evolution of human being.					
UNIT II		ANIMAL DIVERSITY			9
Basis of classification, levels of organization (Symmetry, diploblastic and triploblastic organization), Coelom, segmentation, Notochord. The nature of natural selection, Examples of natural selection, levels of selection, selection of organisms and groups, species selection.					
UNIT III		STRUCTURAL ORGANIZATION AND CELL CULTURE TECHNIQUES			9
Animals Tissues: Epithelial Tissue, connective Tissue, Muscle Tissue, Neural Tissue. Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture- monolayer culture, suspension culture.					
UNIT IV		MICROMANIPULATION OF EMBRYOS			9
What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.					
UNIT V		TRANSGENIC ANIMALS			9
Concepts of transgenic animal technology; strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals.					
TOTAL: 45 PERIODS					
COURSE OUTCOMES:			BT L	POs	PSOs
CO1:	Understand the evolution of life and animal diversity.		K3	1,2,3,4,5,7	1,2
CO2:	Understand the animal cell culture.		K2	1,3,4,7,12	2
CO3:	Know the concepts of micromanipulation technology and transgenic animal technology.		K4	1,2,3,4,7,11	3

CO4:	Develop proficiency in PCR, DNA sequencing, cloning, and hybridoma technology.	K3	1,2,3,4,5	1,2
CO5:	Learn how genetic modifications are used in animal breeding, disease resistance, and pharmaceutical production. Explore ethical concerns and legal regulations surrounding animal biotechnology.	K3	1,2,3,5,11,12	3

TEXT BOOKS:

1.	Ashish S. Verma and Anchal Singh (Ed). Animal Biotechnology Models in Discovery and Translation. Academic Press (Elsevier) 2014, p-1-79.
2.	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.
3.	Hansjörg Hauser, Roland Wagner (Eds.) Animal Cell Biotechnology. 2014. p1-719, ISBN 978-3-11-027886-6.

REFERENCES:

1.	Sue Dallas, Emily Jewell. Animal Biology and Care Wiley-Blackwell; 3rd edition.
2.	Franklin Shull A, George R. Larue, Alexander G. Ruthven. Principles of animal biology. Mc GrawHill agricultural and Biological publications.
3.	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23BTE020	ANIMAL HEALTH AND NUTRITION				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT502 - IMMUNOLOGY								
COURSE OBJECTIVES:								
1.	To provide the basic nutritional requirements for laboratory animals.							
2.	To gain knowledge about the animal health management and its behavior.							
3.	To study essential nutrients, feed formulation, and dietary requirements for different species.							
4.	To learn about the biological systems of animals, including digestion, metabolism, and immune responses.							
5.	To understand about ethical and sustainable practices in livestock management and food production.							
UNIT I		BASIC NUTRITIONAL REQUIREMENTS AND FEEDING						9
Nutritional requirements for rat, Mice, guinea pigs, rabbit. Types of diets: Natural, semi synthetic and synthetic. Feeding of water, nutritions to kids, young adults, mature adults. Significance of carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins.								
UNIT II		ANIMAL HEALTH AND DISEASE MANAGEMENT						9
Bacterial and viral diseases in animals like rat, Mice, guinea pigs, rabbit, monkeys and horse-Type of diseases, Symptoms, causative agent, colonization and disease transmission. Control of parasites.								
UNIT III		ANIMALDISEASE DIAGNOSIS						9
Monoclonal antibodies and their use in diagnosis; Antigen-antibody based diagnostic assays including radioimmunoassay and enzyme immunoassays; Immunoblotting; Nucleic acid based diagnostic methods including nucleic acid probe hybridization; Restriction endonuclease analysis; PCR, Real time PCR; Nucleic acid sequencing; Probiotics.								
UNIT IV		ANIMALVACCINES AND THERAPEUTICS						9
Introduction to the concept of vaccines; Conventional methods of vaccine production; Recombinant approaches to vaccine production; Recombinant cytokines and their use in the treatment of animal infections; monoclonal antibodies in therapy; gene therapy for animal diseases.								
UNIT V		ANIMAL BEHAVIOR IN EXPERIMENTAL RESEARCH						9
Types of behavior, Behavioral observation of Mice, guinea pigs, rabbit. neuroscience research, chicken welfare, Spatial behavior, rat social behavior, zebrafish studies. Livestock and wild life summary data sheet.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs		PSOs	
CO1:	Understand the basic nutritional requirements.			K3	1,2,3,4,5,7		1,2	
CO2:	Understand the feeding strategy for livestock animals.			K2	1,3,4,7,12		2	
CO3:	Know the various diseases and its diagnostic methods.			K4	1,2,3,4,7,11		3	
CO4:	Know the concepts of therapeutic methods.			K3	1,2,3,4,5		1,2	
CO5:	Understand the behavior of animal on experiments.			K3	1,2,3,5,11,12		3	

TEXT BOOKS:															
1.	Gita Cherian. A Guide to the Principles of Animal Nutrition. 2019. Oregon state university Press. ISBN. 978-1-955101-12-7.														
2.	Guoyao Wu. Principles of Animal Nutrition. ISBN 9781032095998. CRC Press, 2021, p1-800.														
3.	Tanmoy Rana. Microbiomes in Animal Nutrition, Health, and Disease. Nova Publisher, 2025, p1-414.														
REFERENCES:															
1.	Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002.														
2.	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.														
3.	Zipser B, Schleking A, Kaiser S, Sachser, N. 2014. Effects of domestication of biobehavioural profiles: a comparison of domestic guinea pigs and wild cavy from early to late adolescence. Frontiers in Zoology, 11, 30.														
CO's – PO's & PSO's Mapping:															
CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AV G	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23BTE021	ANIMAL PHYSIOLOGY AND METABOLISM	L	T	P	C
		3	0	0	3
PREREQUISITES:					
➤ 23BTT301 - BIOCHEMISTRY					
➤ 23BTT302 – CELL BIOLOGY					
COURSE OBJECTIVES:					
1.	To gain knowledge about the animal physiology.				
2.	To understand the concept of various system.				
3.	To know the nutrient transport and metabolism.				
4.	To study metabolic activities and physiological responses to various environmental changes.				
5.	To analyse differences in physiological mechanisms across various animal model.				
UNIT I	INTRODUCTION TO ANIMAL PHYSIOLOGY				9
The various physiological organ---systems and their importance to the integrative functions of the animal body. The concept of homeostasis, including set point, negative and positive feedback loops, and compensatory responses. Body fluid and its dynamics. Transport of through biological membranes.					
UNIT II	BLOOD AND CIRCULATORY SYSTEM				9
Composition of blood, structure & functioning of its constitutes. Blood coagulation and anti---coagulants. Hemoglobin and its polymorphism. Anaemias. Sreticule---endothelial System. Body defense mechanism and immunogenesis. Structure and functions of the cardiovascular system, including the mechanical and electrical properties of cardiac muscle function. Excitation---contraction coupling in cardiac muscle. Reflex regulation of blood pressure.					
UNIT III	RESPIRATORY SYSTEM AND DIGESTIVE SYSTEM				9
Respiration:Structure and functions of the respiratory system, Structure and functions of smooth muscle, including excitation---contraction coupling in smooth muscle. Digestion: Structure, function and physiology of digestive system. Control of motility and secretion of alimentary canal and reflexes in the control of digestive functions. Control of rumen motility. Digestion in ruminant and monogastric animals.					
UNIT IV	NUTRIENT TRANSPORT AND ENERGY METABOLISM				9
Food, energy, ATP, carbohydrates, lipids, proteins, major minerals, trace minerals, fat soluble vitamins, water soluble vitamins, metabolic disorders, comparative nutrition, nutriagenomics, endocrinology, ruminology.					
UNIT V	MICROMANIPULATION OF EMBRYOSAND REPRODUCTION				9
What is micromanipulation technology; equipments used in micromanipulation; enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.					
TOTAL: 45 PERIODS					
COURSE OUTCOMES:		BT L	POs	PSOs	
CO1:	Understand the basics of animal physiology.	K3	1,2,3,4,5,7	1,2	
CO2:	Know the various animal system.	K2	1,3,4,7,12	2	
CO3:	Understand the nutrient transport and metabolism.	K4	1,2,3,4,7,11	3	

CO4:	Learn the micromanipulation technique.	K3	1,2,3,4,5	1,2											
CO5:	Develop analytical skills for studying metabolic disorders and physiological dysfunctions.	K3	1,2,3,5,11,12	3											
TEXT BOOKS:															
1.	William S. Hoar, General and Comparative Animal Physiology, Prentice Hall, India.														
2.	Animal Physiology, Richard W, Gordon A and Margaret A. Sinauer Associates, USA.														
3.	Ramadass P, Meera Rani S. Text Book Of Animal Biotechnology. Akshara Printers, 1997.														
REFERENCES:															
1.	Schmidt---Nielsen, Animal Physiology, Cambridge University Press.														
2.	Christopher D. Moyes and Patricia M. Schulte, Principles of Animal Physiology, Pearson Press.														
3.	Arthur C. Guyton and John E. Hall, Textbook of Medical Physiology, W.B. Saunders Company.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23BTE022	ANIMAL CELL CULTURE TECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT401 – MOLECULAR BIOLOGY								
COURSE OBJECTIVES:								
1.	To know the basic requirements of animal cell culture laboratory.							
2.	To understand the cell culture media, types and reactors.							
3.	To understand the applications of cell culture.							
4.	To gain hands-on experience in bioreactor design, cell growth optimization, and process analytics.							
5.	To develop skills in aseptic techniques, cryopreservation, and cell banking procedures.							
UNIT I		BASIC REQUIREMENTS OF LAB FACILITY						9
Safety: biosafety levels, SDS, safety equipments, personal protective equipments, safe laboratory practices. cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage, cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination.								
UNIT II		MEDIA PREPARATION AND TYPES						9
Media components-Serum, tissue extracts, growth factors, hormones, carrier proteins, lipids, vitamins, additive, detergents. Types: natural media, synthetic media, chemically defined and serum free media – advantages, disadvantages, BSS, CMRL, Eagle’s, RPMI, animal cell cultures, their maintenance and preservation.								
UNIT III		BIOREACTORS AND GROWTH OF CELLS						9
Bioreactor process control, stirred animal cell culture, Air-lift fermentor, hemostat/Turbidostat; Culturing: various types of cultures suspension cultures, continuous flow cultures, immobilized cultures; somatic cell fusion; growth of cells.								
UNIT IV		GENETIC ENGINEERING OF ANIMAL CELL						9
Gene therapy-prospects and problems, Recent advancements in Gene therapy; Knockout mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications. Recent advancements in diagnostic tool development and its diagnostic procedure.								
UNIT V		PRODUCTS FROM ANIMAL CELL						9
Enzymes – asperagenase, collagenase, urokinase, pepsin, hyaluronidase. Hormones- leutinizing hormones, FSH, chronic. Vaccines - FMD, measles and mumps, rubella, rabies monoclonal antibodies, interferons, plasminogen activator.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs		PSOs	
CO1:	Understand the basic requirements of lab facility.			K3	1,2,3,4,5,7		1,2	
CO2:	Know the various types of media.			K2	1,3,4,7,12		2	
CO3:	Understand the bioreactor and growth of cells.			K4	1,2,3,4,7,11		3	

CO4:	Learn the role of genetic engineering in animal cell culture.	K3	1,2,3,4,5	1,2											
CO5:	Understand the valuable products from animal cell.	K3	1,2,3,5,11,12	3											
TEXT BOOKS:															
1.	Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007.														
2.	Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003.														
3.	Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.														
REFERENCES:															
1.	Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002.														
2.	Freshney R.I. Animal Cell Culture- a practical approach, 6th ed., 2010.														
3.	Freshney R.I. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications 7th Edition. Wiley-Blackwell, 2016, p1-736.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23BTE023	ADVANCES IN ANIMAL BIOTECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES:								
➤ 23BTT302 – CELL BIOLOGY								
➤ 23BTT401 – MOLECULAR BIOLOGY								
COURSE OBJECTIVES:								
1.	To educate the students about the scope, regulatory issues and commercially available products produced using of animal biotechnology.							
2.	To provide depth knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research/project work related to biopharming.							
3.	To teach the importance of cell culture study for in-vitro study purposes and for scaling up the products at commercial level.							
4.	To educate the principle behind in-vitro fertilization and biopharming in order to create transgenic animal of commercial importance.							
5.	To experience advance hands-on animal cell culturing techniques.							
UNIT I		BASICS OF ANIMAL BIOTECHNOLOGY						9
Scope of Animal Biotechnology, Animal Biotechnology for production of regulatory proteins, blood products, vaccines, hormones and other therapeutic proteins.								
UNIT II		MOLECULAR BIOLOGY						9
Biology of animal viral vectors- SV40, adeno virus, retrovirus, vaccinia virus, herpes virus, adenoassociated virus and baculo virus. Applications of commercially available viral vectors and their pros and cons.								
UNIT III		CELL CULTURE TECHNOLOGY IN ANIMAL SCIENCE						9
Culturing of cells, primary and secondary cell lines, Cell culture-Scaling up of animal cell culture monolayer culture, suspension culture; Various bio-reactors used for animal cell culture-Roller bottle culture; Bioreactor process control, stirred animal cell culture, Air-lift fermentor, hemostat/Turbidostat; High technology vaccines; Hybridoma technology; Cell lines and their applications.								
UNIT IV		GENETIC ENGINEERING APPLICATIONS IN ANIMAL SCIENCE						9
Gene therapy-prospects and problems, Recent advancements in Gene therapy; Knockout mice and mice model for human genetic disorder; Baculo virus in biocontrol; Enzymes technology, Somatic manipulation of DNA, Nucleic acid hybridization and probes in diagnosis- preparation of probes, evaluation and applications. Recent advancements in diagnostic tool development and its diagnostic procedure.								
UNIT V		ADVANCEMENTS AND APPLICATIONS IN ANIMAL BIOTECHNOLOGY						9
Rumen manipulation- probiotics embryo transfer technology, invitro fertilization, transgenesis-methods of transferring genes into animal oocytes, eggs, embryos and specific tissues by physical, chemical and biological methods; Biopharming –Transgenic animals (case study : Mice, Cows, Pigs, Sheep, Goat, Birds and Insects); Artificial insemination and embryo transfer.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Understand the scope, regulatory issues and commercially available products produced using of animal biotechnology.			K3	1,2,3,4,5,7		1,2	

CO2:	Gain knowledge about the available viral vectors that can be used to create recombinant DNA for gene therapy purposes so that they can undertake research/project work related to biopharming.	K2	1,3,4,7,12	2
CO3:	Understand the importance of cell culture study for in-vitro study purposes and for scaling up the products at commercial level.	K4	1,2,3,4,7,11	3
CO4:	Gain knowledge in creating recombinant products for gene therapy purpose and the importance of molecular probe which is an important tool for medical and forensic studies.	K3	1,2,3,4,5	1,2
CO5:	Understand the principle behind invitro fertilization and biopharming in order to create transgenic animal of commercial importance.	K3	1,2,3,5,11,12	3

TEXT BOOKS:

1.	Davis J.M. Basic Cell Culture: A Practical Approach, IRL Press, 2nd ed., 2002
2.	Suresh Kumar Gahlawat et al. Advances in Animal Biotechnology and its Applications, Springer press, 2018. Ebook ISBN: 978-981-10-4702-2
3.	Ashish Verma Anchal Singh Animal Biotechnology: Models In Discovery And Translation, 2Nd Edition. AP, Elsevier Publisher, 2023. ISBN: 9780128117101.

REFERENCES:

1.	Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007.
2.	Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003.
3.	Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO1	PSO2	PSO3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

23BTE024	BIO-TECHNIQUES IN ANIMAL BREEDING			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23BTT503 – GENETIC ENGINEERING							
COURSE OBJECTIVES:							
1.	To educate the students about the basic tools requirement for cell culture and Micromanipulation.						
2.	To provide depth knowledge about micromanipulation and application.						
3.	To teach the importance of stem cell mediated production and guidelines.						
4.	To study transgenic technology, including case studies on genetically modified animals like Dolly the sheep.						
5.	To Understand the research ethics, laboratory animal care, CPCSEA guidelines, and animal welfare considerations.						
UNIT I		BASIC TOOLS REQUIREMENTS FOR CELL CULTURE AND MICROMANIPULATION					9
Biosafety levels, safety equipments, personal protective equipments, safe laboratory practices. Cell culture equipments: basic equipments - centrifuge, Inverted microscope, confocal microscope, flow cytometer, Hemocytometer, cell culture vessels, bioreactors. Cell culture laboratory: Aseptic work area, Cell culture hood, Incubator, cryostorage, cell counter, aseptic technique, Maintenance of nutrients, prevention of cross contamination. Micromanipulation tools: micromanipulator, pipette puller, pipette grinder, holding pipette.							
UNIT II		MICROMANIPULATION AND ITS APPLICATION					9
Enrichment of x and y bearing sperms from semen samples of animals; artificial insemination and germ cell manipulations; in vitro fertilization and embryo transfer; micromanipulation technology and breeding of farm animals.							
UNIT III		STEM CELLS AND TRANSGENIC ANIMALS					9
Stem cells – sources, types, uses, ES cells, pluripotent stem cells, adult stem cell, epithelial stem cell, bone marrow and hematopoietic, neural stem cell, transgenic techniques, Stem cell mediated transgenic animals.							
UNIT IV		TRANSGENIC ANIMALS IN RESEARCH					9
Ethics of transgenic technology, Dolly (transgenic sheep), Transgenic mice, rat, sheep, goat, rabbit, pig, fish, cow- case studies.							
UNIT V		ETHICAL GUIDELINES ON ANIMAL BREEDING					9
Justification on research, care and housing of laboratory animals, acquisition of laboratory animals, experimental procedure, CPCSEA guidelines. Animal integrity and ethical limits to breeding. Animal welfare issues. Record Maintenance as per guidelines.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BT L	POs	PSOs	
CO1:	Understand the concept of basic tools requirement for cell culture and micromanipulation.			K3	1,2,3,4,5,7	1,2	
CO2:	Gain knowledge on micromanipulation and its application.			K2	1,3,4,7,12	2	
CO3:	Know the concept of stem cells and ES cell of transgenic animals.			K4	1,2,3,4,7,11	3	

CO4:	Understand the research importance in transgenic animals.	K3	1,2,3,4,5	1,2
CO5:	Gain knowledge on ethical CPCSEA guidelines.	K3	1,2,3,5,11,12	3

TEXT BOOKS:

1.	Kareem Amla. Advances in Animal Breeding Biotechnology, 2015.
2.	Sukhvir Singh Tomar & Rajbeer S Tomar, Arun Kumar. Animal Genetics and Breeding. Daya Publishing House, 2020, ISBN-13: 978-9351247777.
3.	Spangler M.L. Animal Breeding And Genetics, Springer NP, 2023. ISBN: 9781071624593.

REFERENCES:

1.	Watson, J.D., Gilman, M., WitowskiJ. and Zoller, M. Recombinant DNA, 3rd ed., Scientific American Books, 2007.
2.	Glick, B.R. and Pasternack, J.J. Molecular Biotechnology, 3rd ed., ASM Press, 2003.
3.	Lewin, B. Genes VIII , Pearson Prentice Hall, 2004.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	2	2	1	1	-	-	-	-	1	1	2	2	1
2	1	1	3	3	2	1	-	-	-	-	2	1	3	2	2
3	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
4	2	2	3	3	2	1	-	-	-	-	2	1	2	2	2
5	2	1	2	3	2	2	-	-	-	-	3	1	2	2	2
AVG	1.8	1.6	2	2.8	1.8	1.2					2	1	2.2	2	1.8

PROFESSIONAL ELECTIVE – V
(COMPUTATIONAL BIOTECHNOLOGY)

23BTE025	PROGRAMMING FOR BIOINFORMATICS APPLICATIONS				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23GET101 – PROGRAMMING IN C ➤ 23BTT601 – BIOINFORMATICS								
COURSE OBJECTIVES:								
1.	To improve the programming skills and database development of the student.							
2.	To introduce the fundamentals of Perl programming language to the student.							
3.	To familiarize with Perl modules and to write scripts for manipulating/processing							
UNIT I		INTRODUCTION						9
Introduction to Operating systems, Linux commands, File transfer protocols FTP and telnet, Data life cycle, Database management system models. Structured Query Language (SQL) - Data Definition Language (DDL), Data Manipulation Language (DML) and Query by example.PL/SQL – Stored procedure, Database triggers; Relational Data Base Management system.								
UNIT II		PERL PROGRAMMING						9
Perl overview, variables and data types, control Structure, loops- while loop, for loop, until loop, File handles - opening and closing files, reading and writing file handles, Library Functions: String specific functions, User defined functions.								
UNIT III		OPERATORS						9
Arithmetic Operators, Assignment Operators, Logical operators, Equality Operators, Increment and Decrement Operators, String Concatenation and Repetition, Operators precedence and Associativity, Conditional Operators, Logical Operators, Operators for manipulating arrays, Operators for Manipulating hashes.								
UNIT IV		REGULAR EXPRESSIONS						9
Simple characters, * special character, . character, character, Grouping with ()s, anchor characters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl.								
UNIT V		APPLICATIONS OF PERL IN BIOINFORMATICS						9
Concatenating DNA Fragments, Transcription: DNA to RNA, Reading Protein Files, Finding Motifs, Simulating DNA, Generating Random DNA, Analysing DNA, Translating DNA to Proteins, Reading DNA from Files in FASTA format, Separating Sequence and Annotation, Parsing Annotation, Parsing PDB files, Parsing BLAST output, Bio-perl								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Understand the basics of Linux operating system and the SQL for database creation and management.			K3	1, 2, 4, 5, 12		3	
CO2:	Use the Perl data types to construct programs in Perl.			K2	1, 2, 3, 5, 12		2	
CO3:	Apply the various operators in Perl programs.			K4	2, 6, 8		1	

CO4:	Apply the Regular expressions, conditional statements and loops in Perl programs.	K3	3, 9	1
CO5:	Understand the applications of Perl Programming in handling genomics and Proteomics data.	K3	1, 2, 3, 4, 8, 11, 12	2

TEXT BOOKS:

1.	James Tisdall, “Beginning Perl for Bioinformatics”, O’Reilly & Associates, 2001
2.	James Tisdall, “Mastering Perl for Bioinformatics”, O’Reilly, 2003.
3.	Elmasri and Navathe. 2006. Fundamentals of Database Systems. Addison Wesley.

REFERENCES:

1.	Cynthia Gibas& Per Jambeck, “Developing Bioinformatics Computer Skills”, O’Reilly & Associates,2000.
2.	Rex A. Dawyer, “Genomic Perl”, Cambridge University Press 3. Learning Perl, 3rd Edition Author:Randal L. Schwartz and Tom Phoenix, O’Reilly

CO’s – PO’s & PSO’s Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	3	3	0	0	1	0	0	2	3	2	0	3
2	3	3	3	2	3	0	0	2	2	2	1	3	1	3	0
3	2	3	1	2	2	3	2	3	1	0	2	2	3	1	0
4	2	2	3	2	2	0	1	0	3	0	1	2	3	1	2
5	3	3	3	3	2	0	0	3	2	0	3	3	1	3	0
AVG	2.6	2.8	2.4	2.4	2.4	0.6	0.6	1.8	1.6	0.4	1.8	2.6	2.0	1.6	1.0

23BTE026	FUNDAMENTALS OF ALGORITHMS FOR BIOINFORMATICS				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT601 – BIOINFORMATICS								
COURSE OBJECTIVES:								
1.	To study various Algorithm design techniques and applying it in bioinformatics.							
2.	To understand the algorithms such as Dynamic programming, HMM and ANN in Biotechnological applications.							
UNIT I		INTRODUCTION TO ALGORITHMS						9
Algorithms-Complexity of algorithms and running time, Polynomial, NP complete problems, Recursion, Linear, Exhaustive search, Branch and Bound, divide and conquer algorithms, Travelling sales man problem, sorting.								
UNIT II		DYNAMIC PROGRAMMING AND SEQUENCE BASED ALGORITHMS						9
Dynamic programming Principles and its uses. Local and Global alignment principles, Finding longest common subsequences, Heuristics second generation alignment tools for database searching : (Blast, FASTA, ClustalW), Statistical and Similarity based methods for gene prediction, Models of evolution.								
UNIT III		EXACT MATCH AND HIDDEN MARKOV MODELS						9
Knuth-Morris- Pratt and Boyer-Moore algorithm for exact match and graph and maximum likelihood algorithm, Hidden Markov Model: Forward and Backward Algorithms, Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs:-Baum-Welch Algorithm, EM Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA								
UNIT IV		ARTIFICIAL NEURAL NETWORKS						9
Simple characters, * special character, . character, character, Grouping with ()s, anchor characters, pattern matching, regular expression shortcuts, defining subroutines, returning values, using arguments, inheritance in Perl, polymorphism in Perl.								
UNIT V		DNA AND RNA RELATED ALGORITHMS						9
Restriction enzyme mapping algorithms: algorithms for partial digest- double digest problem, Motif finding, Finding regulatory motifs in DNA, DNA computing, Genome alignment, Suffix Trees, RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimization and the Zuker folding algorithm, Design of covariance models, Application of RNA Fold.								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs		PSOs	
CO1:	Understand the basics of algorithms used in Bioinformatics.			K3	3, 8, 11		3	
CO2:	Apply dynamic programming in sequence analysis.			K2	7, 12		2	
CO3:	Analyze the macromolecules using HMM, ANN and other related algorithms.			K4	1, 4, 5, 12		3	
CO4:	Apply the Regular expressions, conditional statements and loops in Perl programs.			K3	1, 3, 9		3	
CO5:	Understand the applications of Perl Programming in handling genomics and Proteomics data.			K3	1, 5, 8		1, 3	

TEXT BOOKS:															
1.	Dan Gusfield- Algorithims on Strings, Trees and Sequences : Computer Science and Computational Biology (1997) Cambridge University Press. ISBN-10: 0521585198														
2.	Horowitz, S. Sahini, and Rajasekharan : Fundamentals of Computer Algorithms, Galgotia Publications.														
REFERENCES:															
1.	Neil C. Jones and Pavel .A Pevzner An introduction to Bioinformatics Algorithms. (computational Molecular Biology) (2004) MIT press. ISBN-10: 0262101068.														
2.	R. Durbin, S. Eddy, A. Krogh, G. Mitchison Biological sequence analysis: Probabilistic models of Proteins and Nucleic acids (2005) Cambridge University Press 052154079														
3.	Michael. S. Waterman Introduction to Computational Biology: Maps, Sequences and Genomes. Waterman. Edition 2 (2012) Chapman and Hall/ CRC Press ISBN:1439861315														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PSO1	PSO2	PSO 3
1	2	2	3	1	2	0	0	3	0	0	3	2	1	0	2
2	2	1	0	0	2	1	3	1	0	1	0	3	0	3	2
3	3	2	1	3	3	2	1	2	0	2	1	3	0	2	3
4	3	2	3	1	1	0	0	2	3	0	0	0	2	0	3
5	3	1	2	2	3	0	1	3	1	2	1	2	2	0	2
AV G	2.6	1.6	1.8	1.4	2.2	0.6	1.0	2.2	0.8	1.0	1.0	2.0	1.0	1.0	2.4

23BTE027	MOLECULAR MODELING				L	T	P	C
					2	1	0	3
PREREQUISITES:								
➤ 23BTT503 – GENETIC ENGINEERING								
➤ 23BTT601 – BIOINFORMATICS								
COURSE OBJECTIVES:								
1.	Understand the molecular behaviour of proteins, nucleic acids and small molecules in the biological system							
2.	Explain the principles involved in molecular modelling							
UNIT I		INTRODUCTION TO CLASSICAL MECHANICS						9
Newtons laws of motion – time intervals- algorithms								
UNIT II		INTRODUCTION TO STATISTICAL MECHANICS						9
Boltzman’s Equation – Ensembles – Distribution law for non-interacting molecules – Statistical mechanics of fluids.								
UNIT III		QUANTUM MECHANICS						9
Photoelectric effect – De Broglies hypothesis – Uncertainty principle – Schrodingers time independent equation – particle in a one -dimensional box								
UNIT IV		GROMOS , GROMACS, AMBER & DOCK						9
Various forcefields for proteins and nucleic acids – Molecular mechanics – Molecular dynamics– Molecular dynamics simulations in water and organic solvents.								
UNIT V		GAUSSIAN						9
Preparing input files – job types – model chemistries – basis sets – molecule specifications running Gaussian – examples								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs		PSOs	
CO1:	Understand the behaviour of Small and macro molecules in biological system.			K3	1, 2, 9, 12		1, 2	
CO2:	Simulate the biomolecules using molecular modelling softwares			K2	1, 10, 11		3	
CO3:	Assess and utilize various softwares and tools which utilizes quantum and Molecular mechanics principles.			K4	3, 10		2	
CO4:	Understanding of GROMACS & GROMOS in force field applications using proteins & DNA molecules.			K3	2, 5		1	
CO5:	Learn the geometry of protein molecules using Gaussian software for calculating properties especially in molecular dynamics.			K3	3, 4, 12		1	
TEXT BOOKS:								
1.	Leach, Andrew R. “Molecular Modelling: Principles and Applications” IInd Edition, Pearson,2010							
2.	Cohen, N.C. “Guide Book on Molecular Modeling in Drug Design” Academic Press/ Elsevier,1996							
REFERENCES:								

1.	Statistical Mechanics; D. McQuarrie, Narosa, University Science Books; 1st edition 2000
2.	Quantum Mechanics; D. McQuarrie, Narosa, 1999.
3.	GROMOS Handbook www.gromacs.org

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	2	0	0	2	1	2	3	2	0	3	3	3	0
2	3	2	1	2	0	0	0	2	2	3	3	2	0	1	3
3	2	1	3	2	1	0	0	0	1	3	2	1	0	3	2
4	2	3	2	2	3	1	1	0	0	2	2	1	3	1	0
5	2	2	3	3	2	2	0	0	0	0	0	3	3	1	0
AVG	2.4	2.2	2.2	1.8	1.2	1.0	0.4	0.8	1.2	2.0	1.4	2.0	1.8	1.8	1.0

23BTE028	COMPUTER AIDED DRUG DESIGN			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23BTT601 – BIOINFORMATICS							
COURSE OBJECTIVES:							
1.	Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically						
2.	To know the informatics approaches to the prediction of chemical properties of new drugs						
3.	To present the appropriate tools for such a modelling, ranging from electronic Structure						
4.	Methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics						
UNIT I		ELECTRONIC STRUCTURE METHODS					9
Quantum chemical methods semi-empirical and ab initio methods. Conformational analysis, energy minimization, predicting the mechanism of organic reactions using electronic structure methods.							
UNIT II		MOLECULAR MODELING					9
Bioactive vs. global minimum conformations. Automated methods of conformational search. Advantages and limitations of available software. Molecular graphics. Computer methodologies behind molecular modeling including artificial intelligence methods.							
UNIT III		STRUCTURE ACTIVITY RELATIONSHIPS IN DRUG DESIGN					9
Qualitative versus quantitative approaches advantages and disadvantages. Random screening, Non-random screening, rational approaches to lead discovery. Homologation, chain branching, ring-chain transformations. Insights into molecular recognition phenomenon. Structure based drug design, ligand-based drug design.							
UNIT IV		QSAR: ELECTRONIC EFFECTS					9
Hammett equation, lipophilicity effects. Hansch equation, steric effects. Taft equation. Experimental and theoretical approaches for the determination of physicochemical parameters, parameter inter-dependence: Regression analysis, Descriptor calculation. The importance of biological data in the correct form; 2D QSAR; 3D-QSAR examples of CoMFA and CoMSIA.							
UNIT V		MOLECULAR DOCKING					9
Rigid docking, flexible docking, manual docking. Advantages and disadvantages of Flex-X, Flex S, Autodock and Dock softwares, with successful examples. Dynamics of drugs, biomolecules, drug receptor complexes, Monte Carlo simulations and Molecular dynamics in performing conformational search and docking.							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BTL	POs		PSOs
CO1:	Gain knowledge about fundamental concepts, challenges, and rich opportunities in developing and applying algorithms for structural bioinformatics and healthcare.			K3	3, 5, 10, 12		3
CO2:	Interpret and practice the fundamental concepts of Molecular Modeling and Computer Aided Drug Design.			K2	2, 6, 8		1, 3
CO3:	Develop practical skills in computational approaches to analyse, predict, and engineer biomolecules and biomolecular systems			K4	1, 2, 11		2

CO4:	Find a chemical compound that can fit to a specific cavity on a protein target both geometrically and chemically.	K3	1, 7, 9	2
CO5:	Present the appropriate tools for such a modelling, ranging from electronic Structure methods, Molecular modelling, Structure Activity Relationships in drug design, QSAR, Molecular docking and Molecular dynamics	K3	1, 4, 7, 8	2

TEXT BOOKS:

1.	Andrew R. Leach, Molecular Modelling Principle and Application, 2nd Edition, Prentice Hall, England, 2001.
2.	Richard B. Silverman, Mark W. Holladay, Organic Chemistry of Drug Design and Drug Action, 3rd Edition, Academic Press, USA, 2014.
3.	Paul S. Charifson, Practical Applications of computer aided drug design, 1st Edition, Marcel Dekker, New York, 1997.
4.	J. M. Goodman, Chemical Applications of Molecular Modelling, The Royal Society of Chemistry, Cambridge, 1998.

REFERENCES:

1.	Donald J. Abraham, Burger's Medicinal Chemistry and Drug Discovery, Vol V, 6th Edition, John Wiley and Sons, Inc., 2003.
2.	John B. Taylor and David J. Triggle, Comprehensive Medicinal Chemistry II, Vol IV, Elsevier Science, 2006.
3.	Graham L. Patrick, An Introduction to Medicinal Chemistry, 5th Edition, Oxford University Press, UK, 2013.
4.	David. C. Young, Computational Drug Design – A Guide for Computational and Medicinal Chemists, John Wiley and Sons Ltd, Hoboken, United States, 2009.
5.	Alan Hinchliffe, Molecular Modelling for Beginners, 2nd Edition, Wiley, United University of California, 2008.

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	3	1	3	0	0	0	0	3	2	3	1	0	3
2	2	3	0	0	2	3	2	3	0	0	0	2	3	0	3
3	3	3	2	0	0	0	1	2	0	1	3	0	0	3	1
4	3	2	0	0	2	2	3	2	3	0	0	0	2	3	0
5	3	0	2	3	0	0	3	3	2	0	0	2	0	3	2
AVG	2.6	1.8	1.4	0.8	1.4	1.0	1.8	2.0	1.0	0.8	1.0	1.4	1.2	1.8	1.8

23BTE029	METABOLOMICS AND METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3
PREREQUISITES: ➤ 23BTT601 – BIOINFORMATICS					
COURSE OBJECTIVES:					
1.	To provide the fundamental knowledge on upcoming field of Metabolomics and the metabolic engineering in post genomic era.				
2.	To introduce the redesign of metabolism to enable cells to produce new products.				
UNIT I		INTRODUCTION TO METABOLOMICS			9
Role of metabolomics in systems biology –application of metabolomics- Analytical methods in metabolomics – Data standards– Databases for Chemical, Spectral and Biological Data – Reconstruction of dynamic metabolic network model- examples- study of metabolome of a simple organism like <i>E.coli</i> .					
UNIT II		BIOINFORMATICS IN METABOLOMICS			9
Online databases and pipelines for metabolomics – GC-MS based metabolomics – Computational methods to compute and integrate metabolic data-software for metabolomics- metabolomics and medical sciences					
UNIT III		INTRODUCTION TO METABOLIC ENGINEERING			9
Metabolic engineering: introduction, mass balance, black box, metabolic flux analysis, stoichiometry, Principles of metabolic engineering, Importance of metabolic engineering-comprehensive models for cellular reactions-material balances & data consistency- metabolic pathway synthesis					
UNIT IV		METABOLIC FLUX ANALYSIS			9
Flux balance analysis, flux balance methods, group-based flux balance, metabolic control analysis: overview, control coefficients, methods of measuring control. Flux analysis of networks- top-down approach, bottom-up approach.					
UNIT V		METABOLIC NETWORKS AND APPLICATIONS			9
Kinetic model of metabolic networks-Systems metabolic engineering of <i>E. coli</i> . Applications of Metabolomics to biology: examples and case studies, Metabolome informatics, data integration and mining.					
TOTAL: 45 PERIODS					
COURSE OUTCOMES:			BTL	POs	PSOs
CO1:	Understand the concept of Metabolome and Metabolomics.		K3	1, 2, 3	3
CO2:	Apply the Bioinformatics tools in metabolomics.		K2	2, 6, 7, 12	2
CO3:	Understand the fundamentals of Metabolic engineering.		K4	1, 3, 4, 7, 8, 12	1
CO4:	Analyze the metabolic pathways using flux control.		K3	1, 3, 11	1
CO5:	Understand the network of genes within an organism and retrieving their metabolic information.		K3	2, 10, 11	2
TEXT BOOKS:					
1.	Jens Hiirjis Nielsen, Michael C. Jewett, “Metabolomics: A Powerful Tool in Systems Biology”, Springer, 2007.				

2.	Dr. Christoph Wittmann, Sang Yup. Lee, “Systems Metabolic Engineering”, Springer 2012.
3.	Gregory N. Stephanopoulos, “Metabolic Engineering- Principles and Methodologies”, Academic press, First Edition, 1998.
4.	Sang Yup Lee, E. Terry Papoutsakis, “Metabolic engineering”, CRC Press, 1999.

REFERENCES:

1.	Tomita M., T. Nishioka, “Metabolomics: The Frontier of Systems Biology”, Springer, 2003.
2.	Gregory N. Stephanopoulos, “Metabolic Engineering: Principles and Methodologies”, Academic press, First Edition, 1998.
3.	Wolfram Weckwerth, “Metabolomics: Methods And Protocols”, Humana Press, 2007.
4.	Cortassa S. “An Introduction to Metabolic and Cellular Engineering”, World scientific public company Ltd., 2002.

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	3	3	2	2	0	0	0	0	0	2	2	0	0	3
2	2	3	0	0	0	3	3	1	2	2	0	3	2	3	0
3	3	2	3	3	0	0	3	3	0	0	0	3	3	0	0
4	3	2	3	0	0	2	0	0	2	0	3	1	3	1	0
5	0	3	0	2	1	1	0	0	0	3	3	0	0	3	1
AVG	2.2	2.6	1.8	1.4	0.6	1.0	1.0	0.8	0.8	1.0	1.6	1.8	1.0	1.4	0.8

23BTE030	DATA MINING AND MACHINE LEARNING TECHNIQUES FOR BIOINFORMATICS			L	T	P	C
				3	0	0	3
PREREQUISITES: ➤ 23BTT601 – BIOINFORMATICS							
COURSE OBJECTIVES:							
1.	To learn various data mining techniques used to analyses huge biological data to find the hidden patterns.						
2.	To familiarize students with a new rapidly evolving filed of machine learning and mining						
UNIT I		OVERVIEW OF MACHINE LEARNING TECHNIQUES					9
Supervised and unsupervised techniques. Empirical Risk Minimization, Structural Risk Minimization; Measuring the accuracy of learned hypotheses. Comparing learning algorithms: cross-validation, learning curves, and statistical hypothesis testing.							
UNIT II		MACHINE LEARNING TECHNIQUES					9
Classification: Decision tree, Bayesian, Rule based classification, ANN, SVM, HMM; Case based reasoning and Applications in Bioinformatics. Clustering: Partition Methods, Hierarchical methods, Density based methods, Grid based clustering, Model based clustering, clustering of high dimensional data, constraints-based clustering, Analysis of MD trajectories, Protein Array data Analysis.							
UNIT III		INTRODUCTION TO DATA MINING					9
Introduction to Data mining, Data mining Functionalities, Classification of Data mining Systems, Data Mining Task Primitives, Integration of Data mining systems, Major issues of Data mining.							
UNIT IV		DATA PREPROCSSING AND VISUALIZATION					9
Overview of data preprocessing, Data cleaning, Data integration, Data reduction, Data transformation and discretization, Visualization- Visualizing a single attribute, Visualizing pair of attributes, Visualizing several attributes, Visualizing results of machine learning.							
UNIT V		APPLICATIONS OF DATA MINING					9
Application of Data Mining in Biodata analysis: DNA/protein sequence Analysis, Genome analysis, Protein Structure Analysis, Pathway analysis, microarray data analysis, annotation, gene ontology, gene mapping. Biological data mining tools: Entrez, Blast, sequence retrieval system (SRS).							
TOTAL: 45 PERIODS							
COURSE OUTCOMES:				BTL	POs	PSOs	
CO1:	Know the basic notions and terminology used in Machine learning and Data mining.			K3	2, 7, 8, 9, 11, 12	2, 3	
CO2:	Understand fundamental principles of modern data analysis.			K2	3, 4, 5, 10, 11	3	
CO3:	Understand the applications of Machine learning and Data mining in biological Data processing and visualization.			K4	1, 10, 11	1, 2	
CO4:	Know the preprocessing of biological data and visualizing it through machine learning concepts.			K3	1, 4, 5, 6, 8	1	
CO5:	Understand the application of data mining in biological databases and knowing the tools.			K3	3, 7, 8, 9, 10	1, 2	
TEXT BOOKS:							
1.	Witten, H. I., Frank, E. and Hall, M. A. 2011. Data Mining: Practical Machine LearningTools and Techniques.						

2.	Hastie, T., Tibshirani, R., Friedman, J. H. 2009. The Elements of Statistical Learning: Data Mining Interface and Prediction.
3.	Clarke, S. B., Fokoue, E. and Zhang, H. H. 2009 Principles and Theory for Data Mining and Machine Learning.

REFERENCES:

1.	Data Mining: Concepts and Techniques by Jiawei Han and Micheline Kamber, 2000
2.	Data Mining Techniques, A. K. Pujari, University Press, Hyderabad, 2006
3.	Data mining in bioinformatics by Wang et al, Springer-Verlag, 2005

CO's – PO's & PSO's Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	0	0	2	3	3	3	0	3	3	0	3	3
2	0	2	3	3	3	0	0	0	0	3	3	2	0	2	3
3	3	0	0	2	1	0	0	0	2	3	3	2	3	3	0
4	3	1	0	3	3	3	2	3	0	0	0	0	3	0	0
5	0	2	3	0	0	0	3	3	3	3	2	2	3	3	0
AVG	1.4	1.6	1.6	1.6	1.4	1.0	1.6	1.8	1.6	1.8	2.2	1.8	1.8	2.2	1.2

PROFESSIONAL ELECTIVE – VI
(AGRO-BIOTECHNOLOGY)

23BTE031	PLANT ANATOMY				L	T	P	C
					3	0	0	3
PREREQUISITES: No prerequisites								
COURSE OBJECTIVES:								
1.	To help students become familiar with the basic structure and organization of plant cells.							
2.	To develop a clear understanding of different plant tissues and their functions.							
3.	To provide knowledge about the anatomical features of the stem, root, and leaf.							
4.	To enable students to identify and differentiate internal structures in various plant organs.							
5.	To lay a strong foundation for advanced studies in plant biology and physiology.							
UNIT I		PLANT CELL STRUCTURE						9
Plant cell structure and tissues Plant cell structure –nature of plant cell wall. Tissue and tissue systems -meristematic tissue, permanent tissue and secretary cells								
UNIT II		MORPHOLOGICAL CHARACTERS OF PLANT CELL						9
Morphogenesis and Differentiation Morphogenesis in plants -Differentiation of stem, root and leaf - Vascular bundles and Vascular cambium.								
UNIT III		CELLULAR ORGANIZATION OF MERISTEMS						9
Organization of meristems Meristems – types of meristems: apical, intercalary and lateral; primary meristem and secondary meristem. Apical meristems – theories on organization of meristems – apical cell theory, Tunica-Corpus theory and histogen theory.								
UNIT IV		ANATOMY OF STEM AND ROOT						9
Structure of Dicot stem–primary and secondary structure; Structure of Monocot stem; Nodal anatomy. Structure of Dicot root–primary and secondary structure; Structure of monocot root								
UNIT V		ANATOMY OF LEAF AND ANOMALOUS						9
Secondary growth Leaf anatomy–dorsiventral and isobilateral; Stomatal types Anomalous secondary growth –Bignonia, Aristolochia, Boerhaavia (dicot stem)Dracaena(monocot stem).								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:				BT L	POs	PSOs		
CO1:	Understand the structure and function of plant cells, cell walls, and various tissue systems including meristematic, permanent, and secretory tissues.			K2	1,2,3,7,12	1		
CO2:	Explain morphogenesis and differentiation in plants, including the development of stem, root, and leaf, as well as vascular bundles and cambium.			K2	1,3,4,7	2,3		
CO3:	Describe the types and organization of meristems along with theories such as apical cell theory, Tunica-Corpus theory, and histogen theory.			K2	1,2,3,4,5	1,3		

CO4:	Analyze the anatomical differences in dicot and monocot stems and roots, including primary and secondary structures and nodal anatomy.	K4	1,2,3,5,7,9	1,2
CO5:	Interpret leaf anatomy, stomatal types, and identify features of anomalous secondary growth in selected dicot and monocot stems.	K3	1,2,3,4,5,1 1	1

TEXT BOOKS:

1.	Vashishta, P.C. 1997. Plant Anatomy, Pradeep Publications. 2. Fahn, A.1992. Plant Anatomy. Pergamon Press

REFERENCES:

1.	Esau, K. 1990. Plant Anatomy. Wiley Eastern Pvt Ltd New Delhi.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	P O3	P O4	PO 5	P O6	P O7	P O8	P O9	PO 10	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2
2	3	3	2	3	2	2	3	2	2	3	2	2	3	3	2
3	3	3	2	3	3	2	3	2	2	3	2	2	3	2	3
4	3	3	3	3	3	2	2	2	2	2	3	3	3	2	3
5	3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
AV G	3	2.8	2.6	2.8	2.6	2	2.6	2	2	2.4	2.2	2.2	2.8	2.2	2.6

23BTE032	THERAPEUTIC APPLIATION OF PHYTOCHEMICALS		L	T	P	C
			3	0	0	3
PREREQUISITES: ➤ 23BTT301 - BIOCHEMISTRY						
COURSE OBJECTIVES:						
1.	To provide a comprehensive overview of plant-derived natural products and their significance.					
2.	To explore the natural occurrence and sources of various phytochemicals.					
3.	To understand the basic chemical structure and classification of plant secondary metabolites.					
4.	To highlight the therapeutic and medicinal applications of plant-based natural compounds.					
5.	To establish a foundational understanding for further study and research in natural product chemistry and pharmacognosy.					
UNIT I		INTRODUCTION PLANT NATURAL PRODUCTS				9
History- general significance- classification- list of floral sources- general detection, extraction and characterization procedures						
UNIT II		GLYCOSIDES AND FLAVONOIDS GLYCOSIDES				9
Classification, therapeutic value, chemical properties & tests for identification. Flavonoids: Sources, classification, biogenesis, extraction, isolation, identification and therapeutic applications.						
UNIT III		ANTHOCYANINS AND COUMARINS ANTHOCYANINS				9
Sources, classification, extraction, isolation, identification and therapeutic applications. Coumarins: Sources, classification, biosynthesis - furanocoumrarins and pyranocoumarins: pharmacological properties and photo-toxicity						
UNIT IV		LIGNANS, TERPENES, VOLATILE OILS, SAPONINS LIGNANS AND NEOLIGNANS				9
Classification, naturalsources and pharmacological applications. Terpenes: Classification, biosynthesis, origin of 5-carbons isoprene unit, head to tail coupling and tail-totail coupling of isoprene units - Volatile Oils: Classifications, sources, medicinal and non-medicinal uses - Saponins : Sources, classification, physical and biological properties						
UNIT V		CAROTENOIDS AND ALKALOIDS CAROTENOIDS				9
Sources, biogenesis, classification and therapeutic values. Alkaloids: Classification, distribution in nature, localization, nomenclature, physico -chemical properties, extraction, detection, isolation, purification, biosynthetic origin and pharmacological activities.						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BT L	POs	PSOs	
CO1:	Gain knowledge of the historical background, classification, and general methods of detection, extraction, and characterization of plant natural products.		K2	1,3,7,12	1,2	
CO2:	Understand the classification, chemical properties, and therapeutic applications of glycosides and flavonoids along with their extraction and identification methods.		K2	1,3,4,7	1,2	

CO3:	Explain the sources, classification, biosynthesis, and pharmacological relevance of anthocyanins and coumarins, including their phototoxic effects.	K2	1,2,3,4,5,7,12	3
CO4:	Analyze the classification, biosynthesis, and applications of lignans, terpenes, volatile oils, and saponins, with emphasis on isoprene unit coupling and biological activities.	K4	1,2,3,4,5,7,9	1,2
CO5:	Describe the origin, properties, and therapeutic significance of carotenoids and alkaloids, including their biosynthesis, extraction, purification, and pharmacological actions.	K2	1,2,3,4,5	1,3

TEXT BOOKS:

1.	Agarwal, O. P. 2002. Organic chemistry–Chemistry of organic natural products. Vol. II. Goel publishing house , Meerut.
2.	Farooqui, A. A. and Sreeraman, B. S. 2001. Cultivation of medicinal and aromatic crops. Universities Press.
3.	Harborne, J. B. 1998. Phytochemical methods –a guide to modern techniques of plant analysis 3 rd edition, Chapman and Hall.
4.	Yesodha, D., Geetha, S and Radhakrishnan, V. 1997. Allied Biochemistry. Morgan publications, Chennai.

REFERENCES:

1.	Gurdeep Chatwal, 1980. Organic chemistry of natural productis. Vol. I.Himalaya Publishing house.
2.	Kalsi, P. S. and Jagtap, S., 2012. Pharmaceutical medicinal and natural product chemistry. N.K. Mehra for Narosa Publishing House Pvt. Ltd. New Delhi.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO1	PSO2	PSO3
1	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2
2	3	3	2	3	2	2	3	2	2	3	2	2	3	3	2
3	3	3	2	3	3	2	3	2	2	3	2	2	3	2	3
4	3	3	3	3	3	2	2	2	2	2	3	3	3	2	3
5	3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
AV G	3	2.8	2.6	2.8	2.6	2	2.6	2	2	2.4	2.2	2.2	2.8	2.2	2.6

23BTE033	BIO-FERTILIZER PRODUCTION AND MUSHROOM CULTIVATION				L	T	P	C
					3	0	0	3
PREREQUISITES: ➤ 23BTT305 – BASIC INDUSTRIAL BIOTECHNOLOGY								
COURSE OBJECTIVES:								
1.	To train the students to gain hands on experience in mushroom cultivation, using different types of mushrooms.							
2.	To equip the students with skills in bio-composting and biofertilizer production.							
3.	To instill in students the ability and skills required to become self-employed / entrepreneur.							
4.	To gain knowledge on the marketing potential of the produced mushroom and composts							
5.	To develop an understanding of hygiene, quality control, and safety measures in mushroom cultivation and biofertilizer production							
UNIT I		MUSHROOM BIOLOGY MORPHOLOGY						9
Classification: edible and poisonous mushrooms. Life cycle of Basidiomycetes fungi Breeding and Genetic improvement of mushroom strains. Medicinal and Nutritional value of mushrooms.								
UNIT II		MUSHROOM CULTIVATION TECHNIQUES						9
Cultivation conditions for tropical and temperate countries. Isolation, spawn production, growth media, spawn running and harvesting of mushrooms (Volvariella spp., Pleurotus spp., Agaricus spp., Calocybe spp., and Lentinus spp). Diseases / contamination; Post Harvest Technology: Freezing, drying, freeze drying and canning.								
UNIT III		ECONOMICS OF MUSHROOM CULTIVATION						9
Economics of the production of oyster mushroom, milky mushroom and paddy straw mushroom cultivation : Infrastructure facilities, expenditure on fixed assets, plant and machinery, cost of the project, recurring expenditure , interest and depreciation of the expenditure, cost of production and profit. Entrepreneurship in mushroom cultivation								
UNIT IV		COMPOSTING TECHNIQUE INTRODUCTION						9
history of composting – compost - composting processes - microbiology of composting fate of pathogens - ingredients in composting - various methods of composting: vermi-composting and home composting-steps in composting.								
UNIT V		BIO-FERTILIZERS AND THEIR PRODUCTION						9
Introduction - Types: Microbes as biofertilizer, Green manure, importance of macronutrients ;Biofertilizers vs Chemical fertilizers; Nitrogen fixers – types and examples; Phosphate solubilizers – role of bacteria and Mycorrhizae -Mass cultivation and Application of the following biofertilizers: i)Rhizobium ii)Azospirillum iv) Cyanobacteria v) Mycorrhizae Quality control; Challenges and opportunities; Biofertilizer Entrepreneurshi								
TOTAL: 45 PERIODS								
COURSE OUTCOMES:					BT L	POs	PSOs	
CO1:	Understand the biology, classification, life cycle, and nutritional and medicinal value of edible and poisonous mushrooms, along with genetic improvement techniques.				K2	1,2,3,4,5,7,1 2	1,2	
CO2:	Gain practical knowledge in mushroom cultivation methods, including spawn production,				K2	1,3,4,7	2	

	maintenance, harvesting, and post-harvest technologies for various mushroom species.			
CO3:	Analyze the economic aspects of mushroom cultivation and explore entrepreneurship opportunities through cost analysis, infrastructure planning, and profit estimation.	K4	1,2,3,4,5	3
CO4:	Acquire an in-depth understanding of composting techniques, microbiological processes, and various methods like vermi-composting and home composting.	K4	1,2,3,4,5,7,9	1,2
CO5:	Learn about different types of biofertilizers, their production, mass cultivation, application, and the comparative advantages over chemical fertilizers, along with entrepreneurship prospects.	K3	1,2,3,4,5,11,12	3

TEXT BOOKS:

1.	Nita Bahl, 2002. Hand Book on Mushroom Cultivation. 4th Edition, Vijay Primlani for Oxford & IBH Publishing Co., Press, New York, New Delhi.
2.	Biswas, S, Datta, M and Nagachan, S.V. 2012.
3.	Krishnamoorthy, 1999. Hand Book of Mushroom Cultivation. TNAU publications, Coimbatore, TN, India.
4.	SubbaRao, N. S., 1988, Biofertilizers in agriculture. Oxford & IBH Publishing Company, New Delhi.
5.	SubbaRao, N. S., 1977, Soil microorganisms and Plant Growth. Oxford & IBH Publishing Company, New Delhi.

REFERENCES:

1.	Chang, T.S. and Hayes, W.A. 1978. The Biology and Cultivation of Edible Mushrooms. Academic Press, New York.
2.	M.C. Nair, C. Gokulapalan and Lulu Das, 1997. Topics on Mushroom Cultivation. Scientific Publishers, Jodhpur, India.

CO's – PO's & PSO's Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	3	2	2	2	2	2	2	2	2	2	2	2	2
2	3	3	2	3	2	2	3	2	2	3	2	2	3	3	2
3	3	3	2	3	3	2	3	2	2	3	2	2	3	2	3
4	3	3	3	3	3	2	2	2	2	2	3	3	3	2	3
5	3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
AV G	3	2.8	2.6	2.8	2.6	2	2.6	2	2	2.4	2.2	2.2	2.8	2.2	2.6

23BTE034	PHYTOTHERAPEAUTICS			L	T	P	C
				3	0	0	3
PREREQUISITES: 23BTT301 - BIOCHEMISTRY							
COURSE OBJECTIVES:							
1.	To understand the the scope and importance of medicinal plants						
2.	To recognize the the classification of herbal drugs						
3.	To gain knowledge about the importance of ethanobotany						
4.	To become familiar with the Phytotherapeutic compounds						
5.	To gain knowledge about bioavability and pharmacokinetic aspects for herbal drugs						
UNIT I		INTRODUCTION					9
Key Historical events, Scope and importance of medicinal plants. Traditional medicinal systems: Siddha, Ayurveda, Homeopathy, Chinese medicine, Unani, Naturopathy and Aromatherapy. Status of Indian medicinal plant trade, medicinal plants prohibited from export, leading companies in India in trade of medicinal plants							
UNIT II		CLASSIFICATION OF HERBAL DRUGS					9
Classification of herbal drugs based on the Alphabetical, Morphological, Taxonomical, Chemical and pharmacological. Collection and processing of herbal raw materials for drugs preparation- Post Harvesting care, Drying, Dressing, Packing and Storage. Conservation and mass propagation of important medicinal plants through In vitro propagation methods. Role of NMPB, CDRI and CIMAP on medicinal plants conservation and research development. WHO regulation and Guidelines for quality control and trade of herbal me							
UNIT III		ETHANOBOTANY					9
Ethno botany - concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Role of ethnobotany in modern Medicine Medico-Ethnobotanical sources – Eg. Contribution of Kani Tribes. Ethnobotany and plant genetic resources conservation of medicinal plants with special reference to India. Major tribes of South India and their ethno botanical knowledge.							
UNIT IV		PHYTOTHERAPEUTIC COMPOUNDS OF MEDICINAL PLANTS					9
Phytotherapeutic compounds of medicinal plants - Alkaloids, Glycosides, Terpenoids, Tannins, Flavonoids and Phenols. Patent guidelines for Phytotherapeutic compounds. Identification and utilization of the medicinal herbs in curing various ailments – Catharanthus roseus (Anti-cancer), Aegle marmelos (Cardiotonic), Withania somnifera (Drugs acting on nervoussystem), Cardiospermum halicacabum (Anti-rheumatic) and Centella asiatica (Memory booster), Phyllanthus emblica (Rejuvenating) and (Hepato-protective).							
UNIT V		BIOAVABILITY & PHARMACOKINETIC ASPECTS FOR HERBAL DRUGS					9
Preparation of liquid orals, tablets, capsules, ointments, creams and cosmetics, Methods involved in monoherbal and polyherbal formulation with their merits and demerits. Excipients used in herbal formulation, Compatibility studies, Stability studies, Bioavability & Pharmacokinetic aspects for herbal drugs with examples of well-known documented, clinically used herbal drugs. Quality Control of finished herbal medicinal products							

TOTAL: 45 PERIODS																
COURSE OUTCOMES:												BT L	POs		PSOs	
CO1:	Apply the scope and importance of medicinal plants											K3	1,2,3,4,5,7		1,2	
CO2:	Analyze the classification of herbal drugs											K4	1,3,4,7		2	
CO3:	Analyze the importance of ethanobotany.											K4	1,2,3,4,5		3	
CO4:	Analyze the Phytotherapeutic compounds											K4	1,2,3,4,7,9		1,2	
CO5:	Evaluate the bioavailability and pharmacokinetic aspects for herbal drugs											K5	1,2,3,4,11,12		3	
REFERENCES BOOKS:																
1.	Iqbal Ramzan, (2020) Phytotherapies: Efficacy, Safety, and Regulation, 015 John Wiley & Sons, Inc.															
2.	Michael Heinrich, Joanne Barnes, Jose Prieto-Garcia , Simon Gibbons Elizabeth and M. Williamson, (2018)															
3.	Fundamentals of Pharmacognosy and Phototherapy, 3rd Edition, Elsevier															
4.	Williamson, E. M. ; Okpako, D. T. ; Evans, F. J. (1996)Pharmacological methods in phytotherapy research: volume 1: Selection, preparation and pharmacological evaluation of plant material. John Wiley & Sons Ltd.															
CO's – PO's & PSO's Mapping:																
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO 1	PSO2	PSO 3	
1	3	2	3	2	2	2	2	-	2	2	2	2	2	2	2	
2	3	3	2	3	2	2	3	-	2	3	2	2	3	3	2	
3	3	3	2	3	3	2	3	-	2	3	2	2	3	2	3	
4	3	3	3	3	3	2	2	-	2	2	3	3	3	2	3	
5	3	3	3	3	3	2	3	-	2	2	2	2	3	2	3	
AV G	3	2.8	2.6	2.8	2.6	2	2.6	-	2	2.4	2.2	2.2	2.8	2.2	2.6	

23BTE035	ADVANCE TECHNIQUES IN AGRO FORESTRY	L	T	P	C
		3	0	0	3
PREREQUISITES: No prerequisites					
COURSE OBJECTIVES:					
1.	To gain a foundational understanding of phytogeography, including the distribution and classification of plant species in India.				
2.	To learn about the major vegetation types and ecological zones across different regions of the country.				
3.	To understand the principles and practices of forestry in the Indian context.				
4.	To explore the importance of forest resources, their conservation, and sustainable management.				
5.	To develop awareness about the role of forestry and plant geography in biodiversity conservation and environmental balance.				
UNIT I	SILVICULTURE				9
General silvicultural principles; ecological and physiological factors influencing vegetation; natural and artificial regeneration of forests; nursery techniques; seed technology collection, storage, pretreatment and germination; establishment and tendings. Silvicultural systems-clear felling, uniform, shafter-wood, selection, coppice and conversion systems. Social forestry-objectives, scope, necessity; agro-forestry; extension forestry: recreation forestry; people's participation.					
UNIT II	FOREST MENSURATION, MANAGEMENT AND UTILIZATION				9
Methods of measuring-diameter, girth, height and volume of trees; form factor; volume estimation of stand: sampling methods; yield calculation; current annual increment; mean annual increment; sample plots; yield and stand tables; scope and objectives of forest inventory; aerial survey and remote-sensing techniques. Forest management-objectives and principles; techniques; sustained yield relation; normal forest; growing stock; regulation of yield-methods of application; working plans-preparation and control. Forest utilisation: Logging and extraction techniques and principles; transport, storage and sale. Minor and major forest product : definition and scope. Collection, processing and disposal of minor and major forest products					
UNIT III	ADVANCES IN TREE IMPROVEMENT				9
Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees. Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees. Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes					
UNIT IV	ADVANCES IN WOOD AND NON-WOOD FOREST PRODUCTS				9
Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing. Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.					
UNIT V	CLIMATE CHANGE AND FORESTRY				9
Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India					

TOTAL: 45 PERIODS															
COURSE OUTCOMES:								BTL		POs		PSOs			
CO1:	Comprehensive knowledge of silvicultural principles, forest regeneration methods, nursery practices, and various forest management systems.							K3		1,2,3,4,5,7		1,2			
CO2:	Develop the ability to measure and analyze forest parameters such as tree dimensions, volume, yield, and use advanced tools like remote sensing and inventory techniques.							K2		1,3,4,7		2			
CO3:	Insights into modern tree improvement techniques, including genetic, cytological, and molecular approaches for enhancing tree traits.							K4		1,2,3,4,5		3			
CO4:	The mechanical properties and processing methods of wood and non-wood forest products along with their commercial potential.							K4		1,2,3,4,7,9		1,2			
CO5:	The impact of climate change on forests and explore adaptive forest management strategies to ensure sustainability in changing environmental conditions.							K5		1,2,3,4,11,12		3			
TEXT BOOKS:															
1.	McManus B. Collins and Fred M White, 1981. Elementary Forestry. Reston Publishing Company, Inc., Reston, Virginia.														
2.	MacDonald, G.2003. Biogeography: Introduction to Space, Time and Life. John Wiley & Sons, Inc.														
3.	Sagreiya, K.P.,1967.Forestsand Forestry. National Book Trust, India.														
REFERENCES:															
1.	Dwivedi, A.P.,1993.A Text Book of Silviculture.International Book Distributors, Dehra Dun.														
2.	Lal, J.B., 2003. Tropical Silviculture: New Imperatives: New Systems, International Book Distributors, Dehra Dun.														
3.	Longman, K.A. and Jenik, J., 1987. Tropical forest and its Environment: ELBS, 2nd edn. London														
4.	Shanmughavel, P., 2003: Techniques in Forestry, Pointer, Jaipur.														
5.	Simmons, I. G. 1979. Biogeography: Natural and Cultural. Edward Arnold Ltd.														
6.	Tiwari, K.M. and Singh, R.V., 1984. Social Forestry Plantations. Oxford & IBH Publishing Co., New Delhi														
CO's – PO's & PSO's Mapping:															
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	3	2	-	2	2	-	2	2	2	2	2	2	2
2	3	3	2	3	-	2	3	-	2	3	2	2	3	3	2
3	3	3	2	3	-	2	3	-	2	3	2	2	3	2	3
4	3	3	3	3	-	2	2	-	2	2	3	3	3	2	3
5	3	3	3	3	-	2	3	-	2	2	2	2	3	2	3
AVG	3	2.8	2.6	2.8	-	2	2.6	-	2	2.4	2.2	2.2	2.8	2.2	2.6

23BTE036	PLANT TISSUE CULTURE AND TRANSFORMATION TECHNIQUES		L	T	P	C
			3	0	0	3
PREREQUISITES: 23BTT503 – GENETIC ENGINEERING						
COURSE OBJECTIVES:						
1.	To understand the basic principles of plant tissue culture					
2.	To understand the methods in biotechnology					
3.	To get knowledge of insight into Recombinant DNA technology and Methods of gene transfer.					
4.	To understand and appreciate the applications of Biotechnology give me one more course outcome					
5.	To develop practical skills in handling biotechnological tools and techniques for plant and microbial research.					
UNIT I		PLANT TISSUE CULTURE				9
History of plant tissue culture research - basic principles of plant tissue callus culture, meristem culture, organ culture, Totipotency of cells, differentiation and dedifferentiation. Methodology - sterilization (physical and chemical methods), culture media, Murashige and Skoog’s (MS medium), phytohormones, medium for micro-propagation/clonal propagation of ornamental and horticulturally important plantsCallus subculture maintenance, growth measurements, morphogenesis						
UNIT II		PLANT TISSUE CULTURE				9
Endosperm culture – Embryo culture -culture requirements – applications, embryo rescue technique. Production of secondary metabolites. Cryopreservation; Germ plasm conservation						
UNIT III		ORGAN CULTURE				9
Anther, Embryo & Meristem culture. Organogenesis, somatic embryogenesis and artificial seeds. Somatic Hybridization: Isolation, fusion and protoplast culture. Somoclonal Variation & cryopreservation						
UNIT IV		TISSUE CULTURE IN FOREST TREES				9
In vitro propagation via enhanced release of auxiliary buds. Somatic organogenesis and somatic embryo genesis, leaf diseases, embryoid and synthetic seed production. Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration.						
UNIT V		TRANSFORMATION TECHNIQUES				9
Genetic transformation techniques in plants: Gene transfer methods in plants – Direct DNA transfer methods, Agro bacterium mediated nuclear transformation. Ti and Ri plasmids, binary & cointegrated vector systems; genetic markers; reporter genes; genetic transformation techniques for overcoming biotic and abiotic stress. Green house and green home technology. Arid and semiarid technology						
TOTAL: 45 PERIODS						
COURSE OUTCOMES:			BT L	POs		PSOs
CO1:	Understand the basic principles of plant tissue culture		K2	1,2,3,4,		1,2
CO2:	Understand the methods in biotechnology		K2	1,3,4,7		2
CO3:	Get an insight into Recombinant DNA technology and Methods of gene transfer.		K3	1,2,3,4,5		3

CO4:	Appreciate the applications of Biotechnology	K3	1,2,3,4,7,9	1,2											
CO5:	Develop practical skills in handling biotechnological tools and techniques for plant and microbial research.	K4	1,2,3,4,11,12	3											
TEXT BOOKS:															
1.	Botany-Plant tissue culture and its biotechnological applications, by B. R. C. Murthy & V. S. T. Sai, Venkateswara Publications, Gu														
REFERENCES:															
1.	Pullaiah. T. and M.V.Subba Rao. 2009. Plant Tissue culture. Scientific Publishers, New Delhi.														
2.	Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.														
3.	Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.														
4.	Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. VikasPublicationHouse Pvt. Ltd., New Delhi. 5th edition.														
5.	Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition														
6.	Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	P O3	P O4	PO 5	P O6	P O7	P O8	P O9	PO 10	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	3	2	3	2	-	2	2	-	2	2	2	2	2	2	2
2	2	3	2	3	-	2	3	-	2	3	2	2	3	3	2
3	2	3	2	3	-	2	3	-	2	3	2	2	3	2	3
4	3	3	3	3	-	2	2	-	2	2	3	3	3	2	3
5	3	3	3	3	-	2	3	-	2	2	2	2	3	2	3
AV G	2.6	2.8	2.6	2.8	-	2	2.6	-	2	2.4	2.2	2.2	2.8	2.2	2.6

OPEN ELECTIVE – I & II

23CSO001	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING FUNDAMENTALS			L	T	P	C
				2	0	2	3
PREREQUISITES: No prerequisites							
COURSE OBJECTIVES:							
1.	Understand the importance, principles, and search methods of AI						
2.	Provide knowledge on predicate logic and Prolog						
3.	Introduce machine learning fundamentals						
4.	Study of supervised learning algorithms						
5.	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							
TOTAL: 30 PERIODS							
PRACTICAL EXERCISES: 30 PERIODS							
Programs for Problem solving with Search							
1. Implement breadth first search							
2. Implement depth first search							
3. Analysis of breadth first and depth first search in terms of time and space							
4. Implement and compare Greedy and A* algorithms.							
Supervised learning							

5. Implement the non-parametric locally weighted regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs
6. Write a program to demonstrate the working of the decision tree based algorithm.
7. Build an artificial neural network by implementing the back propagation algorithm and test the same using appropriate data sets.
8. Write a program to implement the naïve Bayesian classifier.

Unsupervised learning

9. Implementing neural network using self-organizing maps
10. Implementing k-Means algorithm to cluster a set of data.
11. Implementing hierarchical clustering algorithm.

Note:

- Installation of gnu-prolog, Study of Prolog (gnu-prolog).
- The programs can be implemented in using C++/JAVA/ Python or appropriate tools can be used by designing good user interface
- Data sets can be taken from standard repositories (<https://archive.ics.uci.edu/ml/datasets.html>) or constructed by the students.

COURSE OUTCOMES:		BTL	POs	PSOs
CO1:	Understand the foundations of AI and the structure of Intelligent Agents	K2	1,2,6,7,8,11	1
CO2:	Use appropriate search algorithms for any AI problem	K2	1,2,6,7,8,11	1
CO3:	Study of learning methods	K3	1,2,6,7,8,11	1
CO4:	Solving problem using Supervised learning	K3	1,2,6,7,8,11	1
CO5:	Solving problem using Unsupervised learning	K3	1,2,6,7,8,11	1

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

CO's – PO's & PSO's Mapping:

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	2	2	1	1	1	3	3	2	1	1	2	2	2	1	1
2	2	2	1	1	2	3	3	2	1	1	2	2	2	1	1
3	2	2	2	2	2	3	3	2	2	2	2	2	2	1	2
4	3	3	2	2	2	3	3	2	2	2	2	3	2	2	2
5	3	3	2	2	2	3	3	2	2	2	2	3	2	2	2
AV G	2.4	2.4	1.6	1.6	1.8	3.0	3.0	2.0	1.6	1.6	2.0	2.2	2.0	1.4	1.6

23CSO002	IoT CONCEPTS AND APPLICATIONS			L	T	P	C
				2	0	2	3
PREREQUISITES: No prerequisites							
COURSE OBJECTIVES:							
1.	To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT						
2.	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.						
3.	To introduce the technologies behind Internet of Things(IoT).						
4.	To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.						
5.	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							
TOTAL: 30 PERIODS							
PRACTICAL EXERCISES: 30 PERIODS							
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							
COURSE OUTCOMES:			BTL	POs	PSOs		
CO1:	Explain the concept of IoT		K2	1,2,6,7,8,11	1		

CO2:	Understand the communication models and various protocols for IoT	K2	1,2,6,7,8,11	1
CO3:	Design portable IoT using Arduino/Raspberry Pi /open platform	K3	1,2,6,7,8,11	1
CO4:	Apply data analytics and use cloud offerings related to IoT	K3	1,2,6,7,8,11	1
CO5:	Analyze applications of IoT in real time scenario.	K3	1,2,6,7,8,11	1

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

CO's – PO's & PSO's Mapping:

CO	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PSO 3
1	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
2	3	2	2	-	3	-	-	-	2	2	1	2	2	1	2
3	3	2	2	1	3	-	-	-	3	2	2	3	3	1	2
4	3	3	2	2	3	-	-	-	3	2	1	2	3	2	2
5	3	3	3	2	3	-	-	-	3	2	2	3	3	2	2
AV G	3.0	2.6	2.4	2.0	3.0	-	-	-	2.8	2.2	1.8	2.6	28	1.8	2.2

23CSO003	DATA SCIENCE FUNDAMENTALS	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites • Basic Python programming • Foundations of Probability and Statistics • Basic Linear Algebra concepts • Understanding of data formats and basic computer usage					
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.				

b)	Bivariate Analysis: Linear and logistic regression modelling														
7	Apply supervised learning algorithms and unsupervised learning algorithms on any data set.														
8	Apply and explore various plotting functions on any data set.														
Note: Example data sets like: UCI, Iris, Pima Indians Diabetes etc.															
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		
CO1: Gain knowledge on data science process.													Understand		
CO2: Perform data manipulation functions using Numpy and Pandas													Apply		
CO3: Understand different types of machine learning approaches.													Understand		
CO4: Perform data visualization using tools.													Apply		
CO5: Handle large volumes of data in practical scenarios.													Apply		
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	3	—	—	—	—	—	—	1	3	3	2
CO3	3	2	2	2	1	—	—	—	—	—	—	1	3	3	—
CO4	3	2	3	2	3	—	—	—	—	—	—	2	3	3	2
CO5	3	3	3	3	2	—	—	—	—	—	—	3	3	3	3
1 - Low, 2 - Medium, 3 - High , ‘—’ No correlation															

23CSO004	AUGMENTED REALITY /VIRTUAL REALITY	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites • Basic Programming Knowledge (C/C++/Python) • Fundamentals of Computer Graphics • Basic Mathematics (Linear algebra, transformations) • Basic understanding of hardware components (sensors, input devices)					
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 AnnotationNavigation-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. Augmented Reality: Principles & Practice — Dieter Schmalstieg, Tobias Höllerer Very good for AR fundamentals: tracking, sensors, display, interaction. |
| 2. Developing Virtual Reality Applications: Foundations of Effective Design — Alan B. Craig, William R. Sherman, Jeffrey D. Will |
| 3. Virtual and Augmented Reality Technology-Enhanced Learning: Research and Applications — Edited by Yiyu Cai, Umesh Ramnarain, Jean Jieqiong Chen Focused on educational uses of VR/AR |

Course Outcomes:	Blooms Taxonomy

Course Outcomes:	Blooms Taxonomy

CO1: Understand the basic concepts of AR and VR	Understand

CO1: Understand the basic concepts of AR and VR	Understand

CO2: Understand the tools and technologies related to AR/VR	Understand

CO2: Understand the tools and technologies related to AR/VR	Understand

CO3: Know the working principle of AR/VR related Sensor devices	Apply

CO3: Know the working principle of AR/VR related Sensor devices	Apply

CO4: Design of various models using modeling techniques	Apply

CO4: Design of various models using modeling techniques	Apply

CO5: Develop AR/VR applications in different domains	Apply

CO5: Develop AR/VR applications in different domains	Apply

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	2	2	—
CO2	3	2	1	1	2	—	—	—	—	—	—	1	2	3	—
CO3	3	2	2	2	3	—	—	—	—	—	—	1	2	3	2
CO4	3	2	3	2	3	—	—	—	—	—	—	2	3	3	2
CO5	3	3	3	3	3	—	—	—	—	—	—	3	3	3	3

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

OPEN ELECTIVE – III

23HSO001	ENGLISH FOR COMPETITIVE EXAMINATIONS	Category: OEC			
		L	T	P	C
		2	0	2	3
Prerequisites • Basic proficiency in English grammar and vocabulary • Fundamental reading and writing skills • Ability to comprehend short texts and respond appropriately • Basic speaking and listening skills in English					
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					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					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					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					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					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.					
Lecture : 30		Practical : 30		Total periods: 60	
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

CO1: Expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required													Understand		
CO2: Identify errors with precision and write with clarity and coherence													Apply		
CO3: Understand the importance of task fulfilment and the usage of task-appropriate vocabulary													Understand		
CO4: Communicate effectively in group discussions, presentations and interviews													Apply		
CO5: Write topic based essays with precision and accuracy													Apply		
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	–	–	–
CO2	1	2	–	–	–	–	–	–	–	3	–	1	–	–	–
CO3	1	2	–	–	–	–	–	–	–	3	–	1	–	–	–
CO4	–	–	–	–	–	–	–	–	2	3	–	1	–	–	–
CO5	1	2	–	–	–	–	–	–	–	3	–	1	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘–’ No correlation															

23CEO001	LEAN CONCEPTS, TOOLS AND PRACTICES		Category: OEC			
			L	T	P	C
			3	0	0	3
Prerequisites • Basic understanding of construction project management • Knowledge of planning, scheduling, and productivity measurement • Fundamentals of construction processes and resource management						
Course Objectives: • To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.						
Unit I		INTRODUCTION				9
Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with resOECt to its management practices -construction project phases - The problems with current construction management techniques.						
Unit II		LEAN MANAGEMENT				9
Introduction to lean management - Toyota’s management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.						
Unit III		CORE CONCEPTS IN LEAN				9
Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.						
Unit IV		LEAN TOOLS AND TECHNIQUES				9
Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting- Daily Huddles – Root cause analysis – Continuous improvement – Just in time.						
Unit V		LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY				9
Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.						
Total Periods :45 PERIODS						
Text Books:						
1 . Koskela, L. "Application of the New Production Philosophy to Construction", Stanford University, 1992.						
2 . Howell, G. & Ballard, G. "Lean Construction Theory and Practice", Lean Construction Institute, 2000.						
References:						
1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.						
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.						
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.						
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.						
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.						
Course Outcomes:						Blooms Taxonomy
CO 1: Explains the contemporary management techniques and the issues in present scenario.						Understand
CO2: Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.						Apply
CO3: Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.						Understand
CO4: Apply lean techniques to achieve sustainability in construction projects.						Apply
CO5: Apply lean construction techniques in design and modeling.						Apply

CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PSO3
CO1	2	2	–	–	–	1	–	–	1	2	–	–	2	1	–
CO2	2	3	2	–	–	1	–	–	2	2	–	–	2	2	–
CO3	3	3	2	–	–	1	–	–	2	2	–	–	3	2	–
CO4	2	2	2	–	–	2	2	–	2	2	–	–	2	3	–
CO5	2	3	2	1	3	1	–	–	2	3	–	–	2	3	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MGO001	NGOS AND SUSTAINABLE DEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	3	3
Prerequisites • Basic understanding of social science concepts • Awareness of environmental issues • General knowledge of Indian society and governance • Interest in sustainability, ecology, and community development					
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 PERIODS					
Text Books:					
1. Environmental NGOs: Sustainability Stewardship Authors: S. Kulsange & R. Kamble Publisher: Lap Lambert Academic Publishing, 2019 ISBN: 978-6200442444 Why: This book focuses on the role of NGOs in sustainability, community development, and environmental stewardship, which aligns directly with Units II, III, and IV of your syllabus					
2. Indian Environmental Law: Key Concepts and Principles Editor: S. Ghosh Publisher: Orient BlackSwan, 2019 ISBN: 978-9352875795 Why: Covers the legal frameworks, environmental legislation, and enforcement mechanisms in India, which matches Unit V and aspects of Unit I of your syllabus.					
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													Understand		
CO2: Have a knowledge on the role of NGOs towards sustainable developemnt													Understand		
CO3 Present strategies for NGOs in attaining sustainable development													Apply		
CO4: Recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment													Analyze		
CO5: Understand the environmental legislations													Understand		
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	2	–	1	–	3	–	–	–
CO2	2	2	–	–	–	2	3	3	–	1	–	3	–	–	–
CO3	2	3	2	–	–	3	3	3	2	2	–	3	–	–	–
CO4	2	3	–	–	–	3	3	3	–	2	–	3	–	–	–
CO5	2	3	–	–	–	3	3	3	–	1	–	3	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MGO002	DEMOCRACY AND GOOD GOVERNANCE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic awareness of Indian polity and constitution • General understanding of social systems, governance, and civic structures • Interest in public policy, democracy, political economy, and social issues					
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	Structure and Process of Governance				9
Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governance					
Unit II	Regulatory Institutions				9
Regulatory Institutions – SEBI, TRAI, Competition Commission of India,					
Unit III	Lobbying Institutions				9
Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.					
Unit IV	Contemporary Political Economy of Development in India				9
Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E- governance					
Unit V	Dynamics of Civil Society				9
New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.					
Total periods: 45 PERIODS					
Text Books:					
1. The Success of India's Democracy Editor: Atul Kohli Publisher: Cambridge University Press, 2001 Focus: Indian democratic institutions, federalism, party politics, electoral behavior, and governance structures (Unit I & general course framework).					
2. India: Economic Development and Social Opportunity Authors: J. Dreze and A. Sen Publisher: Clarendon Press, 1995 Focus: Political economy, development models, social policy, and e-governance (Unit IV & related governance discussions).					
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
CO1: Understand the structure and processes of governance in India, including democratic institutions and functioning.					Understand

CO2: Gain knowledge of regulatory institutions and their role in governance and public administration.													Understand		
CO3: Analyse the functioning of lobbying institutions and their influence on policy-making.													Analyze		
CO4: Evaluate policy debates and contemporary political–economic issues related to India’s development model and e-governance.													Analyze		
CO5: Understand the role of civil society, social movements, NGOs, media, and popular culture in shaping democracy and governance													Understand		
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	2	1	2	–	3	–	–	–
CO2	2	3	1	–	–	3	2	2	–	2	–	3	–	–	–
CO3	2	3	2	–	–	3	3	3	–	2	–	3	–	–	–
CO4	2	3	2	–	–	3	3	3	–	2	–	3	–	–	–
CO5	2	3	–	–	–	3	3	3	1	3	–	3	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MEO002	REVERSE ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Engineering materials and their properties • Manufacturing processes • Basics of CAD modeling • Fundamentals of engineering design					
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 PERIODS					
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", SpringerVerlag London Limited 2008.

Course Outcomes:

	Blooms Taxonomy

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

Apply	

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

Apply	

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

Apply	

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

Apply

C05: Analyze the various legal aspect

Analyze

CO - PO & PSO Mapping												
Particulars	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

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

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

23MEO003	SUSTAINABLE MANUFACTURING	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of manufacturing processes • Fundamental understanding of materials and production systems • Awareness of environmental concerns and industrial practices					
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	SUSTAINABILITY PRACTICES				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 SUSTAINABILIT				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 PERIODS					
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, Eµpper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.					
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
CO1: Discuss the importance of economic sustainability.					Understand
CO2: Describe the importance of sustainable practices.					Understand
CO3: Identify drivers and barriers for the given conditions.					Apply
CO4: Formulate strategy in sustainable manufacturing.					Analyze

CO5: : Plan for sustainable operation of industry with environmental, cost consciousness.													Apply		
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	–	–	–	3	–	–	–
CO2	2	2	2	–	–	2	3	2	–	–	–	3	–	–	–
CO3	2	3	2	2	–	2	3	–	–	1	–	3	–	2	–
CO4	3	3	3	3	2	2	3	2	2	2	–	3	2	3	2
CO5	3	3	2	2	2	3	3	2	–	2	–	3	2	2	3
1 - Low, 2 - Medium, 3 - High , ‘–’ No correlation															

23EEO002	ELECTRIC AND HYBRID VEHICLES												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites - Basic electrical engineering knowledge - Understanding of DC and AC machines - Basic knowledge of vehicle systems and energy storage																
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 ionSodium 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 PERIODS																
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		
CO1: Understand the operation and architecture of electric and hybrid vehicles														Understand		
CO2: Identify various energy source options like battery and fuel cell														Understand		
CO3: Select suitable electric motor for applications in hybrid and electric vehicles.														Apply		
CO4: Explain the role of power electronics in hybrid and electric vehicles.														Understand		
CO5: Analyze the energy and design requirement for hybrid and electric vehicles.														Analyze		
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	2	2	–	–	–	2	3	2	–	
CO2	3	2	2	–	–	2	2	2	–	–	–	2	3	3	–	
CO3	3	3	3	–	–	2	3	2	–	–	–	2	3	3	–	
CO4	3	2	2	2	–	2	2	2	–	–	–	2	3	3	–	
CO5	3	3	3	2	–	2	3	2	–	–	–	2	3	3	–	

23ECO002	SPACE ENGINEERING												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites - Basic Physics (Mechanics, Thermodynamics) - Engineering Mathematics (Calculus, Linear Algebra) - Fundamentals of Aerodynamics (recommended but not mandatory)																
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 PERIODS																
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			
CO1: Illustrate the history of aviation & developments over the years													Understand			
CO2: Ability to identify the types & classifications of components and control systems													Understand			
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere													Understand			
CO4:Identify the types of fuselage and constructions.													Apply			
CO5:Analyze the energy and design requirement for hybrid and electric vehicles.													Analyze			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
CO2	2	2	-	-	-	-	-	-	-	-	-	-	1	1	-	
CO3	2	-	2	-	-	-	-	-	-	-	-	-	1	-	-	
CO4	2	-	1	-	-	-	-	-	-	-	-	-	-	1	-	
CO5	3	2	2	-	-	-	-	-	-	-	-	-	2	2	1	
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation																

23MGO004	INDUSTRIAL MANAGEMENT	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of engineering fundamentals • Basic understanding of mathematics and communication skills • Awareness of general industrial practices					
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 PERIODS					
Text Books:					
1. Koontz, Harold & Weihrich, Heinz, Essentials of Management: An International, Innovation, and Leadership Perspective, McGraw Hill Education, Latest Edition.					
2. S Chand & Jain, Industrial Engineering and Management, S. Chand Publications, Latest Edition.					
References:					
1. Maynard H.B, “Industrial Engineering Hand book”, McGraw-Hill, sixth 2008					
Course Outcomes:					Blooms Taxonomy
CO1: Understand the basic concepts of industrial management					Understand
CO2: Identify the group conflicts and its causes.					Understand
CO3: Perform swot analysis					Apply
CO4: Analyze the learning curves					Analyze

C05: Understand the placement and performance appraisal													Understand		
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	–	1	–	–	–
CO2	2	2	1	–	1	1	1	2	3	2	1	1	–	–	–
CO3	2	2	1	1	1	–	–	2	2	2	–	1	–	–	–
CO4	2	3	2	2	1	–	–	1	2	2	–	1	–	–	–
CO5	2	1	–	–	1	1	–	2	3	3	–	1	–	–	–

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

23MGO003	QUALITY ENGINEERING											Category: BSC			
												L	T	P	C
												3	0	0	3
Prerequisites • Basic knowledge of statistics and probability • Fundamentals of manufacturing processes • Basic mathematical skills															
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 processor oriented industries. • Analyzing and understanding the process capability study.															
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 PERIODS															
Text Books:															
1. Douglas C. Montgomery, “Introduction to Statistical Quality Control”, 7th Edition, Wiley, 2012															
2. E.L. Grant & Richard S. Leavenworth, “Statistical Quality Control”, 7th Edition, McGraw-Hill, 1996															
References:															
1. Juran, J.M. & Gryna, F.M., “Juran’s Quality Planning and Analysis”, McGraw-Hill, 2001.															
2. Kume, H., “Statistical Methods for Quality Improvement”, 3rd Edition, Asian Productivity Organization, 1998.															
Course Outcomes:													Blooms Taxonomy		
CO1: Control the quality of processes using control charts for variables in manufacturing industries													Understand		
CO2: Control the occurrence of defective product and the defects in manufacturing companies													Understand		
CO3: Control the occurrence of defects in services.													Apply		
CO4: Analyzing and understanding the process capability study.													Analyze		
CO5: Developing the acceptance sampling procedures for incoming raw material.													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	–	–	–	1	2	–	2	3	2	–
CO2	3	3	2	3	3	–	–	–	1	2	–	2	3	2	–
CO3	2	2	1	2	2	–	–	–	2	2	–	1	2	1	–
CO4	3	3	2	3	3	–	–	–	1	2	–	3	3	3	–
CO5	3	3	2	3	3	–	–	–	1	2	–	3	3	3	–
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CHO001	FIRE SAFETY ENGINEERING	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of civil / structural engineering materials • Basic understanding of building design and construction methods • Fundamentals of engineering safety & hazard identification					
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					
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 PERIODS					
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

CO2: Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.													Understand		
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		
CO4: To decide the method of fire protection to RCC, steel, and wooden structural elements and their repair methods if damaged due to fire.													Apply		
CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	–	–	–	–	1	–	1	3	2	–
CO2	3	3	3	2	2	–	–	–	–	1	–	2	3	3	–
CO3	2	2	3	3	2	–	–	–	1	2	–	2	2	3	–
CO4	2	3	2	3	2	–	–	1	1	2	–	3	3	3	–
CO5	1	2	1	2	1	3	2	3	3	3	–	2	2	2	–
1 - Low, 2 - Medium, 3 - High , ‘–’ No correlation															

23CE0001	INTRODUCTION TO NON-DESTRUCTIVE TESTING	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of Materials Science • Fundamentals of Manufacturing Processes • Basic Engineering Physics					
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 fibrosopes – 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, Penetrameters, safety in radiography.					
Total periods: 45 PERIODS					
Text Books:					
1. Baldev Raj, T. Jayakumar and M. Thavasimuthu, Practical Non Destructive Testing, Alpha Science International Limited, 3rd edition, 2002.					
2.J. Prasad and C. G. K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition, 2011.					
3.Ravi Prakash, “Non-Destructive Testing Techniques”, 1st revised edition, New Age International Publishers, 2010.					
References:					
1. ASM Metals Handbook, V-17, "Nondestructive Evaluation and Quality Control", American Society of Metals, USA, 2001.					
2.Barry Hull and Vernon John,"Nondestructive Testing", Macmillan, 1989.					
3.Chuck Hellier, “Handbook of Nondestructive Evaluation”, Mc Graw Hill, 2012.					
4.Louis Cartz, "Nondestructive Testing", ASM International, USA, 1995.					
Course Outcomes:					Blooms Taxonomy
CO1: Realize the importance of NDT in various engineering fields.					Understand

CO2: Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.													Apply		
CO3: Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.													Analyze		
CO4: Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.													Analyze		
CO5: Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.													Evaluate		
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	-	1
CO2	3	2	2	-	1	-	-	-	-	1	-	2	3	2	-
CO3	3	2	2	2	2	-	-	-	-	1	-	2	3	2	-
CO4	3	3	2	2	2	-	-	-	-	1	-	3	3	2	-
CO5	3	3	2	3	2	-	-	-	-	1	-	3	3	3	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MEO004	MECHATRONICS	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of Electrical & Electronics Engineering • Basic knowledge of Sensors and Measurement • Fundamentals of Programming					
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 MICROPROCESSOR				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 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. 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
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.					Apply
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.					Analyze

CO4: Apply PLC as a controller in mechatronics system.													Apply		
CO5: Design and develop the apt mechatronics system for an application.													Evaluate		
CO-PO 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	3	2	-
CO2	3	3	2	2	2	-	-	-	-	1	-	2	3	2	-
CO3	3	3	3	3	3	-	-	-	-	1	-	3	3	3	-
CO4	3	2	2	2	3	-	-	-	-	1	-	3	3	3	-
CO5	3	3	3	3	3	1	-	-	-	1	-	3	3	3	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MEO005	FOUNDATION OF ROBOTICS	Category: BSC			
		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 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.													Understand		
CO2: Apply the basic engineering knowledge and laws for the design of robotics.													Apply		
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		
CO4: Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.													Understand		
CO5: Demonstrate the image processing and image analysis techniques by machine vision system.													Apply		
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	-	-	-	-	1	-	1	3	2	-
CO2	3	3	3	2	2	-	-	-	-	1	-	2	3	3	-
CO3	3	2	2	2	2	-	-	-	-	1	-	1	3	3	-
CO4	3	3	2	3	2	-	-	-	-	1	-	2	3	3	-
CO5	2	2	2	3	3	-	-	-	-	1	-	2	3	3	2

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

23MEO006	FUNDAMENTALS OF AERONAUTICAL ENGINEERING												Category: BSC			
													L	T	P	C
													3	0	0	3
Prerequisites - Fundamentals of Physics (mechanics, basic forces) - Basic Engineering Mathematics (algebra, vectors, units) - Basics of materials and mechanical systems																
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 PERIODS																
Text Books:																
1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 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, 2nd edition, AIAA Education Series, 2004.																
References:																
1. Sadhu Singh, “Internal Combustion Engines and Gas Turbine”-, SS Kataraiia & 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													Understand			
CO2: Ability to identify the types & classifications of components and control systems													Understand			
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere.													Understand			
CO4: Identify the types of fuselage and constructions. .													Apply			
CO5: Distinguish the types of Engines and explain the principles of Rocket													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	–	–	
CO2	3	2	2	–	–	–	–	–	–	–	–	1	3	2	–	
CO3	3	3	–	2	2	–	–	–	–	–	–	1	3	2	–	
CO4	3	3	2	–	–	–	–	–	–	–	–	1	3	3	–	

CO5	3	2	–	2	1	–	–	–	–	1	–	1	3	2	–
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23CEO002	REMOTE SENSING CONCEPTS	Category: BSC			
		L	T	P	C
		3	0	0	3
Prerequisites - Fundamentals of physics (Electromagnetic waves, basic optics) - Basic mathematics (algebra, trigonometry, calculus) - Earth science fundamentals (landforms, soil, water, vegetation) - Basic computer skills for handling digital data					
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 PERIODS					
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:					Blooms Taxonomy
CO1: Understand the concepts and laws related to remote sensing					Understand

CO2: Understand the interaction of electromagnetic radiation with atmosphere and earth material													Understand		
CO3: Acquire knowledge about satellite orbits and different types of satellites													Understand		
CO4: Understand the different types of remote sensors													Understand		
CO5: Gain knowledge about the concepts of interpretation of satellite imagery													Analyze		
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	–
CO2	3	2	–	–	1	–	–	–	–	–	–	1	3	1	–
CO3	3	1	–	–	–	–	–	–	–	–	–	1	2	2	–
CO4	3	2	–	1	2	–	–	–	–	–	–	1	3	2	–
CO5	2	2	1	2	3	–	–	–	–	–	–	2	3	2	1
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CEO003	URBAN AGRICULTURE												Category: BSC			
													L	T	P	C
													3	0	0	3
Prerequisites - Fundamentals of plant biology (photosynthesis, growth, nutrients) - Basic environmental science (soil, water, climate) - General science knowledge at higher secondary level - Basic understanding of urban environment & sustainability concepts																
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 periods: 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): 323–329. https://www.sciencedirect.com/science/article/pii/S0269749103002458#aep-section-id24 .																
3.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		
CO1: Demonstrate the principles behind crop production and various parameters that influences the crop growth on roof tops														Understand		
CO2: Explain different methods of crop production on roof tops														Understand		
CO3: Explain nutrient and pest management for crop production on roof tops														Understand		
CO4: Illustrate crop water requirement and irrigation water management on roof tops														Apply		
CO5: Explain the concept of waste management on roof tops														Understand		
CO-PO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	

23CEO004	DRINKING WATER SUPPLY AND TREATMENT												Category: BSC			
													L	T	P	C
													3	0	0	3
Prerequisites - Fundamentals of environmental science - Basic chemistry (pH, alkalinity, hardness, reactions) - Basic fluid mechanics (pressure, flow, continuity) - Fundamentals of civil engineering materials																
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 PERIODS																
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.																
Course Outcomes:													Blooms Taxonomy			
CO1: An understanding of water quality criteria and standards, and their relation to public health													Understand			
CO2: The ability to design the water conveyance system													Apply			
CO3: The knowledge in various unit operations and processes in water treatment													Understand			
CO4: An ability to understand the various systems for advanced water treatment													Understand			
CO5: An insight into the structure of drinking water distribution system													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	3	1	–	–	–	2	2	–	–	
CO2	3	3	2	2	2	–	1	1	–	–	–	2	3	2	–	
CO3	3	2	–	–	1	1	2	–	–	–	–	2	2	–	–	

CO4	2	2	1	–	2	1	2	–	–	–	–	2	2	–	–
CO5	2	2	1	1	2	–	2	–	–	–	–	3	2	2	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23EEO003	ELECTRIC VEHICLE TECHNOLOGY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic knowledge of electrical machines • Fundamentals of power electronics • Basic circuit theory • Understanding of mechanics and energy concepts • Basic knowledge of automotive systems					
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 PERIODS					
Text Books:					
1.L.O – Work Study, International Labour Office, Geneva					
2.Khrishnaveni K. – Work Study and Ergonomics, Lakshmi Publications					
3.R. Panigrahi & C. Pattanaik – Productivity and Work Study, Scitech Publications					
References:					
1.Stephen D. Umans, “Fitzgerald & Kingsley’s Electric Machinery”, Tata McGraw Hill, 7th Edition, 2020.					
2.Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011					
3.Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek “Analysis of Electric Machinery and Drive Systems”, 3rd Edition, Wiley-IEEE Press, 2013.					
4.Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.					

5.Iqbal Husain, ‘Electric and Hybrid Electric Vehicles’, CRC Press, 2021.															
6.Wei Liu, ‘Hybrid Electric Vehicle System Modeling and Control’, Second Edition, WILEY, 2017															
7.James Larminie and John Lowry, ‘Electric Vehicle Technology Explained’, Second Edition, Wiley, 2012															
Course Outcomes:													Blooms Taxonomy		
CO1: Able to understand the principles of conventional and special electrical machines.													Understand		
CO2: Acquired the concepts of power devices and power converters													Apply		
CO3: Able to understand the control for DC and AC drive systems.													Understand		
CO4: Learned the electric vehicle architecture and power train components.													Understand		
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric													Analyze		
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	2	1	1	1	1	3	3	2	1
CO2	3	3	2	2	3	2	2	1	1	1	1	3	3	3	2
CO3	3	2	2	2	2	2	2	1	1	1	1	3	3	2	2
CO4	3	2	2	2	2	2	2	2	1	1	1	3	3	2	2
CO5	3	3	3	2	3	3	3	2	1	1	1	3	3	3	3
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

23EEO004	INTRODUCTION TO PLC PROGRAMMING												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites - Basics of Digital Electronics - Fundamentals of Microprocessors & Microcontrollers - Basic Electrical and Electronics Engineering - Knowledge of Sensors and Actuators																
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 Communication architectures																
Unit V		CASE STUDIES												9		
Stepper Motor Control- Elevator Control-CNC Machine Control- conveyor control-Interlocking Problems																
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.Madhuchannd Mitra and Samerjit Sengupta, 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.													Understand			
CO 2: Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.													Understand			
CO 3: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.													Apply			
CO 4: Able to develop a PLC logic for a specific application on real world problem.													Analyze			
CO 5: Ability to Understand the Concepts of Communication used for PLC/SCADA.													Apply			
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	-	1	2	-	-	
CO2	2	3	2	1	2	-	-	-	1	1	-	1	2	1	-	
CO3	2	3	3	2	2	-	-	-	1	1	-	2	3	1	1	

CO4	3	3	3	3	2	1	-	1	2	2	1	2	3	2	2
CO5	2	2	1	2	3	-	-	-	1	1	-	2	2	1	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHO002	NANOTECHNOLOGY				L	T	P	C
					3	0	0	3
PREREQUISITES: No prerequisites								
COURSE OBJECTIVES:								
1.	To educate about the health hazards and the safety measures to be followed in the industrial environment.							
2.	Describe industrial legislations (Factories Acts, Workmen's Compensation and other laws) enacted for the protection of employees health at work settings							
3.	Describe methods of prevention and control of Occupational Health diseases, accidents / emergencies and other hazards							
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: 45 PERIODS								
COURSE OUTCOMES:				BTL	POs	PSOs		
CO1:	understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications			K2	2,4,5,12	3		
CO2:	able to acquire knowledge about the different types of nano material synthesis			K2	2,4,5,12	3		
CO3:	describes about the shape, size,structure of composite nano materials and their interference			K3	4,5,12	3		
CO4:	understand the different characterization techniques for nanomaterials			K3	4,5,12	3		
CO5:	develop a deeper knowledge in the application of nanomaterials in different fields			K3	4,5,12	3		

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”, 3rd 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 Gibtl & Co														
3.	Ivor Brodie and Julius J.Muray,'The physics of Micro/Nano – Fabrication',Springer International Edition,2010														
CO's – PO's & PSO's Mapping:															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2	PS O3
1	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
2	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
3	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
4	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
5	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
AV G	2	2	1	3	3	1	1	1	1	1	1	3	2	1	3

23MEO007	FUNCTIONAL MATERIALS												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites • Basic knowledge of Chemistry • Fundamentals of Materials Science • Basic understanding of polymers and molecular interactions																
Course Objectives: • The course emphasis on the molecular safe 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 PERIODS																
Text Books:																
1. Vijayamohanan K. Pillai and MeeraParthasarathy, “Functional Materials: A chemist’s perspective”, Universities Press Hyderabad (2012).																
References:																
1. Stephen Manne “Biomimetic Materials Chemistry” Wiley-VCH Newyork, 1966																
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			
CO2: Understand the concepts and mechanisms behind molecular self-assembly and its technological relevance.													Understand			
CO3: Explain the principles of bio-inspired materials and relate natural phenomena to functional material design.													Understand			
CO4: Identify and describe different smart/intelligent materials and evaluate their significance in advanced engineering applications.													Understand			
CO5: Apply the knowledge of polymer electronics to analyze materials used in OLEDs, FETs, LCDs, and data-storage systems.													Apply			
CO-PO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	3	3	2	2	3	1	1	-	-	1	-	2	3	2	1	

[illegible]

23BTO003	IPR FOR PHARMA INDUSTRY	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic understanding of pharmaceutical sciences • Basic knowledge of laws or regulations in pharma (desired but not mandatory) • Ability to read and understand legal/technical documents					
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 PERIODS					
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:					Blooms Taxonomy
CO 1: Understand and differentiate the categories of intellectual property rights.					Understanding
CO 2: Describe about patents and procedure for obtaining patents.					Applying

CO 3: Distinguish plant variety, traditional knowledge and geographical indications under IPR.													Analyzing		
CO 4: Provide the information about the different enforcements and practical aspects involved in protection of IPR.													Evaluating		
CO 5: Provide different organizations role and responsibilities in the protection of IPR in the international level.													Understanding		
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	-	-
CO2	3	3	2	-	1	-	-	-	-	2	-	1	2	-	-
CO3	3	2	2	1	1	-	-	-	-	2	-	1	2	-	-
CO4	3	3	2	1	2	-	-	-	-	3	-	1	3	1	-
CO5	2	2	-	1	1	-	-	-	-	2	-	1	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 - Basic knowledge of textile materials and textile processing - Familiarity with fibres, yarns, and fabric manufacturing - Basic understanding of chemical processing in textiles (desirable but not mandatory)															
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 PERIODS															
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			
CO 1: Basics of Resin Finishing Process.												Knowledge / Understanding			
CO 2: Concept of Flame proof & flame retardancy, waterproof and water repellent Antimicrobial finishes.												Application			
CO 3: Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.												Analysis			
CO 4: Concept of Mechanical finishing.												Understanding			
CO 5: Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.												Evaluation			
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	-
CO2	3	3	2	-	1	-	-	-	-	2	-	1	2	1	-
CO3	3	2	3	1	2	-	-	-	-	3	-	1	3	2	1
CO4	2	2	1	1	1	-	-	-	-	2	-	1	2	1	-
CO5	3	3	2	1	2	-	-	-	-	3	-	1	3	2	1

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 - Basic understanding of garment manufacturing processes. - Familiarity with sewing operations and production workflow (recommended).					
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
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 PERIODS					
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 (P) Ltd., New Delhi, 1988, ISBN: 0882756311 ISBN-13: 9780882756318					
2.Chuter A. J., “Introduction to Clothing Production Management”, Wiley-Black well Science, U.S. A., 1995, ISBN: 0632039396 ISBN-13: 9780632039395					
3.GordanaColovic., “Ergonomics in the garment industry”, Wood publishing India Pvt. Ltd., India, 2014, ISBN: 0857098225 ISBN-13: 9780857098221					
4.Rajesh Bheda, “Managing Productivity in Apparel Industry “CBS Publishers & Distributors, 2008					
Course Outcomes:					Blooms Taxonomy
CO1: Fundamental concepts of industrial Engineering and productivity					Understand
CO2: Method study					Apply

CO3: Motion analysis												Analyze			
CO4: Work measurement and SAM												Apply			
CO5: Ergonomics and its application to garment industry												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	-	1	1	-	2	-	1	2	1	1
CO2	3	3	2	1	2	-	1	2	1	2	-	1	3	2	1
CO3	3	3	2	1	2	-	1	2	1	3	-	1	3	2	2
CO4	3	3	2	2	3	-	1	2	1	3	-	1	3	2	2
CO5	3	2	1	1	2	1	2	2	1	2	-	2	3	2	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CHO005	BASICS OF TEXTILE MANUFACTURE	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Fundamental knowledge of basic physics and chemistry – Students should understand basic concepts of matter, polymers, chemical bonding, and material properties. - Basic understanding of mathematics – Ability to perform simple calculations related to yarn numbering, production sequences, and machine parameters. - General awareness about textiles – Familiarity with common textile products and everyday textile materials (helpful but not mandatory). - Interest in material science and manufacturing processes – Useful for understanding fibre formation, yarn production, weaving, knitting, and fabric-related processes.					
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 PERIODS					
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. 7					
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 Spinning, Vol.1”, Rieter Machine Works Ltd., Winterthur, 2014, ISBN 10 3-9523173-1-4 / ISBN 13 978-3-9523173-1-0.					
4.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.					
5.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.					
6.Talukdar. M.K., Sriramulu. P.K., and Ajgaonkar. D.B., “Weaving: Machines, Mechanisms, Management”, Mahajan Publishers, Ahmedabad, 1998, ISBN: 81-85401-16-0.					
7.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					
8.Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958					

Course Outcomes:												Blooms Taxonomy				
CO1: Classification of fibres and production of natural fibres												Understand				
CO2: Regenerated and synthetic fibres												Understand				
CO3: Yarn spinning												Apply				
CO4: Weaving												Analyze				
CO5: Knitting and nonwoven												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	1	-	1	-	1	3	2	1	
CO2	3	3	1	-	1	-	1	1	-	1	-	1	3	2	1	
CO3	3	3	2	1	1	-	1	1	-	2	-	1	3	3	2	
CO4	3	3	2	1	2	-	1	2	1	2	-	1	3	3	2	
CO5	3	2	1	1	2	-	2	2	1	2	-	1	3	3	2	
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 - Engineering Chemistry - Introduction to Chemical Engineering / Process Calculations - Thermodynamics and Fluid Mechanics (basic concepts)						
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 PERIODS						
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:					Blooms Taxonomy	
CO 1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process Learn the					Understand	
CO2: Understand the insights of primary treatment processes to produce the precursors					Understand	
CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.					Analyze	
CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.					Evaluate	
CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes.					Understand	

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

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

23EE0005	ENERGY CONSERVATION AND MANAGEMENT		Category: OEC			
			L	T	P	C
			3	0	0	3
Prerequisites Basic knowledge of thermodynamics, heat transfer, mechanical and electrical engineering concepts						
Course Objectives: - 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 &U sage: 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 PERIODS						
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	
CO 1: 1: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment					Remember	
CO2: : Study the Importance of Stoichiometry relations, Theoretical air requiredfor complete combustion					Understand	
CO3: Skills on combustion thermodynamics and kinetics					Apply	

CO4: : Apply calculation and design tube still heaters													Analyze		
CO5: Studied different heat treatment furnace													Understand		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	-	1	-	-	-	-	1	1	-	-
CO2	1	1	-	1	-	-	1	-	-	-	-	1	1	-	-
CO3	1	1	1	1	-	-	1	-	-	-	-	1	1	-	-
CO4	1	1	1	1	1	-	1	-	-	-	-	1	1	1	-
CO5	1	1	1	-	1	-	1	-	-	-	-	1	1	1	1
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23ECO003	SIGNALS AND SYSTEMS											Category: OEC			
												L	T	P	C
												3	0	0	3
Prerequisites • Engineering Mathematics (Calculus, differential equations) • Basic Electrical Engineering • Fourier series and transforms (introductory exposure) • Basic circuit theory (Kirchhoff’s laws, linear circuits)															
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: 45 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:															
References:															
1.B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd 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:													Blooms Taxonomy		
CO 1: Determine if a given system is linear/causal/stable													Apply		
CO2: Determine the frequency components present in a deterministic signal													Apply		
CO3: Characterize continuous LTI systems in the time domain and frequency domain													Analyze		
CO4: Characterize discrete LTI systems in the time domain and frequency domain													Analyze		
CO5: Compute the output of an LTI system in the time and frequency domains													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

[illegible]

23ECO004	FUNDAMENTALS of ELECTRONIC DEVICES AND CIRCUITS											Category: OEC			
												L	T	P	C
												3	0	0	3
Prerequisites - Basic knowledge of electrical circuits and semiconductor fundamentals - High school physics on current, voltage, and resistance - Understanding of basic electronic components like resistors, capacitors, and diodes															
Prerequisites - Basic knowledge of electrical circuits and semiconductor fundamentals - High school physics on current, voltage, and resistance - Understanding of basic electronic components like resistors, capacitors, and diodes															
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: 45 PERIOD															
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:															
1Donald.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:													Blooms Taxonomy		
CO 1: Explain the structure and working operation of basic electronic devices													Understand		
CO2: Design and analyze amplifiers													Apply		
CO3: Analyze frequency response of BJT and MOSFET amplifiers													Analyze		
CO4: Design and analyze feedback amplifiers and oscillator principles													Apply		
CO5: Design and analyze power amplifiers and supply circuits													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

[illegible]

23MEO008	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites - Fundamentals of engineering design - Basic project management concepts - Ability to work in teams and communicate effectively					
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					
3.John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.					
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

Analyze

C02:Solve specific problems independently or as part of a team

Apply

CO3: Gain knowledge of the Innovation & Product Development process in the Business Context

Understand

CO4:Work independently as well as in teams

Apply

C05:Manage a project from start to finish

Evaluate

CO-PO Mapping

[illegible]

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

23BMO002	ASSISTIVE TECHNOLOGY												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites • Basic human anatomy and physiology • Fundamentals of biomedical instrumentation • Basic electrical and electronic devices																
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, 1stedition, 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		
CO2: Describe the underlying principles of hemodialyzer machine.														Understand		
CO3: Indicate the methodologies to assess the hearing loss.														Apply		
CO4: Evaluate the types of assistive devices for mobilization														Evaluate		
CO5: Explain about TENS and biofeedback 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	2	1	2	1	1	-	-	-	1	3	2	1	
CO2	3	2	2	1	1	1	1	1	-	-	-	1	3	2	1	
CO3	2	2	2	2	1	1	1	1	1	2	1	1	3	2	1	
CO4	3	3	3	2	1	1	2	2	1	2	1	2	3	3	2	

CO5	2	2	2	1	1	1	1	1	-	1	-	1	2	2	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MAO001	OPERATIONS RESEARCH	Category: OEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Engineering Mathematics (Algebra, Calculus) • Matrices and linear algebra operations • Basic optimization concepts (introductory)					
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.					Apply

CO2: Analyze the concept of developing, formulating, modeling and solving transportation and assignment problems													Analyze		
CO3: Solve the integer programming problems using various methods.													Apply		
CO4: Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming													Analyze		
CO5: Determine the optimum solution for non linear programming problems													Apply		
CO-PO Mapping															
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	-	-	-	-	1	-	2	3	2	1
CO2	3	3	3	3	2	-	-	-	-	1	-	2	3	2	1
CO3	3	3	3	2	2	-	-	-	-	1	-	2	3	3	1
CO4	3	3	3	3	2	-	-	-	-	1	-	2	3	3	2
CO5	3	3	2	2	3	-	-	-	-	1	-	2	3	2	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 • Basic algebra (sets, functions, relations) • Elementary number theory concepts (divisibility, primes) • Basic proof techniques (mathematical induction, direct & indirect proofs)																
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 – 2x2 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			
CO2: Demonstrate accurate and efficient use of advanced algebraic techniques													Apply			
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 proven by the text													Analyze			
CO4: Apply algebraic and number-theoretic methods to solve Diophantine equations, linear congruences, and related problems.													Apply			
CO5: Analyze classical theorems (Wilson, Fermat, Euler) and multiplicative functions (Euler’s Phi, Tau, Sigma) to solve advanced number-theoretic problems.													Analyze			
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	-	1	3	2	1	
CO2	3	3	2	1	1	-	-	-	-	1	-	1	3	2	1	
CO3	3	3	3	2	1	-	-	-	-	1	-	2	3	3	2	

CO4	3	3	2	2	1	-	-	-	-	1	-	2	3	2	2
CO5	3	3	3	2	1	-	-	-	-	1	-	2	3	3	2
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23MAO003	LINEAR ALGEBRA												Category: OEC			
													L	T	P	C
													3	0	0	3
Prerequisites • Basic algebra and arithmetic operations • Elementary matrices and determinants • High school level vector operations																
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 PERIODS																
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, 5th Edition,2019																
References:																
1. Bernard Kolman, David R. Hill, Introductory Linear Algebra, Pearson Educations, New Delhi, 8th Edition, 2009.																
2. Gerald C.F. and Wheatley P.O, Applied Numerical Analysis, Pearson Educations, New Delhi, 7th 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, 4th 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													Apply			
CO2: Find the basis and dimension of vector space													Apply			
CO3: Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.													Analyze			
CO4: Find orthonormal basis of inner product space and find least square approximation													Analyze			
CO5: Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.													Analyze			
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	-	-	3	2	1	
CO2	3	3	2	2	1	-	-	-	-	1	-	1	3	2	2	
CO3	3	3	3	2	1	-	-	-	-	1	-	1	3	3	2	

CO4	3	3	3	2	1	-	-	-	-	1	-	1	3	3	2
CO5	3	3	3	2	1	-	-	-	-	1	-	1	3	3	2
1 - Low, 2 - Medium, 3 - High , ‘-’ No correlation															

OPEN ELECTIVE – IV

22HSO002	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															

23CEO008	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 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	-	-	-	

[illegible]

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 sOECialized random processes which are apt for modelling the real time scenario. - To understand the concept of correlation and sOECtral 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		SOECIAL RANDOM PROCESSES				9
Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.						
Unit IV		CORRELATION AND SOECTRAL DENSITIES				9
Auto correlation functions – Cross correlation functions – Properties – Power sOECtral density – Cross sOECtral 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 sOECtral 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 respect 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					

[illegible]

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, <i>Multivariate Data Analysis</i>, 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

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 problem Pricing 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

23EEO006	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, antiglare 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 DhaneshN.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 R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.															
4. Samuel C. Certo: Modern Management, 2012.															
Course Outcomes:													Blooms Taxonomy		
CO 1: Plan an organizational structure for a given context in the organization to carry out 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 PERT and CPM.													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 Productivityand 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 andSupply 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, HimalayaPublishing 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 requirements and developing capacity alternatives													Analyze		
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 sOECifications - 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- InsOEction 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

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

23EEO007	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 & amp; 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			
		L	T	P	C
		3	0	0	3
Prerequisites • Basic Materials Science • Solid-State Physics • Fundamentals of Chemistry (esOEcially 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															

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

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 Illah R. Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.					
References:					
1. Dragomir N. Nenchev, Atsushi Konno, Teppei Tsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018					
2. Mohanta Jagadish 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	

[illegible]

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	-	

[illegible]

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: Createthe 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	

23CEO006	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 programmers (EDP)-Generation incubation and commercialization of ideas and innovations- Motivation and entrepreneurship development- Globalization and the emerging business entrepreneurial environment.					
Unit II	AGRIPRNEURSHIP 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															

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

23EEO010	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															

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 dying- 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		SYNTHETIC 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, sOECial 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 INSOECTION AND DIMENSIONAL CHANGES												9		
Raw material, in process and final insOEction; 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 68abelling 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. Peggall 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 insOEction and dimensional changes													Analyse (K4)		
CO 5: Garment pressing, packing and care 68abelling													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															

23CEO009	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 insOEction – 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 sOECific 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 Plastcis, 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 sOECifications.													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 Eshranghian, “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 Bonfiglio 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	

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 inclinical 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. 1. 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															

VERTICAL 1: FINTECH AND BLOCK CHAIN

23CMG001	FINANCIAL MANAGEMENT												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites Nil																
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 Periods																
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			
CO1: Explain the scope, objectives, and fundamental concepts of financial management including time value of money and risk–return relationships													Understand			
CO2: Analyze various sources of long-term and short-term finance and evaluate their features, merits, and limitations													Analyze			
CO3: Apply and evaluate capital budgeting techniques, estimate cost of capital, and compute weighted average cost of capital for investment decisions.													Apply			
CO4: Assess financing and dividend decisions using leverage concepts, capital structure determinants, and dividend policy frameworks.													Evaluate			
CO5: Examine working capital management decisions including cash management strategies, receivable policies, and determinants of working capital													Analyze			
CO - PO & PSO Mapping																
Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	

[illegible]

23CMG002	FUNDAMENTALS OF INVESTMENT												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites																
• Nil																
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 Periods																
References:																
1. Charles P. Jones, Gerald R. Jensen. Investments: analysis and management. Wiley, 14 th Edition, 2019																
2. Chandra, Prasanna. Investment analysis and portfolio management. McGraw-hill education, 5 th , Edition, 2017.																
3. Rustagi, R. P. Investment Management Theory and Practice. Sultan Chand & Sons, 2021.																
4. ZviBodie, Alex Kane, Alan J Marcus, PitabusMohanty, Investments, McGraw Hill Education (India), 11 Edition (SIE), 2019																
Course Outcomes:													Blooms Taxonomy			
CO1: Explain the investment environment, types of investment avenues, market participants, trading mechanisms, risk–return concepts, and the impact of taxes and inflation													Understand			
CO2: Analyze fixed-income securities, bond valuation, yield estimation, and various bond risks including default risk and credit ratings													Analyze			
CO3: Evaluate approaches to equity analysis using fundamental analysis, technical analysis, and valuation models including dividend and P/E methods													Evaluate			
CO4: Examine and interpret portfolio concepts, diversification, mutual funds, and derivative instruments relevant to the Indian financial markets													Analyze			
CO5: Assess investor protection mechanisms, including the role of SEBI, stock exchanges, grievance redressal systems, insider trading regulations, and investor awareness													Evaluate			
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	–	–	–	1	–	2	–	–	–	
CO2	2	3	1	2	2	–	–	–	–	–	–	2	–	–	–	
CO3	1	3	1	2	2	1	–	1	–	1	–	3	–	–	–	
CO4	1	3	1	3	2	–	–	–	1	1	1	3	–	–	–	

CO5	1	3	1	3	1	3	1	2	–	1	1	3	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG003	BANKING, FINANCIAL SERVICES AND INSURANCE											Category: MEC			
												L	T	P	C
												3	0	0	3
Prerequisites															
• Nil															
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 Periods															
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		
CO1: Explain the structure, functions, regulations, and customer–banker relationships within the Indian banking system.													Understand		
CO2: Analyze bank fund management, negotiable instruments, asset–liability management, NPA issues, and banking products													Analyze		
CO3: Evaluate developments in banking technology, e-payment systems, IT Act compliance, cybersecurity threats, and RBI technology guidelines.													Evaluate		
CO4: Examine and differentiate major financial services, including leasing, hire purchase, NBFC operations, venture capital, factoring, and merchant banking.													Analyze		
CO5: Interpret and assess insurance concepts, regulatory frameworks, policy structures, and claim settlement procedures in India.													Evaluate		
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	2	1	2	–	1	–	2	–	–	–
CO2	2	3	1	2	2	1	1	–	–	–	–	2	–	–	–
CO3	2	2	2	3	3	1	–	–	1	1	1	3	–	–	–
CO4	1	3	1	3	2	1	1	–	–	1	1	3	–	–	–
CO5	1	3	1	2	2	2	1	2	–	1	1	3	–	–	–

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

23CMG004	INTRODUCTION TO BLOCKCHAIN AND ITS APPLICATIONS	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites					
• Nil					
Course Objectives:					
- To provide foundational knowledge of blockchain technology, including its evolution, architecture, types, decentralization principles, and consensus mechanisms. - To develop an in-depth understanding of cryptocurrencies, focusing on Bitcoin, alternative coins, digital wallets, mining, transactions, and smart contract deployment. - To enable students to explore the Ethereum ecosystem, including the EVM, test networks, private networks, and hands-on smart contract development. - To familiarize learners with Web3 concepts and enterprise blockchain platforms, including Hyperledger Fabric, Corda, and decentralized application frameworks. - To expose students to emerging trends, research challenges, and advanced blockchain solutions, including scalability, privacy, and notable modern blockchain projects and tools.					
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 Periods					
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
CO1: Explain the fundamental concepts of blockchain technology, including distributed systems, decentralization, and consensus mechanisms					Understand
CO2: Analyze the functioning of major cryptocurrencies by examining Bitcoin transactions, mining processes, altcoins, and smart contract operations					Analyze
CO3: Develop and deploy smart contracts and decentralized applications using the Ethereum ecosystem, the EVM, and test/private networks					Apply
CO4: Compare and evaluate Web3 frameworks and enterprise blockchain platforms such as Hyperledger and Corda for various application scenarios					Evaluate
CO5: Investigate and critique emerging blockchain trends, scalability and privacy challenges, and recent research developments to identify potential innovation opportunities.					Analyze
CO - PO & PSO Mapping					

[illegible]

23CMG005	FINTECH PERSONAL FINANCE AND PAYMENTS	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites Nil					
Course Objectives: - To provide foundational understanding of cryptocurrencies, digital wallets, payment systems, and their legal, ethical, and security implications. - To expose learners to digital finance innovations, including crowdfunding, ICOs, and the digitization of financial services. - To introduce InsurTech advancements driven by AI, ML, IoT, risk modelling, fraud detection, and claims automation. - To explore peer-to-peer (P2P) lending ecosystems, marketplace lending technologies, crowdfunding platforms, and MSME financing challenges. - To familiarize students with global and domestic FinTech regulations, RegTech ecosystems, and AI-driven compliance and fraud detection systems.					
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 Crowd funding 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 Periods					
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:TheBeginner’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
CO1: Explain cryptocurrencies, digital payments, blockchain-based systems, and associated legal, ethical, and security issues					Understand

CO2: Analyze digital finance mechanisms including crowdfunding models, ICOs, and financial service digitization													Analyze		
CO3: Apply AI/ML, IoT, and digital tools in InsurTech processes such as risk modeling, fraud detection, and claims processing													Apply		
CO4: Evaluate P2P lending architectures, marketplace lending models, MSME financing innovations, and global crowdfunding ecosystems													Evaluate		
CO5: Assess and interpret FinTech regulations, RegTech frameworks, and AI-driven compliance and fraud detection systems													Analyze		
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	2	–	1	–	2	–	–	–
CO2	2	3	1	2	2	1	1	–	–	–	–	2	–	–	–
CO3	2	2	2	2	3	–	–	–	1	1	1	2	–	–	–
CO4	1	3	2	3	2	1	1	–	–	1	1	3	–	–	–
CO5	2	3	1	3	3	2	1	2	–	1	1	3	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23CMG006	INTRODUCTION TO FINTECH	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites • Nil					
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 Periods					
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
CO1: Explain the concepts, evolution, significance, and sector-wise development of FinTech and its role in economic growth					Understand
CO2: Analyze the applications of FinTech in payment systems, digital wallets, lending models, microfinance, and crowdfunding					Analyze
CO3: Evaluate the role of FinTech in wealth management and insurance industries, including automated investing, P2P insurance, and digital policy servicing					Evaluate
CO4: Compare and assess global FinTech developments, regulatory environments, and the collaborations between financial institutions and FinTech firms					Analyze

CO5: Interpret and critique emerging FinTech trends, the future of financial services, innovation through data, and ethical implications of digital finance													Evaluate		
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	2	1	1	–	1	–	2	–	–	–
CO2	2	3	1	2	2	1	1	–	–	–	–	2	–	–	–
CO3	1	2	2	2	2	1	–	–	1	1	1	2	–	–	–
CO4	1	3	1	3	2	2	1	1	–	1	1	3	–	–	–
CO5	1	3	1	3	2	3	2	2	–	1	1	3	–	–	–
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

VERTICAL 2: ENTREPRENEURSHIP

23CMG007	FOUNDATIONS OF ENTREPRENERUSHIP	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: ❖ To develop and strengthen entrepreneurial mindset, qualities, and motivation among learners. ❖ To impart essential entrepreneurial skills and traits required for successful venture creation. ❖ To enable learners to apply entrepreneurship and management principles in technology-oriented businesses. ❖ To equip learners with the ability to plan, launch, and manage technology-driven enterprises effectively. ❖ To empower learners to innovate, sustain, and grow as competent technopreneurs in a competitive environment.					
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 – Buiness Envrionnemental Factors – Political-Economic Sociological-Technological-Environmental-Legal aspects – Human Reosources 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 - Characterisitcis of a technopreneur - Impacts of Technopreneurship on Society – Economy- Job Opportuinites 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 ENTREPRENERUSHIP				9
Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneuruship - NGO Entrepreneurship – Recent Entrprneruial Develoments - 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. Edi: 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													K2		
CO2: Understand the business ownership patterns and environment													K2		
CO3: Understand the Job opportunities in Industries relating to Technopreneurship													K2		
CO4: Learn about applications of technopreneurship and successful technopreneurs													K3		
CO5: Acquaint with the recent and emerging trends in entrepreneurship													K3		
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	-	-	-

23CMG008	TEAM BUILDING & LEADERSHIP MANAGEMENT FOR BUSINESS	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: ❖ To develop and strengthen leadership qualities and motivational abilities among learners. ❖ To impart essential leadership skills and traits required for successful entrepreneurial growth. ❖ To enable learners to apply team-building principles and theories in managing technology-oriented businesses. ❖ To equip learners with the capability to build, manage, and lead effective teams in a business environment. ❖ To empower learners to lead technology-driven enterprises efficiently through strong leadership and team-building practices.					
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					
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. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).					
4. Daft, R.L., The Leadership Experience, Cengage, (2015).					
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.					
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5thed, Jossey-Bass, (2013).					
Course Outcomes:					Blooms Taxonomy
CO1: Learn the basics of managing teams for business.					K2
CO2: Understand developing effective teams for business management					K2
CO3: Understand the fundamentals of leadership for running a business.					K2
CO4: Learn about the importance of leadership for business development.					K3

CO5: Acquaint with emerging trends in leadership effectiveness for entrepreneurs													K3		
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	-	-	-

23CMG009	CREATIVITY & INNOVATION IN ENTREPRENEURSHIP												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites NIL																
Course Objectives: - To develop creativity and innovative thinking skills among learners. - To impart knowledge on creative intelligence essential for entrepreneurial success. - To understand the applications of innovation in entrepreneurship and business growth. - To enable learners to design and develop innovative business models. - To encourage learners to apply creative and innovative approaches to solve business challenges.																
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																
References:																
1. Creativity and Inovation in Entrepreneurship, Kankha, Sultan Chand Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.																
2. Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.																
3. Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.																
4. Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.																
5.A.Dale Timpe, Creativity, Jaico Publishing House, 2003.																
6. Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.																
7. Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.																
Course Outcomes:													Blooms Taxonomy			
CO1: Learn the basics of creativity for developing Entrepreneurship													K2			
CO2: Understand the importance of creative inteligence for business growth													K2			
CO3: Understand the advances through Innovation in Industries													K2			
CO4: Learn about applications of innovation in building successful ventures													K3			
CO5: Acquaint with developing innovative business models to run the business effecientlty and effectively													K3			
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	-	-	-	

C02	3	1	1	-	-	1	2	-	2	-	1	1	-	-	-
C03	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C04	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C05	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-

23CMG010	PRINCIPLES OF MARKETING MANAGEMENT FOR BUSINESS	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: ❖ To provide learners with foundational knowledge of marketing concepts, principles, tools, and techniques relevant to entrepreneurship. ❖ To expose students to the nature, scope, and functions of marketing essential for industry practice. ❖ To enable learners to understand the fundamentals of market-driven strategies for business growth. ❖ To familiarize students with the philosophies and tools of marketing management used by business owners. ❖ To equip learners with the ability to apply marketing concepts effectively in entrepreneurial ventures.					
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					
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 process					K2
CO2: Understand the marketing environment					K2
CO3: Acquaint about product and pricing strategies					K3
CO4: Knowledge of promotion and distribution in marketing management.					K3
CO5: Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.					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	-	-	-

23CMG011	HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS		Category: MEC			
			L	T	P	C
			3	0	0	3
Prerequisites						
• NIL						
Course Objectives:						
❖ To introduce learners to the basic concepts, structure, and functions of Human Resource Management (HRM) relevant to entrepreneurs.						
❖ To create awareness about the roles and responsibilities of the Human Resource Department in an organization.						
❖ To help learners understand the various methods and techniques used by HRM practitioners.						
❖ To enable students to appreciate the importance of effective HRM practices in entrepreneurial ventures.						
❖ To equip learners with foundational HRM knowledge to manage people efficiently in business environments.						
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
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.						
7. K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill, 2021.						
8. Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012						
Course Outcomes:					Blooms Taxonomy	
CO1: To understand the Evolution of HRM and Challenges faced by HR Managers					K2	
CO2: To learn about the HR Planning Methods and practices.					K2	
CO3: To acquaint about the Recruitment and Selection Techniques followed in Industries.					K3	
CO4: To know about the methods of Training and Employee Development..					K2	
CO5: To comprehend the techniques of controlling human resources in organisations.					K4	
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	-	-	-

23CMG012	FINANCING NEW BUSINESS VENTURES	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites • NIL					
Course Objectives: ❖ To develop foundational knowledge of business venture financing among learners. ❖ To impart essential financial knowledge required for entrepreneurs to fund new ventures. ❖ To familiarize learners with various sources of debt and equity financing. ❖ To equip students with the skills needed to plan and execute effective fundraising strategies. ❖ To enable learners to make informed financial decisions for launching and sustaining entrepreneurial ventures.					
Unit I	ESSENTIALS OF NEW BUSINESS 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					
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. Mcgraw-Hill Higher Education, 2014.					
10. Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.					
Course Outcomes:					Blooms Taxonomy
CO1: Learn the basics of starting a new business venture.					K2

CO2: Understand the basics of venture financing.													K2		
CO3: Understand the sources of debt financing.													K2		
CO4: Understand the sources of equity financing.													K2		
CO5: Acquaint with the methods of fund raising for new business ventures.													K3		
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	-	-	-

VERTICAL 3: PUBLIC ADMINISTRATION

23CMG013	PRINCIPLES OF PUBLIC ADMINISTRATION	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: ❖ To introduce the foundational concepts, evolution, and scope of Public Administration as an academic discipline and professional field. ❖ To explain the structure, functions, and processes of governmental organizations at various administrative levels. ❖ To analyze classical and modern administrative theories to understand their relevance in contemporary governance. ❖ To develop an understanding of decision-making, public policy formulation, personnel administration, budgeting, and accountability mechanisms. ❖ To enable students to critically evaluate administrative challenges and propose efficient, ethical, citizen-centric solutions.					
Unit I	FOUNDATIONS OF PUBLIC ADMINISTRATION				9
Meaning, Nature and Scope of Public Administration,Importance of Public Administration,Evolution of Public Administration					
Unit II	Contemporary Trends in Public Administration				9
New Public Administration,New Public Management,Public and Private Administration.					
Unit III	Administrative Approaches and Disciplinary Relationships				9
Relationships with Political Science, History and Sociology,Classical Approach,Scientific Management Approach					
Unit IV	Major Administrative Theoretical Frameworks				9
Bureaucratic Approach: Max Weber,Human Relations Approach : Elton Mayo,Ecological Approach : Riggs					
Unit V	Administrative Behaviour and Decision Processes				9
Leadership: Leadership - Styles - Approaches,Communication: Communication Types - Process - Barriers ,Decision Making: Decision Making - Types, Techniques and Processes.					
Total periods:45					
Text Books:					
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.					
References:					
1.R.B. Jain: Public Administration in India,21st Century Challenges for Good Governance, New Delhi: Deep and Deep, 2002.					
2.Rumki Basu: Public Administration:Concept and Theories, New Delhi:Sterling, 2013.					
3.R. Tyagi, Public Administration, Atma Ram & Sons, New Delhi, 1983.					
Course Outcomes:					Blooms Taxonomy
CO1: Students will be able to recall and describe the fundamental concepts, evolution, and significance of Public Administration.					K1
CO2: Students will explain administrative structures, relationships, and functions across various levels of government.					K2
CO3: Students will apply administrative principles and theories to assess governance scenarios.					K3
CO4: Students will analyze public policy processes, budgeting systems, personnel administration, and accountability frameworks.					K4

CO5: Students will evaluate administrative challenges and design ethical, efficient, citizen-oriented governance solutions.													K5		
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	-	-	-

23CMG014	CONSTITUTION OF INDIA												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites																
• NIL																
Course Objectives:																
❖ To outline the historical background and constitutional developments in India from 1909 to 1947.																
❖ To explain the philosophy and core components of the Indian Constitution, including Fundamental Rights, Duties, and Directive Principles.																
❖ To describe the structure, powers, and functioning of major Union government institutions such as the President, Parliament, and Supreme Court.																
❖ To examine the organization and roles of State-level institutions including the Governor, State Legislature, and High Court.																
❖ To develop an understanding of key constitutional values																
Unit I	Historical Foundations of the Indian Constitution												9			
Constitutional Development Since 1909 to 1947,Making of the Constitution.,Constituent Assembly																
Unit II	Principles and Philosophy of the Indian Constitution												9			
Fundamental Rights,Fundamental Duties,Directive Principles of State Policy																
Unit III	Union Government and Judiciary												9			
President,Parliament,Supreme Court																
Unit IV	State Government and Judiciary												9			
Governor,State Legislature,High Court																
Unit V	Constitutional Values and Protective Measures												9			
Secularism,Social Justice,Minority Safeguards																
Total periods:45																
Text Books:																
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																
References:																
1.Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi																
2. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi.																
Course Outcomes:													Blooms Taxonomy			
CO1: Students will be able to recall and explain the major constitutional developments from 1909–1947 and the process of constitution-making.													K1			
CO2: Students will be able to interpret and differentiate the Fundamental Rights, Fundamental Duties, and Directive Principles of State Policy.													K2			
CO3: Students will be able to examine the structure, powers, and functions of key Union-level institutions such as the President, Parliament, and Supreme Court.													K3			
CO4: Students will be able to analyze and compare the roles and functions of the Governor, State Legislature, and High Court within the federal framework.													K4			
CO5: students will be able to evaluate constitutional values such as secularism, social justice, and minority safeguards, and assess their relevance in contemporary													K5			
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	-	-	-	

23CMG015	PUBLIC PERSONNEL ADMINISTRATION											Category: MEC			
												L	T	P	C
												3	0	0	3
Prerequisites • NIL															
Course Objectives: ❖ To explain the meaning, scope, and significance of Public Personnel Administration in modern governance. ❖ To understand various personnel systems and the nature of relationships between civil servants, specialists, and political executives. ❖ To examine recruitment, training, and promotion processes within public services. ❖ To describe the structure and functioning of All India Services, service conditions, and State Public Service Commissions. ❖ To analyze employer–employee relations, wage and salary administration, and employee benefits in the public sector.															
Unit I	Foundations of Public Personnel Administration											9			
Meaning, Scope and Importance of Personnel Administration, Types of Personnel Systems: Bureaucratic, Democratic and Representative systems															
Unit II	Administrative Roles and Ethical Relationships											9			
Generalist Vs Specialist, Civil Servants' Relationship with Political Executive, Integrity in Administration.															
Unit III	Personnel Processes: Recruitment, Training, and Promotion											9			
Recruitment: Direct Recruitment and Recruitment from Within, Training: Kinds of Training, Promotion															
Unit IV	Public Services Structure and Regulatory Bodies											9			
All India Services, Service Conditions, State Public Service Commission															
Unit V	Employee Relations and Compensation Systems											9			
Employer Employee Relations, Wage and Salary Administration, Allowances and Benefits															
Total periods: 45															
Text Books:															
1. Stahl Glean O: Public Personnel Administration															
2. Parnandikar Pai V.A: Personnel System for Development Administration.															
References:															
1. Bhambhiru . P: Bureaucracy and Policy in India.															
2. Dwivedi O.P and Jain R.B: India's Administrative state.															
3. Muttalis M.A: Union Public Service Commission.															
4. Davar R.S. Personnel Management & Industrial Relations															
5. Bhakara Rao .V: Employer Employee Relations in India.															
Course Outcomes:													Blooms Taxonomy		
CO1: Describe the meaning, scope, and importance of personnel administration and identify different personnel systems.													K1		
CO2: Explain the roles of generalists and specialists, assess civil servant–political executive relations, and interpret issues related to integrity in administration.													K2		
CO3: Apply principles of recruitment, training, and promotion to evaluate personnel management practices in public organizations.													K3		
CO4: Discuss the structure and functioning of All India Services, service conditions, and State Public Service Commissions.													K2		
CO5: Evaluate employer–employee relations and analyze wage, salary, allowances, and benefits for improving personnel policies.													K4		
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	-	-	-

C02	3	1	1	-	-	1	2	-	2	-	1	1	-	-	-
C03	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C04	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C05	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-

23CMG016	ADMINISTRATIVE THEORIES												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites NIL																
Course Objectives: ❖ Introduce the meaning, scope, significance, and evolution of Public Administration as an academic discipline. ❖ To explain major organizational theories, including Scientific Management, Classical, and Human Relations approaches. ❖ To examine organizational behaviour, group dynamics, organizational goals, and structural design. ❖ To analyze major motivation and leadership theories, along with decision-making processes in administration. ❖ To understand and evaluate the contributions of prominent administrative thinkers such as Kautilya, Woodrow Wilson, C.I. Barnard, and Peter Drucker.																
Unit I	Foundations and Evolution of Public Administration												9			
Meaning, Scope and significance of Public Administration, Evolution of Public Administration as a discipline and Identity of Public Administration																
Unit II	lassical and Modern Organizational Theories												9			
Theories of Organization: Scientific Management Theory, Classical Model, Human Relations Theory																
Unit III	Organizational Behaviour, Group Dynamics, and Design												9			
Organization goals and Behaviour, Groups in organization and group dynamics, Organizational Design.																
Unit IV	Motivation, Leadership, and Decision-Making Theories												9			
Motivation Theories, content, process and contemporary; Theories of Leadership: Traditional and Modern: Process and techniques of decision-making																
Unit V	Contributions of Major Administrative Thinkers												9			
Administrative thinkers: Kautilya, Woodrow Willson, C.I. Barnard . Peter Drucker																
Total periods:45																
Text Books:																
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																
References:																
1. Johari J.C.: Indian Politics, Vishal Publications Ltd, New Delhi																
2. Agarwal R.C: Indian Political System; S.Chand & Co., New Delhi.																
Course Outcomes:													Blooms Taxonomy			
CO1: Describe the meaning, scope, significance, and evolution of Public Administration as a discipline.													K1			
CO2: Explain and compare different organizational theories including Scientific Management, Classical, and Human Relations approaches.													K2			
CO3: Students will be able to examine the structure, powers, and functions of key Union-level institutions such as the President, Parliament, and Supreme Court.													K4			
CO4: Apply motivation and leadership theories and evaluate decision-making techniques in administrative settings.													K3			
CO5: Assess the contributions of key administrative thinkers and their relevance to modern administrative practice.													K4			
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	-	-	-	

C02	3	1	1	-	-	1	2	-	2	-	1	1	-	-	-
C03	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C04	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C05	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-

23CMG017	INDIAN ADMINISTRATIVE SYSTEM.	Category: MEC			
		L	T	P	C
		3	0	0	3
Prerequisites NIL					
Course Objectives: ❖ To explain the evolution and constitutional framework of the Indian administrative system and the roles of key constitutional authorities. ❖ To understand the structure, functions, and interrelationships of district-level administration and local government institutions. ❖ To examine the major features of the 73rd and 74th Constitutional Amendment Acts and their impact on decentralisation. ❖ To analyze the influence of coalition politics and the mechanisms ensuring integrity and vigilance in Indian administration. ❖ To evaluate issues of corruption and the role of institutional mechanisms such as the Ombudsman, Lokpal, and Lokayukta.					
Unit I	Constitutional Foundations and Key Authorities of Indian Administration				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	District Administration and Local Governance				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	Constitutional Amendments and Decentralisation				9
Main Features of 73rd Constitutional Amendment Act 1992, Salient Features of 74th Constitutional Amendment Act 1992.					
Unit IV	Political Dynamics, Integrity, and Vigilance in Administration				9
Coalition politics in India, Integrity and Vigilance in Indian Administration					
Unit V	Anti-Corruption Institutions and Mechanisms				9
Corruption – Ombudsman, Lok Pal & Lok Ayuktha.					
Total periods:45					
Text Books:					
1.S.R. Maheswari : Indian Administration					
2.Khera. S.S : Administration in India					
References:					
1.Ramesh K. Arora : Indian Public Administration					
2.T.N. Chaturvedi : State administration in India					
3.Basu, D.D : Introduction to the Constitution of India					
Course Outcomes:					Blooms Taxonomy
CO1: Describe the evolution, constitutional context, and functions of key constitutional authorities in Indian administration.					K1
CO2: Explain the roles and functions of the District Collector, Superintendent of Police, Block Development Officer, and local government bodies.					K2
CO3: Analyze the salient features of the 73rd and 74th Constitutional Amendments and their relevance to decentralised governance.					K4
CO4: Examine the impact of coalition politics on governance and assess mechanisms promoting integrity and vigilance in administration.,					K4
CO5: Evaluate the causes of corruption and the effectiveness of institutions such as the Ombudsman, Lokpal, and Lokayukta.					K5
CO - PO Mapping					

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3	1	-	-	-	1	2	-	-	-	1	1	-	-	-
C02	3	1	1	-	-	1	2	-	2	-	1	1	-	-	-
C03	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C04	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C05	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-

23CMG018	PUBLIC POLICY ADMINISTRATION												Category: MEC			
													L	T	P	C
													3	0	0	3
Prerequisites																
• NIL																
Course Objectives:																
❖ Understand the meaning, nature, scope, and importance of public policy.																
❖ Analyze different approaches to policy analysis and policy-making.																
❖ Examine the stages involved in the policy-making process, including formulation, implementation, and evaluation.																
❖ Evaluate the roles of institutions, bureaucracy, interest groups, and political parties in policy-making.																
❖ Explore key public policies in India, including economic, population, agricultural, and information technology policies.																
Unit I	Introduction to Public Policy													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	Approaches in Policy Analysis													9		
Approaches in Policy Analysis - Institutional Approach – Incremental Approach and System’s Approach – Dror’s Optimal Model																
Unit III	Policy-Making Process													9		
Major stages involved in Policy making Process – Policy Formulation – Policy Implementation – Policy Evaluation.																
Unit IV	Institutional Framework of Policy-Making													9		
Institutional Framework of Policy making – Role of Bureaucracy – Role of Interest Groups and Role of Political Parties.																
Unit V	Key Public Policies in India													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.																
2.Kuldeep Mathur : Public Policy and Politics in India, Oxford University Press, 2016.																
References:																
1.Bidyutv Chakrabarty: Public Policy: Concept, Theory and Practice, 2015.																
2.Sapru R.K. : Public Policy: Formulation, Implementation and Evaluation, Sterling Publishers, 2016.																
3.Pradeep Saxena : Public Policy Administration and Development																
Course Outcomes:													Blooms Taxonomy			
CO1: Define and explain the concept of public policy and its importance.													K1			
CO2: Compare and contrast different approaches to policy analysis.													K2			
CO3: Apply knowledge of policy-making stages to real-world policy examples.													K3			
CO4: Analyze the influence of institutions, political parties, and interest groups in shaping public policy.													K4			
CO5: Evaluate the impact of major Indian public policies on society and governance.													K5			
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	-	-	-	

C04	3	1	-	-	1	1	2	-	2	-	1	1	-	-	-
C05	3	1	-	-	1	1	2	-	-	-	1	1	-	-	-

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 nterval 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 environments.													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	3	2	2	2	–	–	–	–	1	–	2	–	–	–
CO2	2	3	2	2	2	–	–	–	–	–	–	2	–	–	–
CO3	3	3	2	3	3	–	–	–	1	1	–	3	–	–	–
CO4	2	3	2	3	2	–	–	–	1	2	1	3	–	–	–
CO5	2	3	2	3	3	–	–	–	1	1	1	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	3	2	2	1	1	–	–	1	2	–	2	–	–	–
CO2	2	2	2	3	1	–	–	–	1	3	2	1	–	–	–
CO3	3	3	3	2	2	1	–	–	1	2	–	2	–	–	–
CO4	3	3	2	2	1	1	–	–	1	2	–	2	–	–	–
CO5	3	2	3	3	2	2	–	–	2	2	1	2	–	–	–

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	3	2	2	2	2	1	–	1	2	2	1	2	–	–	–
CO2	3	3	2	3	2	1	–	–	2	2	–	2	–	–	–
CO3	3	3	2	3	3	–	–	–	1	2	–	2	–	–	–
CO4	3	3	3	3	2	1	–	1	1	2	1	2	–	–	–
CO5	3	3	3	3	2	2	–	2	2	3	1	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	3	2	2	2	2	1	–	1	2	2	1	2	–	–	–
CO2	3	3	2	3	3	1	–	–	2	2	–	2	–	–	–
CO3	3	3	2	3	2	–	–	1	1	2	–	2	–	–	–
CO4	3	3	3	3	3	1	–	1	1	2	1	3	–	–	–
CO5	3	2	3	2	3	1	–	2	2	3	1	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	3	2	3	–	–	–	1	2	–	2	–	–	–
CO2	3	3	2	3	3	–	–	–	1	2	–	2	–	–	–
CO3	3	3	3	3	3	–	–	1	1	2	–	3	–	–	–
CO4	3	3	3	2	3	1	–	1	1	3	1	3	–	–	–
CO5	3	2	2	2	2	–	–	–	1	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	

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	-	-	-
CO2	3	3	2	-	2	-	2	-	-	2	-	1	-	-	-
CO3	3	3	3	2	2	-	2	1	-	3	-	1	-	-	-

CO4	2	3	2	2	2	1	2	2	-	3	-	2	-	-	-
CO5	2	2	2	2	3	1	3	2	1	3	-	2	-	-	-
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 <i>V/s.</i> 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	-	-	-
CO2	3	3	2	-	2	-	2	-	-	2	-	1	-	-	-
CO3	3	3	3	2	2	-	2	1	-	3	-	1	-	-	-
CO4	2	3	2	2	2	1	2	2	-	3	-	2	-	-	-
CO5	2	2	2	2	3	1	3	2	1	3	-	2	-	-	-
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 Compsite(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
Meatllicnanobiomaterials–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 Introductioin” 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	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	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	-	-	-	1	2	2	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	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	-	-	-	1	2	2	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	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	-	-	-	1	2	2	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	3	2	-	-	-	-	-	-	-
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 (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. 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	-	-	-	1	2	2	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	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 , Define 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
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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
CO1	2	2	-	-	-	1	2	2	-	-	-	-	-	-	-
CO2	2	2	2	-	2	1	2	2	-	-	-	-	-	-	-
CO3	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO4	2	3	3	2	2	1	2	2	-	-	-	-	-	-	-
CO5	2	3	3	3	2	2	3	2	-	-	-	-	-	-	-

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