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.

(i) Proficiency Modules

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

(ii) 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.

(iii) 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.

(iv) 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.

(v) 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

<table>
<tr><td rowspan="3">23HST101</td><td rowspan="3">PROFESSIONAL ENGLISH-I
(Common to All BE/B.Tech students except CSBS)</td><td colspan="4">Category: HSMC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">Prerequisites
• NIL</td></tr>
<tr><td colspan="6">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.</td></tr>
<tr><td>Unit I</td><td colspan="4">Introduction to fundamentals of communication</td><td>9</td></tr>
</table>

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. **Writing** - Writing emails, Letter of introducing oneself, Grammar - Present Tense (simple and progressive); Question types: Wh / Yes or No questions Question Tags, Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technicalcontexts).		
Unit II	**Narration And Summation**	**9**
Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. **Writing** - Guided writing-- Paragraph writing, Short Report on an event (field trip), Grammar –Past tense (simple); Subject-Verb Agreement, Prepositions, Vocabulary - Word forms (prefixes & suffixes) Synonyms and Antonyms, Phrasal verbs.		
Unit III	**Description of a Product/Process**	**9**
Reading – Reading advertisements, gadget reviews; user manuals. **Writing** definitions; instructions; and Product /Process description, Grammar - Imperatives; Adjectives, Degrees of comparison, Present & Past Perfect Tenses, Compound Nouns, Homonyms; and Homophones, Discourse markers (connectives & sequence words)		
Unit IV	**Classification And Recommendations**	**9**
Reading – Newspaper articles, Journal reports –and Non Verbal Communication (tables, pie chartsetc,). **Writing**–Note-making/Note-taking(*Study skills to be taught, not tested, Writing recommendations; Transferring information from Non-verbal (chart, graph, etc, to verbal mode), Articles, Pronouns, Possessive & Relative pronouns, Vocabulary – Collocations, Fixed / Semi fixed expressions.		
Unit V	**Expression**	**9**
Reading – Reading editorials, Opinion Blogs, **Writing –** Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation, Negation (Statements & Questions); Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions, Content vs Function words		
Total periods:45		
Text Books:		
1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).		
2. English for Science & Technology Cambridge University Press, 2021.		
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.		

References:

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

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

CO-PO,PSO Mappings

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

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

<table>
<tr><td rowspan="3">23MAT101</td><td rowspan="3">MATRICES AND CALCULUS
(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: BSC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
</table>

Prerequisites

- NIL

Course Objectives:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To understand various techniques of multiple integrals.

Unit I	**MATRICES**	**9+3**

Characteristic equation - Eigenvalues and Eigenvectors of a real matrix - Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton Theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical from by orthogonal transformation – Nature of quadratic forms-Applications of Eigen value and Eigen vector in Engineering (for classroom discussion, assignments and term paper work).

Unit II	**DIFFERENTIAL CALCULUS**	**9+3**

Derivatives – Differentiation rules (Sum, Product, Quotient, Chain rules) – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variables- Role of derivatives in Engineering Problems (for classroom discussion, assignments and term paper work).

Unit III	**FUNCTIONS OF SEVERAL VARIABLES**	**9+3**

Partial differentiation – Total derivative - Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables –Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers-Engineering Problems using Partial derivatives (for classroom discussion, assignments and term paper work).

Unit IV	**INTEGRAL CALCULUS**	**9+3**

The Definite and Indefinite integral – Integration techniques - Substitution methods-Integration by parts – Reduction formula ($Sin^n x$, $Cos^n x$) - Integration of rational functions (Partial fraction method) -Improper Integrals. Role of Integrations in Engineering Problems (for classroom discussion, assignments and term paper work.).

Unit V	MULTIPLE INTEGRALS	9+3
Double integrals– Double integrals in polar coordinates – Change of order of integration– Area enclosed by plane curves- Triple integrals – Volume of solids – Change of variable in double and triple integrals. Double integral models in Engineering (for classroom discussion, assignments and term paper work).		
Total periods: 60 PERIODS		

Text Books:

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

References:

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

Course Outcomes:	**Blooms Taxonomy**
CO 1: Use the matrix algebra methods for solving practical problems.	Apply(K3)
CO2: Apply differential calculus tools in solving various application problems.	Apply(K3)
CO3: Able to use differential calculus ideas on several variable functions.	Understand(K2)
CO4: Apply different methods of integration in solving practical problems.	Apply(K3)
CO5: Apply various techniques in multiple integrals.	Apply(K3)

CO-PO Mapping

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

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

23PHT101	ENGINEERING PHYSICS (Common to AIDS, BME, Biotech, CSE(AIML), CIVIL, CHEMICAL, CSE, CCE, CSBS, ECE, EEE, IT, MECH)	Category: BSC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to be successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

Unit I	MECHANICS	9

Multiparticle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of continuous bodies – M.I of a diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum – rotational energy state of a rigid diatomic molecule - gyroscope - torsional pendulum – double pendulum –Introduction to nonlinear oscillations.

Unit II	ELECTROMAGNETIC WAVES	9

The Maxwell’s equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

Unit III	OSCILLATIONS, OPTICS AND LASERS	9

Simple harmonic motion - resonance –analogy between electrical and mechanical oscillating systems - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect. Reflection and refraction of light waves - total internal reflection - interference – Michelson interferometer –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein’s coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser –Basic applications of lasers in industry.

Unit IV	BASIC QUANTUM MECHANICS	9

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D, 2D and 3D Boxes- Normalization, probabilities andthe correspondence principle.

Unit V	**APPLIED QUANTUM MECHANICS**	**9**
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
		Total periods: 45 PERIODS

Text Books:

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. Mc Graw Hill Education (Indian Edition), 2017.
2. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ. Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, Mc Graw-Hill (Indian Edition), 2017.

References:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the importance of mechanics.	Understand(K2)
CO2: Express their knowledge in electromagnetic waves	Understand(K2)
CO3: Demonstrate a strong foundational knowledge in oscillations, optics and lasers.	Understand(K2)
CO4: Understand the importance of quantum physics.	Remember(K1)
CO5: Comprehend and apply quantum mechanical principles towards the formation of energy bands.	Apply(K3)

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

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

23CYT101	**ENGINEERING CHEMISTRY** **(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: BSC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand water quality parameters, treatment process and corrosion.
- To understand adsorption and phase rule
- To evaluate engineering materials and the nature of polymers
- To Apply recent advanced energy sources and batteries.
- To observe various chemical composition in fuels and apply shock waves.

Unit I	**Universal Solvent (Water) and Corrosion**	**9**

Water quality parameters of-color, odour, turbidity, pH, hardness, TDS, COD and BOD, Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion. Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process. **Corrosion**- causes- factors-types chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control anodic and cathodic methods and corrosion inhibitors.

Unit II	**Surface Chemistry and Phase Rule**	**9**

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms. Langmuir's adsorption isotherm –Catalysis: Catalyst – types of catalysis – criteria – autocatalysis acid base catalysis – enzyme catalysis– Michaelis – Menten equation. Phase rule: Introduction, definition of terms with examples. One component system – water system; Reduced phase rule;– Thermal analysis; Two component system: lead-silver system – Pattinson process.

Unit III	Polymers and Alloys	9
Introduction- Definition- Properties of alloys- Significance and Functions and Ferrous alloys. Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze. Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.		
Unit IV	**Batteries and Energy Sources**	**9**
Batteries: Types of batteries, Primary battery – dry cell, Secondary battery – lead acid battery and lithium-ion battery; Electric vehicles. Advanced Energy Sources-Recent developments in solar cell materials. Fuel cells: H2-O2 fuel cell, microbial fuel cell; Super capacitors: Storage principle, types and examples		
Unit V	**Analytical Chemistry and Shock Wave**	**9**
Proximate and ultimate analysis of coal. Accuracy, precision, sensitivity, detection limits, significant figures, rounding off. Types of errors, determinate and indeterminate errors. Petroleum process. **Shock Wave-** Description of a shock wave and its applications. Methods of creating shock waves in the laboratory using a shock tube, description of hand operated Reddy shock tube and its characteristics.		
Total periods:45		
Text Books:		
1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai, Publishing Company (P) Ltd, New Delhi, 2018.		
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.		
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.		
4. Skoog, D.A.; West, D.M.; Holler, F.J.; Crouch, S.R. (2014),Fundamentals of Analytical Chemistry, Cengage Learning.		
References:		
1. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017		
2. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.		
3. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.		
4. O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.		
5. Shock waves made simple- Chintoo S Kumar, K Takayama and KPJ Reddy: Willey India Pvt. Ltd. New Delhi 2014.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: To know well about water quality parameters and corrosive nature of metals	Remember (K1)
CO2: Understand adsorption, its types and phases, phase rule	Understand (K2)
CO3: To use alloys and polymers in day to day life	Apply (K3)
CO4: To Understand the advantages of batteries, super capacitors and solar cell fabrication	Understand (K2)
CO5: To Analyse chemical composition of coal and understand petroleum process and uses of shock waves in real life.	Analyze (K4)

CO - PO Mapping

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

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

23GET101	**PROGRAMMING IN C**	**Category: ESC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

Unit I	**COMPUTATIONAL THINKING AND PROBLEM SOLVING**	**9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list ofsorted cards, guess an integer number in a range, Towers of Hanoi.

Unit II	**DATA TYPES, EXPRESSIONS, STATEMENTS**	**9**

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

Unit III	CONTROL FLOW, FUNCTIONS, STRINGS	9

Conditionals:Boolean values and operators, conditional (if), alternative (if-else),chained conditional (if-elif-else);Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

Unit IV	LISTS, TUPLES, DICTIONARIES	9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

Unit V	FILES, MODULES, PACKAGES	9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

Total periods: 45 PERIODS

Text Books:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

References:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data'', Third Edition, MIT Press , 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

Course Outcomes:	**Blooms Taxonomy**
CO1: Develop algorithmic solutions to simple computational problems.	Understand (K2)
CO2: Develop and execute simple Python programs.	Apply (K3)
CO3: Write simple Python programs using conditionals and loops for solving problems.	Apply (K3)

CO4: Decompose a Python program into functions.	Analyze (K4)
CO5: Represent compound data using Python lists, tuples, dictionaries etc.	Apply (K3)
CO6: Read and write data from/to files in Python programs.	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	-	-	-
CO2	3	3	2	2	1	-	-	-	-	2	-	1	-	-	-
CO3	3	3	3	2	2	-	-	-	-	2	-	1	-	-	-
CO4	3	3	3	3	2	-	-	-	-	2	-	1	-	-	-
CO5	3	3	2	2	3	-	-	-	-	2	-	1	-	-	-
AVG	3	3	3	2	2	-	-	-	-	2	-	1	-	-	-

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

23GET102	HERITAGE OF TAMILS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: HSMC			
		L	T	P	C
		1	0	0	1

Prerequisites

- Nil

Course Objectives:

- Introduce the richness of Tamil language and literature from ancient to modern times.
- Highlight the cultural and artistic contributions of Tamils such as sculpture, handicrafts, music and temple architecture.
- Expose students to folk traditions and martial arts practiced in Tamil society.
- Understand socio-economic life during the Sangam period, including trade, education and environmental concepts.
- Explain the contribution of Tamils to the Indian national freedom movement, and the impact on Indian culture and heritage.

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 & Jainismin Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

Unit II	LANGUAGE AND LITERATURE	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, Leather puppetry, 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:	

Text Books:

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

2 Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies

3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

4 The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

References:

1. 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)

2. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

3. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

4. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book

Course Outcomes:	Blooms Taxonomy
CO1: Explain the evolution and significance of Tamil language and literature.	Understand (K2)
CO2: Describe the contributions of Tamils in art, architecture and traditional crafts.	Understand (K2)
CO3: Identify and summarize Tamil folk arts and martial traditions.	Understand (K2)
CO4: Discuss the socio-cultural and economic life of Sangam Age including trade and education.	Analyze (K4)
CO5: Evaluate the contribution of Tamils to Indian freedom struggle and national culture.	Evaluate (K5)

CO - PO & PSO Mapping

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

CO2	2	2	-	-	-	-	2	2	-	1	-	-	-	-	-
CO3	1	1	-	-	-	-	3	2	1	1	-	-	-	-	-
CO4	2	2	2	2	-	-	3	2	1	1	-	-	-	-	-
CO5	2	3	2	2	-	-	3	3	2	2	1	1	-	-	-
AVG	1.8	1.8	1	1	-	-	2.4	2.2	1	1.2	1	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23GEP101	**PROGRAMMING IN C LABORATORY (Common to All Branches)**	**Category: ESC**			
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Prerequisites

- Nil

Course Objectives:

- To familiarize with C programming constructs.
- To develop programs in C using basic constructs.
- To develop programs in C using arrays.
- To develop applications 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

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, “Python for Programmers”, Pearson Education, 1st Edition, 2021.

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**
CO1: Demonstrate knowledge on C programming constructs.	Understand (K2)
CO2: Develop programs in C using basic constructs.	Apply (K3)
CO3: Develop programs in C using arrays.	Apply (K3)
CO4: Develop applications in C using strings, pointers, functions.	Apply (K3)
CO5: Develop applications in C using structures.	Apply (K3)
CO6: Develop applications in C using file processing.	Apply (K3)

CO – PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	-	1	1	-	-	-	-	-
CO2	2	2	1	-	-	-	-	-	2	1	-	-	-	-	-
CO3	2	2	2	1	-	-	-	-	2	2	-	-	-	-	-
CO4	2	2	2	2	2	-	-	1	3	3	-	-	-	-	-
CO5	2	3	2	2	2	-	-	2	3	3	-	-	-	-	-
AVG	2	2	1.4	1	1	-	-	1	2.2	2	-	-	-	-	-

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

23BSP101	**PHYSICS AND CHEMISTRY LABORATORY (Common to All Branches)**	**Category: BSC**			
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Prerequisites

- Nil

Course Objectives:

- To learn the proper use of various kinds of physics laboratory equipment.
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student 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	Air wedge - Determination of thickness of a thin sheet/wire
7	a) Optical fibre -Determination of Numerical Aperture and acceptance angle b) Compact disc- Determination of width of the groove using laser.
8	Ultrasonic interferometer – determination of the velocity of sound and compressibilityof liquids
9	Post office box -Determination of Band gap of a semiconductor.
10	Michelson Interferometer.
11	Melde's string experiment
	Total periods: 30 Periods

Text Books:
1. D. Halliday, R. Resnick, J. Walker, *Fundamentals of Physics*, 10th Edition, Wiley, 2018.
2R. Murugeshan, *Modern Physics*, S. Chand Publications, 2017.
References:
1. C. L. Arora, *Practical Physics*, S. Chand, 2015.
2. R. K. Gaur, S. L. Gupta, *Engineering Physics Lab Manual*, Dhanpat Rai & Co., 2015.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the functioning of various physics laboratory equipment.	Understand (K2)
CO2: Use graphical models to analyze laboratory data.	Apply (K3)
CO3: Use mathematical models as a medium for quantitative reasoning and describing physical reality.	Apply (K3)
CO4: Access, process and analyze scientific information.	Analyze (K4)
CO5: Solve problems individually and collaboratively.	Apply (K3)

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

23BSP101	**PHYSICS AND CHEMISTRY LABORATORY (Common to All Branches)**	**Category: BSC**			
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Prerequisites

- Nil

Course Objectives:

- To impart practical skills in the estimation of water quality parameters by volumetry and gravimetry.
- To familiarize the students with the estimation of impurities in aqueous solutions through electro analytical techniques such as, pH metry, potentiometry and conductometry.
- To demonstrate the analysis of metals by UV-Visible spectroscopic and flame photometric methods.
- To enable students to perform titrimetric and instrumental analytical methods with accuracy and precision.
- To promote hands-on training in analyzing chemical compositions using modern analytical instruments.

LIST OF EXPERIMENTS	
1	Determination of total, temporary & permanent hardness of water by EDTA method.
2	Determination of chloride content of water sample by Argentometric method.
3	Determination of types and amount of alkalinity in water sample.
4	Determination of DO content of water sample by Winkler's method.
5	Determination of strength of acids in a mixture of acids using conductivity meter.
6	Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
7	Estimation of iron content of the given solution using potentiometer.
	OPEN ENDED EXPERIMENTS
1	Determination of strength of given hydrochloric acid using pH meter.
2	Conductometric titration of Strong acid against Strong base.

Total periods: 30 Periods

Text Books:

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

2. V. K. Ahluwalia, SunithaDhingra and AdarshGulati, "College Practical Chemistry", Universities Press (India) Pvt. Ltd., 2018

References:

1. K. M. Smith, *Quantitative Inorganic Analysis*, Chapman & Hall, 2003.

Course Outcomes:	Blooms Taxonomy
CO1: To independently estimate the water quality parameters, such as, acidity, alkalinity, hardness, DO, TDS, chloride and copper contents by appropriate wet chemical analyses.	Analyze (K4)
CO2: To quantitatively analyse the impurities in aqueous solution by electro analytical techniques.	Apply (K3)
CO3: To determine the amount of metal ions in aqueous samples by spectroscopic techniques.	Apply (K3)
CO4: Interpret experimental data and generate technical laboratory reports with appropriate calculations, graphs, and error analysis.	Analyze (K4)
CO5: Demonstrate teamwork, laboratory safety practices, and professional ethics while performing chemistry and physics experiments.	Apply (K3)

CO – PO & PSO Mapping

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

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

23HSP102	**English Laboratory** **(Common to All Branches)**	**Category: EEC**			
		L	**T**	**P**	**C**
		0	**0**	**2**	**1**

Prerequisites

- Nil

Course Objectives:

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

LIST OF EXPERIMENTS

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

13	Listening – Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.
14	Speaking –making predictions- talking about a given topic-giving opinions
15	Understanding a website-describing processes
	Total periods: 30

Text Books:

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

References:

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

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

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

SEMESTER II

23HST201	**PROFESSIONAL ENGLISH - II**	**Category: HSMC**			
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Prerequisites

- Nil

Course Objectives:

- To improve the learners skill to read and comprehend the technical texts.
- To strengthen the ability of the learners' official written communication skill on technical context.
- To help learners to enhance the public speaking skills to make technical presentations, participate in group discussions.
- To develop their analytical thinking skills, problem solving skills and interpersonal skills of the learners.
- To develop the ability to write job applications and interviews for internship and effective reports.

Unit I	**STRENGTHENING PROFESSIONAL WRITING**	**12**

Listening – Evaluative Listening: Advertisements, Product Descriptions, -Audio / video; Active and passive Listening. Speaking – Asking and giving directions, Persuasive Speech Techniques. Writing – Professional emails writing - Compare and Contrast Essay; Itinerary Grammar –Tenses in Functional usage, Prepositional phrases Language Development – Contextual meaning of words, Purpose and statement.

Unit II	**BUSINESS WRITING IN TECHNICAL CONTEXT**	**12**

<table>
<tr><td colspan="3">Listening - Listening to longer technical talks and completing– gap filling exercises. Listening to the comprehension talks. – Listening to information from podcasts. Speaking – Describing and discussing the reasons of accidents or disasters based on news reports. Describing about process/ product (Technical and General). Reading - Reading longer technical texts-news reports, journals and understanding the technical terms. Writing - Writing responses to complaints. Letter writing- Accepting, Declining the invitation and seeking clarification. Grammar - Active Passive Voice transformations, Infinitive and Gerunds. Language Development – Word Formation, Adverbs.</td></tr>
<tr><td>Unit III</td><td>ENGLISH IN WORK PLACE</td><td>12</td></tr>
<tr><td colspan="3">Listening – Listening to / Watching movie scenes/ documentaries depicting a technical problem and suggesting solutions. Speaking – Group Discussion (based on case studies), Discussion on a technical topic of common interest by group participants. Reading - Practice in lexical chucking and speed reading, Reading the Case Studies, excerpts from literary texts, news reports etc., Writing – Jumbled sentences, Problem solution essay / Argumentative Essay. Grammar – Direct and Indirect questions; If conditional sentences. Language Development – Embedded sentences, Sentence Completion.</td></tr>
<tr><td>Unit IV</td><td>REPORTING OF THE EVENTS AND ANALYSING THE CONTENT</td><td>12</td></tr>
<tr><td colspan="3">Listening – Listening Comprehension based on IELTS Practice test. Speaking – Public Speaking (Debate, Extempore and just a minute), Presenting an oral report, Mini presentations on select topics. Reading –Newspaper articles; Technical reports and Advertisements. Writing – Minutes of the Meeting, Recommendations, Transcoding, Report writing- Feasibility and Survey report. Grammar – Verbal Analogies, Modals. Language Development – Conjunctions- use of prepositions</td></tr>
<tr><td>Unit V</td><td>THE ABILITY TO NARRATE THE INFORMATION PERSUASIVELY</td><td>12</td></tr>
<tr><td colspan="3">Listening – Listening and its process –Practices and strategies of better Listening. Listening to TED Talks, Presentations, Formal job interviews, (analysis of the interview performance); Speaking – Participating in a Role play, (interview/telephone interview), Types of role play, Mock interviews, Formal conversations. Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job application – Cover letter & Resume; Grammar – Numerical adjectives, Misspelt words. Language Development – Idioms, Error Spotting.</td></tr>
<tr><td colspan="3">Total periods:60</td></tr>
<tr><td colspan="3">Text Books:</td></tr>
<tr><td colspan="3">1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.</td></tr>
<tr><td colspan="3">References:</td></tr>
<tr><td colspan="3">1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.</td></tr>
<tr><td colspan="3">2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.</td></tr>
<tr><td colspan="3">3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003</td></tr>
<tr><td colspan="3">4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.</td></tr>
<tr><td colspan="3">5. Krishna Mohan, Meera Banerji, “Developing Communication Skills”, Trinity Press, 2017.</td></tr>
<tr><td colspan="2">Course Outcomes:</td><td>Blooms Taxonomy</td></tr>
<tr><td colspan="2">CO1: To apply the reading strategies to comprehend the technical terms and helps to compare and contrast products and ideas in technical texts.</td><td>Apply (K3)</td></tr>
<tr><td colspan="2">CO2: To listen and comprehend the cause and effects in events, industrial processes through technical texts.</td><td>Apply (K3)</td></tr>
</table>

CO3: To analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.													Analyze (K4)		
CO4: To speak appropriately and effectively in varied context in formal and informal context.													Apply (K3)		
CO5: To present their opinions in a planned and logical manner, and draft effective resumes in context of job search. It helps to report events and the processes of technical and industrial nature.													Apply (K3)		
CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	-	-	-	-	-	1	1	-	-	-	-	-
CO2	2	2	1	-	-	-	-	-	2	1	-	-	-	-	-
CO3	2	2	2	1	2	-	-	1	2	2	-	-	-	-	-
CO4	2	3	2	1	3	-	-	2	3	3	-	-	-	-	-
CO5	2	3	2	2	3	-	-	2	3	3	-	-	-	-	-
AVG	2	3	2	1	1.6	-	-	1	2.2	2	-	-	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MAT201	**COMPUTATIONAL METHODS** **(Common to all Branches B.E / B.TECH except B.E EEE)**	**Category: BSC**			
		L	**T**	**P**	**C**
		3	**1**	**0**	**4**

Prerequisites

- 23MAT101 Matrices and Calculus

Course Objectives:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the various numerical techniques for interpolation, differentiation and integration, this plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.
- To acquaint the knowledge of numerical methods by MATLAB.

UNIT I	NUMERICAL SOLUTION OF EQUATIONS AND MATRIX PROBLEMS	9+3
Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method - Solution of linear system of equations - Gauss elimination method - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.		
UNIT II	**INTERPOLATION, APPROXIMATION AND INTEGRATION**	**9+3**
Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Newton's forward and backward difference formulae - Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method.		
UNIT III	**NUMERICAL APPROACH FOR IVP IN ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Single step methods - Taylor's series method - Euler's method - Modified Euler's method – Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.		
UNIT IV	**NUMERICAL APPROACH FOR BVP IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**	**9+3**
Finite difference methods for solving second order two - point linear boundary value problems – Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat equation (Crank Nicholson, Bender Schemidt's methods) and One dimensional wave equation		
UNIT V	**MAT LAB INTRODUCTION**	**9+3**
Introduction – Basic features – MATLAB Session – Getting started – Mathematical functions – Basic plotting – Matrix generation-Solutions of algebraic and transcendental equations using MATLAB-Gauss elimination andGauss Jordan method for system of linear equations by MATLAB.		
Total periods:60 PERIODS		
Text Books:		
1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.		
2. Grewal, B.S., "Numerical Methods in Engineering & Science (with Programs in C,C++ & MATLAB)" Khanna Publishers, 10th Edition, New Delhi, 2015.		
3. William J. Palm III., "Introduction to MATLAB® for Engineers" , Published by McGraw-Hill,2005.		
References:		
1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.		

2. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
3. William Bober., "Numerical and analytical methods with MATLAB® for Engineers and Scientists" , Published by CRC press, November 2013.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the basic concepts and techniques of solving algebraic and transcendental equations.	Understanding (K2)
CO2: Appreciate the numerical techniques of interpolation, differentiation and integration for engineering problems.	Applying (K3)
CO3: Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.	Understanding (K2)
CO4: Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.	Applying (K3)
CO5: Understand the basic concepts of MATLAB for Computational Methods.	Understanding (K2)

CO-PO Mapping

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

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

<table>
<tr><td rowspan="3">23BMT201</td><td rowspan="3">BIOSCIENCES FOR MEDICAL ENGINEERING
(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: PCC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- NIL

Course Objectives:

1. To understand the basic principles of biochemistry, including water properties, pH, buffers, biomolecules, and biological membranes.
2. To describe the classification, struct9ure, and properties of carbohydrates, lipids, proteins, amino acids, and nucleic acids.
3. To explain mechanisms of cell injury, degeneration, inflammation, repair, and neoplasia.
4. To understand fluid and hemodynamic imbalances such as edema, thrombosis, embolism, shock, and hematological disorders.
5. To analyze the structure of microorganisms, basics of microscopy, and fundamental immunological mechanisms and techniques.

Unit I	FUNDAMENTALS TO BIOCHEMISTRY	9

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes

Unit II	CARBOHYDRATES, LIPIDS, PROTEIN	9

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates - Classification of lipids- simple, compound, and derived lipids. Nomenclature of fatty acid - Structure and properties of proteins, structural organization of proteins, protein function, classification and properties of amino acids. Nucleic acid: Structural aspects – Components of DNA and RNA, Nucleosides & Nucleotides (introduction, structure & bonding), Double helical structure of DNA (Watson-Crick model), various forms of DNA.

Unit III	CELL DEGENERATION, REPAIR AND NEOPLASIA	9

Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.

Unit IV	FLUID AND HEMODYNAMIC DERANGEMENTS	9

Body Fluids- Composition of Blood, Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas Haemorrhage.

Unit V	FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOPATHOLOGY	9

Structure of Bacteria and Virus - Morphological features and structural organization of bacteria and virus - List of common bacterial, fungal and viral diseases of human beings.- Basics of Microscope: Light microscope, Electron microscope (TEM & SEM). - Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated

tissue injury, Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies
Total periods:45 periods
Text Books:
1.RAFI MD "Text book of biochemistry for Medical Student" Fourth Edition, Universities Press, Orient Blackswan Private Limited - New Delhi 2021
2.Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 10th edition: South Asia Edition Elsevier India, 2020. (Units III & IV).
3.Ananthanarayanan & Panicker, "Microbiology" Orientblackswan, 2017 10th edition. (Units III,IV and V).
References:
1.Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
2.Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
3.Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007
4.Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017

Course Outcomes:	**Blooms Taxonomy**
CO1: Explain the fundamentals of biochemistry	Evaluate (K5)
CO2:Analyze structural and functional aspects of living organisms	Understand (K2)
CO3: Explain the function of microscope	Apply (K3)
CO4: Describe methods involved in treating the pathological diseases.	Analyze (K4)
CO5:Know the etiology and remedy in treating the pathological diseases	Create (K6)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	-	-	-	-	-	-	-	1	-	-	3	2	2
CO2	3	3	-	-	-	-	-	-	-	1	-	-	3	2	2
CO3	3	2	2	-	-	-	1	-	-	2	-	-	3	3	3
CO4	3	2	2	1	-	-	1	-	-	2	-	-	3	3	3
CO5	3	2	3	2	1	-	-	-	-	2	-	-	3	3	2
AVG	3	2.4	1.4	1	1	-	1	-	-	1	-	-	3	3	2

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

23EET202	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	Category: ESC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

<table>
<tr><td colspan="3">Course Objectives:
To introduce the basics of electric circuits and analysis
To impart knowledge in the basics of working principles and application of electrical machines
To introduce analog devices and their characteristics
To educate on the fundamental concepts of digital electronics
To introduce the functional elements and working of measuring instruments</td></tr>
<tr><td>Unit I</td><td>ELECTRICAL CIRCUITS</td><td>9</td></tr>
<tr><td colspan="3">DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state) Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only).</td></tr>
<tr><td>Unit II</td><td>ELECTRICAL MACHINES</td><td>9</td></tr>
<tr><td colspan="3">Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor.</td></tr>
<tr><td>Unit III</td><td>ANALOG ELECTRONICS</td><td>9</td></tr>
<tr><td colspan="3">Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon &Germanium – PN Junction Diodes, Zener Diode –Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters.</td></tr>
<tr><td>Unit IV</td><td>DIGITAL ELECTRONICS</td><td>9</td></tr>
<tr><td colspan="3">Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimizationusing K maps (Simple Problems only).</td></tr>
<tr><td>Unit V</td><td>MEASUREMENTS AND INSTRUMENTATION</td><td>9</td></tr>
<tr><td colspan="3">Functional elements of an instrument, Standards and calibration, Operating Principle , types - Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers-CT and PT,DSO- Block diagram- Data acquisition.</td></tr>
</table>

Total periods: 45 PERIODS

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. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008.
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.

References:

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010

Course Outcomes:	**Blooms Taxonomy**
CO1: Compute the electric circuit parameters for simple problems.	Understanding (K2)
CO2: Explain the working principle and applications of electrical machines.	Applying (K3)
CO3: Analyze the characteristics of analog electronic devices.	Understanding (K2)
CO4: Explain the basic concepts of digital electronics.	Applying (K3)
CO5: Explain the operating principles of measuring instruments.	Understanding (K2)

CO - PO & PSO Mapping

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

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

23BMT202	**MEDICAL PHYSICS**	**Category: ESC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives: • To provide understanding of the application of the radiation concepts and methods of Physicsin Medical science • To accentuate the principle, effects and clinical applications of ionizing, non-ionizing and electromagnetic radiation. • To enunciate the fundamentals of acoustic waves and their interaction with human tissues. • To explore the effects of radiation in matter and how isotopes are produced • To study effects of sound and light in human body		
Unit I	**LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION**	**9**
Physics of light, Intensity of light, limits of vision and colon vision an overview, Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Tissue as a leaky dielectric-Low Frequency Effects- Higher frequency effects., Thermography– Application		
Unit II	**PRINCIPLES OF RADIOACTIVE NUCLIDES**	**9**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide-fission and neutron capture reaction, radionuclide Generator-Technetium generator		
Unit III	**INTERACTION OF RADIATION WITH MATTER LIPIDS**	**9**
Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance		
Unit IV	**RADIATION DOSE AND ITS EFFECTS**	**9**
Dose and Exposure measurements – Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology – effects of radiation, concept of LD 50, Stochastic and Non-stochastic effects, Radiation Syndrome.		
Unit V	**PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE**	**9**
Physics of sound, Normal sound levels, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitations, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications		
Total periods:45 PERIODS		
Text Books:		
1. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose, ―Medical Physics and Biomedical Engineering‖, Institute of physics publishing, Bristol and Philadelphia, 1999		
2. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine‖ Fourth edition Springer, 2006		
References:		
1. W.J. Meredith and J.B. Massey "Fundamental Physics of Radiology" Varghese Publishing house, Third Edition, 2013.		
2. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, Newyork, Second Edition, 2012		
3. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.		

Course Outcomes: Upon completion of the course, students will be able to:	**Blooms Taxonomy**
CO 1: Interpret the properties of electromagnetic radiations and its effect on human.	Understand (K2)
CO2: Apply the principles and understand the production of radioactive nuclides.	Apply (K3)
CO3: Explain the interaction of radiation with matter.	Analyze (K4)
CO4: Identify and Analyse the radiation quantities and its effects	Analyze (K4)
CO5: Demonstrate the knowledge on the properties of sound and its application in medicine.	Understand (K2)

CO - PO & PSO Mapping

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

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

23GET201	**ENGINEERING GRAPHICS** **(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: ESC**			
		L	**T**	**P**	**C**
		2	**0**	**4**	**4**

Prerequisites

- Nil

Course Objectives:

- Drawing engineering curves.
- Drawing 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 TR.

Unit I	**PLANE CURVES AND FREEHAND SKETCHING**	**9**

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.

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.

Unit II	**PROJECTION OF POINTS, LINES AND PLANE SURFACE**	**9**

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**	**9**
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. And auxiliary projection method.		
Unit IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**	**9**
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the 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. Cut-outs and drilled holes in section of solids and development of surfaces.		
Unit V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**9**
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the 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. Cut-outs and drilled holes in section of solids and development of surfaces.		
		Total periods: 90 PERIODS
Text Books:		
1.Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House,53 Edition, 2019.		
2.Natrajan 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 Agarwaland 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.

6. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO1: Use BIS conventions and specifications for engineering drawing.	Understanding (K2)
CO2: Construct the conic curves, involutes and cycloid.	Apply (K3)
CO3: practical Solve problems involving projection of lines	Analyze (K4)
CO4: Draw the orthographic, isometric and perspective projections of simple solids.	Apply (K3)
CO5: Draw the development of simple solids	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	-	-	-	-	2	-	1	3	2	-
CO2	3	2	2	1	1	-	-	-	-	2	-	1	2	3	-
CO3	3	3	2	2	1	-	-	-	-	2	-	1	3	2	-
CO4	3	2	3	1	2	-	-	-	-	2	-	1	3	3	-
CO5	3	2	3	1	2	-	-	-	-	2	-	1	3	3	-
AVG	3	2.2	2.2	1.2	1.4	-	-	-	-	2	-	1	3	2.6	-

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

23GET202	**TAMILS AND TECHNOLOGY** **(Common to all Programmes)**	**Category: HSMC**			
		L	**T**	**P**	**L**
		1	**0**	**0**	**1**

Prerequisites

- NIL

Course Objectives:

- To introduce students to the weaving, ceramic, and architectural technologies of ancient Tamil society.
- To develop understanding of ancient manufacturing, metallurgical, and coinage technologies.
- To familiarize students with agriculture, irrigation, and animal husbandry techniques of Tamil civilization.
- To highlight the development of Scientific Tamil and Tamil computing in the modern era.
- To encourage analysis of Tamil cultural and technological heritage using historical and archaeological evidence.

Unit I	**WEAVING AND CERAMIC TECHNOLOGY**	**9**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

Unit II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**9**

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**	**9**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins 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**	**9**

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**	**9**

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 PERIODS

Text Books:

1.Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print) .

2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

International Institute of Tamil Studies).
References:
1. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand and describe weaving, ceramic, and construction technologies in ancient Tamil society**.**	Understand (K2)
CO2: Analyze the metallurgical, coinage, and manufacturing technologies of Tamil civilization.	Apply (K3)
CO3: Explain ancient agriculture, irrigation, and animal husbandry practices and their social significance.	Understand (K2)
CO4: Apply knowledge of Scientific Tamil and Tamil computing for digitalization and preservation of Tamil heritage.	Apply (K3)
CO5: Evaluate and interpret historical and archaeological evidences to connect Tamil technological developments with societal evolution.	Understand (K2)

CO - PO & PSO Mapping

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

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

23GEP201	**ENGINEERING PRACTICES LABORATORY**	**Category: ESC**			
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

Prerequisites

- Basic knowledge of workshop tools and safety procedures.
- Elementary understanding of electrical, plumbing, and mechanical concepts.

Course Objectives:

- To draw plumbing line plans and lay various pipe connections using fittings commonly used in household plumbing.
- To perform woodworking operations such as sawing, planning, and making joints like T-joint, mortise and tenon joint, and dovetail joint.
- To wire electrical circuits including basic switchboard wiring, staircase wiring, and fluorescent lamp wiring, and assemble household electrical appliances like fans, lamps, and emergency lights.
- To perform basic welding, machining (turning, drilling, tapping), sheet metal work, and mechanical assembly of simple household equipment.

- To assemble, solder, and test simple electronic circuits and components on printed circuit boards (PCB).

CIVIL ENGINEERING PRACTICES
(CIVIL & ELECTRICAL)

PART I:

LIST OF EXPERIMENTS

PLUMBING WORK:

a)	Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers,elbows and other components which are commonly used in household.
b)	Preparing plumbing line sketches.
c)	Laying pipe connection to the suction side of a pump.
d)	Laying pipe connection to the delivery side of a pump.
e)	Connecting pipes of different materials: Metal, plastic and flexible pipes used inhousehold appliances.

WOOD WORK:

a)	Sawing,
b)	Planing and
c)	Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

Wood Work Study:

a)	Studying joints in door panels and wooden furniture.
b)	Studying common industrial trusses using models.

PART II :

ELECTRICAL ENGINEERING PRACTICES

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

Total periods: 60

Text Books:

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

2.Kalpakjian S., **Manufacturing Engineering & Technology**, 7th Edition, Pearson, 2014.

3.R.K. Rajput, **A Textbook of Engineering Workshop**, Laxmi Publications, 2015.

Reference Books:
1. Hajra Choudhury S.K., Workshop Technology, Vol. I & II, Media Promoters & Publishers Pvt. Ltd., 2008.
2. P.Kannaiah & K.Lakshminarayana, Workshop Practice, Scitech Publications, 2012.
3. Bawa H.S., Workshop Technology, Tata McGraw Hill, 2003.
4. Raghuwanshi B.S., Electrical and Electronics Engineering Practice Lab Manual, Wiley India, 2016.

Course Outcomes:	**Blooms Taxonomy**
CO1: Perform plumbing work, including pipe layout, connections, and fittings.	Applying(K3)
CO2: Demonstrate woodworking skills including sawing, planning, and making joints.	Applying(K3)
CO3: Carry out electrical wiring tasks for common household circuits.	Applying(K3)
CO4;Perform basic welding, machining, sheet metal work, and mechanical assembly.	Applying(K3)
CO5: Assemble, solder, and test simple electronic circuits.	Applying(K3)

CO – PO& PSO Mapping

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

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

23BMP201	BIOSCIENCES LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

Prerequisites

- Nil

Course Objectives:

- Estimation and quantification of biomolecules.
- Separation of macromolecules.
- Use Compound microscope
- Practice on chemical examinations, Histopathological examinations etc
- To develop analytical skills and laboratory competency in handling biological samples, performing diagnostic tests, and interpreting results for clinical applications.

LIST OF EXPERIMENTS

1	Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
2	Standardization of pH meter, preparation of buffers, emulsions.
3	Spectroscopy: Determination of absorption maxima (λmax) of a given solution
4	General tests for carbohydrates, proteins and lipids.

5	Identification of Blood Collection Tubes and Phlebotomy equipment
6	Preparation of serum and plasma from blood
7	Estimation of Haemoglobin and blood glucose
8	Estimation of creatinine, urea and Uric acid
9	Separation of proteins by SDS electrophoresis (Demo) and amino acids by thin layerchromatography (Demo).
10	Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
11	Basic staining – Hematoxylin and eosin staining.
12	Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS
13	Types of Staining : Simple stain, Gram stain
14	Study of parts of compound microscope
15	Study of Histopathological slides of benign and malignant tumours.
16	Study of Haematology slides of anemia and leukemia.
	Total periods: 60 Periods

Text Books:

1. Ramnik Sood, Textbook of Medical Laboratory Technology, 6thEdition, Jaypee Brothers Medical Publishers, 2009

References:

1. Boyer, R., *Modern Experimental Biochemistry*, 4th Edition, Pearson Education, 2016.
2. Wilson, K., Walker, J., *Practical Biochemistry: Principles & Techniques*, 6th Edition, Oxford University Press, 2018.
3. Warburg, O., *Manual of Biochemistry Techniques*, Springer, 2015.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the Biochemistry laboratory functional components	Understand (K2)
CO2: Have a sound knowledge of qualitative test of different biomolecules.	Apply (K3)
CO3: Understand the basics knowledge of Biochemical parameter and their interpretation in Blood sample.	Understand (K2)
CO4: Have a sound knowledge of separation technology of proteins and amino acids.	Apply (K3)
CO5: Student can perform practical experiments on staining Processes.	Apply (K3)

CO – PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	-	-	-	-	-	1	1	-	-	2	1	-
CO2	3	2	2	-	-	-	-	-	2	2	-	-	3	2	-
CO3	3	2	2	-	-	-	-	-	2	2	-	-	3	2	-
CO4	3	2	2	-	-	-	-	-	2	2	-	-	3	3	-
CO5	3	2	2	-	-	-	-	-	2	2	-	-	3	3	-
AVG	3	2	2	-	-	-	-	-	2	2	-	-	3	2.2	-

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

<table>
<tr><td rowspan="3">23GEP202</td><td rowspan="3">COMMUNICATION LABORATORY
(Common to All Branches)</td><td colspan="4">Category: EEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- Toanalyze 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**
CO1: Speak effectively in group discussions held in a formal/semi formal contexts.	Remember (K1)
CO2: Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions	Apply (K3)
CO3: Write emails, letters and effective job applications	Understand (K2)
CO4: Write critical reports to convey data and information with clarity and precision	Apply (K3)
CO5: Give appropriate instructions and recommendations for safe execution of tasks	Apply (K3)
CO – PO& PSO Mapping	

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

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

SEMESTER III

23MAT301	Transforms and Partial Differential Equations (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: BSC			
		L	T	P	C
		3	0	0	3

Prerequisites

- 23MAT101 Matrices and Calculus

Course Objectives:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which 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
Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order 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**
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**
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**
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**
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:		
Text Books:		
1.Grewal B.S., "Higher Engineering Mathematics", 44thEdition, 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", 4thEdition, Pearson Education, New Delhi, 2016.		
4.Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.		
5.Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.		
6.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.	Understand (K2)
CO2: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.	Apply (K3)
CO3: Appreciate the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems and one dimensional wave equations.	Analyze (K4)
CO4: Understand 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.	Analyze (K4)
CO5: Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	Apply (K3)

CO - PO & PSO Mapping

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

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

23BMT301	FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS (Department of Biomedical Engineering)	Category: ESC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- Introduce the concept of diodes, Bipolar Junction Transistors and FET.
- Study the various model parameters of Transistors
- Learn the concept of special semiconductor devices, Power & Display devices
- Impart the knowledge of various configurations, characteristics, applications.
- To have knowledge of display and power devices.

Unit I	SEMICONDUCTOR DIODE	9

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

Unit II	BIPOLAR JUNCTION TRANSISTORS	9

NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon- model, Multi Emitter Transistor.

Unit III	FIELD EFFECT TRANSISTORS	9
MOSFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance- Threshold voltage -Channel length modulation, small signal Characteristics, D- MOSFET, E-MOSFET- Characteristics – Comparison of MOSFET with BJT.		
Unit IV	**SPECIAL SEMICONDUCTOR DEVICES**	**9**
Metal-Semiconductor Junction - MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Point Contact Diode, p-i-n Diode, Avalanche Photodiode, Schottky barrier diode- Zener diode- Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR.		
Unit V	**POWER DEVICES AND DISPLAY DEVICE**	**9**
UJT, Thyristor - SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Opto Coupler, Solar cell, CCD.		
Total periods:45 PERIODS		

Text Books:

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, “Electronic Devices and Circuits”, Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, “Electronic Devices and circuits”, 4th Edition, McGraw Hill, 2016.

References:

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford University Press, 2008.

Course Outcomes:	Blooms Taxonomy
CO 1: Analyze the characteristics of semiconductor diodes.	Analyze (K4)
CO2: Analyze and solve problems of Transistor circuits using model parameters.	Apply (K3)
CO3: Identify and characterize diodes and various types of transistors.	Understand (K2)
CO4: Analyze the characteristics of special semiconductor devices.	Analyze (K4)
CO5: Analyze the characteristics of Power and Display devices.	Analyze (K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
AVG	3	3	2.2	-	-	-	-	-	-	-	-	-	1	-	-

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

<table>
<tr><td rowspan="3">23BMT302</td><td rowspan="3">SENSORS AND MEASUREMENTS
(Department of BME)</td><td colspan="4">Category: PCC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- NIL

Course Objectives:

- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers • To learn the different bridges for measurement.
- To know the different display and recording devices.
- To understand various type of biosensors.
- To understand the operation of different display, recording devices, and biosensors for real-time measurement and monitoring.

Unit I	FUNDAMENTALS OF MEASUREMENTS	9

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis- methods of error analysis,- uncertainty analysis-expression of uncertainty: accuracy and precision index, propagation of errors– Calibration - Primary and secondary standards.

Unit II	DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS	9

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics.

Unit III	PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS	9

Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its characteristics.

Unit IV	SIGNAL CONDITIONING CIRCUITS AND METERS	9

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering, Q- meter, PMMC, MI and dynamometer type instruments - DC potentiometer- Digital voltmeter – Multi meter.

Unit V	RECORDING DEVICES AND ADVANCED SENSORS	9

CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Biosensors: transduction mechanism in a biosensor and Classification - Electronic nose.

Total periods:45 periods

Text Books:

1. A.K.Sawhney, “Electrical & Electronics Measurement and Instrumentation”,10th edition, Dhanpat Rai & Co, New Delhi, 19th Revised edition 2011, Reprint 2014.

2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015

3. Ernest O Doebelin and Dhanesh N Manik, “Measurement systems, Application and design”, 6th edition, McGraw-Hill, 2012

References:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, 3rd edition,Tata McGraw-Hill, New Delhi, 2014.

2. Leslie Cromwell, “Biomedical Instrumentation and measurement”, 2nd edition, Prentice hall of India, New Delhi, 2015.

3. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 1st edition, 2016.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Measure various electrical parameters with accuracy, precision, resolution.	Apply (K3)
CO2: Select appropriate passive or active transducers for measurement of physical phenomenon.	Analyze (K4)
CO3: Select appropriate light sensors for measurement of physical phenomenon	Analyze (K4)
CO4: Use AC and DC bridges for relevant parameter measurement.	Apply (K3)
CO5: Employ multimeter, CRO and different types of recorders for appropriate measurement.	Apply (K3)

CO - PO & PSO Mapping

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

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

23BMT303	**ELECTRIC CIRCUIT ANALYSIS (Department of Biomedical Engineering)**	**Category: ESC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Introduce the fundamental concepts of electrical quantities such as charge, current, voltage, and power, and their interrelationships in DC and AC circuits.
- Explain the behavior of electrical circuits under transient and steady-state conditions when subjected to step and sinusoidal excitations.
- Develop an understanding of circuit analysis techniques using network theorems, duality, and topological methods.
- Analyze the frequency response and resonance characteristics of RLC circuits, including series and parallel configurations.
- Familiarize students with coupled circuits and magnetic coupling, and introduce network topology concepts such as trees, links, and loop analysis.

Unit I	**BASIC CIRCUITS ANALYSIS**	**9**
Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Laws, Mesh current and node voltage method of analysis for D.C and A.C. circuits. The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.		
Unit II	**NETWORK THEOREM AND DUALITY**	**9**
Useful Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, application of Network theorems. Network reduction: voltage and current division, source transformation, Delta-Wye Conversion. Duals, Dual circuits.		
Unit III	**SINUSOIDAL STEADY STATE ANALYSIS**	**9**
Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.		
Unit IV	**TRANSIENTS AND RESONANCE IN RLC CIRCUITS**	**9**
Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit- Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.		
Unit V	**COUPLED CIRCUITS AND TOPOLOGY**	**9**
Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.		
	Total periods:45 periods	

Text Books:

1.Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.

2. Joseph Edminister and Mahmood Nahvi, “Electric Circuits”, Schaum’s Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.

References:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.

2. John O Mallay, Schaum’s Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011.

3. Charles.K.Alexander, Mathew N.O.Sadiku,"Fundamentals of Electric Circuits", McGraw Hill, 5th Edition, 2012.

4. Allan H.Robbins, Wilhelm C.Miller, “Circuit Analysis Theory and Practice”, Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Comprehend and design ac/dc circuits.	Understand (K2)
CO2: Apply circuit theorems in real time.	Apply (K3)
CO3: Evaluate ac/dc circuits.	Analyze (K4)
CO4: Analyse the electrical circuits	Analyze (K4)
CO5: Develop and understand ac/dc circuits.	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	3	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	3	-	-	-	-	-	-	-	1	1	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	1	1	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	1	1	-	-
AVG	3	3	2.4	2.2	-	-	-	-	-	-	-	0.4	1	-	-

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

23BMT304	**HUMAN ANATOMY AND PHYSIOLOGY (Department of BME)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**2**	**4**

Prerequisites

- NIL

Course Objectives:

- To understand the structure and function of cells, tissues, and the basic elements of the human body.
- To study the skeletal and muscular systems, including bone types, joints, muscles, and their physiological properties.
- To explain the structure and functions of the cardiovascular and respiratory systems, including blood composition, cardiac cycle, and lung physiology.
- To learn the structure and functional mechanisms of the digestive and excretory systems, including digestion, absorption, and urine formation.
- To understand the nervous and sensory systems, including brain, spinal cord, reflexes, and sensory organs like vision, hearing, taste, and smell.

Unit I	**BASIC ELEMENTS OF HUMAN BODY**	**9**

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

Unit II	**SKELETAL AND MUSCULAR SYSTEM**	**9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes

during muscle contraction- Neuromuscular junction.		
Unit III	**CARDIOVASCULAR AND RESPIRATORY SYSTEM**	**9**
Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.		
Unit IV	**DIGESTIVE AND EXCRETORY SYSTEMS**	**9**
Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.		
Unit V	**NERVOUS AND SENSORY SYSTEM**	**9**
Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.		

LIST OF EXPERIMENTS

1	Collection of Blood Samples
2	Identification of Blood groups (Forward and Reverse)
3	Bleeding and Clotting time
4	Estimation of Hemoglobin
5	Total RBC and WBC Count
6	Differential count of Blood cells
7	Estimation of ESR, PCV, MCH, MCV, MCHC
8	Hearing test – Tuning fork
9	Visual Activity – Snellen's Chart and Jaeger's Chart

Lecture : 45 periods Practical :30 periods Total periods:75 Periods

Text Books:

1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Ninth Edition, Pearson Education, New Delhi, 2018.

2. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine", Third edition Springer, 2006. (Unit 2,3,4)

References:

1. Guyton & Hall, "Text book of Medical Physiology", 13th Edition, Saunders, 2015.

2. Ranganathan T S, "Text book of Human Anatomy", S.Chand& Co. Ltd., New Delhi, 2012.

3. SaradaSubramanyam, K MadhavanKutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.

Course Outcomes:	Blooms Taxonomy
CO 1: Identify and explain basic elements of human body	Understand (K2)
CO2: Explain the functions of skeletal and muscular system	Understand (K2)
CO3: Describe the structure, function of cardiovascular system and respiratory system	Understand (K2)
CO4: Discuss the structure of digestive and excretory system.	Understand (K2)
CO5: Describe the physiological process of Nervous and sensory system	Understand (K2)

CO - PO & PSO Mapping

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

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

23CST304	OBJECT ORIENTED PROGRAMMING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: ESC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To understand the principles of Object Oriented Programming and the basics of Java programming language.
- To learn and apply the concepts of inheritance, packages, and interfaces in Java programs.
- To develop programs using exception handling and multithreading for solving real-world problems.
- To gain proficiency in Java I/O, string handling, collections, and generics for efficient programming.
- To design and build interactive GUI applications using JavaFX, including event handling, controls, and layouts.

Unit I	INTRODUCTION TO OOP AND JAVA	9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors Methods -Access specifiers - Static members- JavaDoc comments		
Unit II	**INHERITANCE, PACKAGES AND INTERFACES**	**9**
Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access –Importing Packages – Interfaces.		
Unit III	**EXCEPTION HANDLING AND MULTITHREADING**	**9**
Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication- Suspending –Resuming, and Stopping Threads – Multithreading. Wrappers – Auto boxing.		
Unit IV	**I/O, GENERICS, STRING HANDLING**	**9**
I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.		
Unit V	**JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS**	**9**
JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, Toggle Button – Radio Buttons – ListView – Combo Box – Choice Box – Text Controls – Scroll Pane. Layouts – Flow Pane – HBox and VBox – Border Pane – Stack Pane – Grid Pane. Menus – Basics – Menu – Menu bars – Menu Ite		
	Total periods:45 PERIODS	

Text Books:

1. Herbert Schildt, "Java: The Complete Reference", 11 th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1 st Edition, McGraw Hill Education, New Delhi, 2015

References:

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11 th Edition, Prentice Hall, 2018.

Course Outcomes:	Blooms Taxonomy
CO 1: Apply the concepts of classes and objects to solve simple problems	Apply (K3)
CO2: Develop programs using inheritance, packages and interfaces	Apply (K3)
CO3: Make use of exception handling mechanisms and multithreaded model to solve real world problems	Apply (K3)
CO4: Build Java applications with I/O packages, string classes, Collections and generics concepts	Apply (K3)
CO5: Integrate the concepts of event handling and JavaFX components and controls for developing GUI based applications	Apply (K3)

CO - PO & PSO Mapping

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

CO3	3	3	1	1	1	-	-	-	-	-	-	-	-	1	1
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-	1	1
CO5	3	3	1	2	1	-	-	-	-	-	-	-	-	1	1
AVG	3	3	1	1	1	-	-	-	-	-	-	-	-	1	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BM P301	**FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS LABORATORY (Common to All Branches)**	**Category: ESC**			
		L	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Prerequisites

- Nil

Course Objectives:

- Provide practical knowledge to complement the theoretical concepts studied in Semiconductor Devices and Basic Electrical Engineering.
- Enable students to experimentally determine the characteristics and behavior of electronic devices such as diodes, transistors, and thyristors.
- Develop hands-on skills in designing, constructing, and testing basic rectifier, regulator, and amplifier circuits.
- Train students to verify and apply various network theorems to analyze and solve electrical and electronic circuits.

Introduce the measurement and analysis of frequency response in RLC circuits, including resonance and bandwidth determination.

LIST OF EXPERIMENTS

1	Calibration of voltmeter and ammeter using shunt type Potentiometer
2	Characteristics of thermistor
3	Characteristics of thermocouple
4	Characteristics of LDR
5	Characteristics of Photo Diode
6	Characteristics of Photo transistor
7	Characteristics of RTD
8	Characteristics of LVDT
9	Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone bridge
10	Measurement of unknown Capacitance using Schering Bridge
11	Measurement of unknown Inductance using Maxwell's & Hay's Bridge
12	Characteristics of Hall effect transducer
13	Characteristics of strain gauge
14	Study of Electronic nose
15	Demonstration of CRO & DSO
16	Characteristics of Piezoelectric Transducer

Total periods:45 periods

Text Books:

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, “Electronic Devices and Circuits”, Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, “Electronic Devices and circuits”, 4th Edition, McGraw Hill, 2016.

References:

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, “Solid State Electronic Devices”, 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, “A Textbook of Electronic Devices and Circuits”, 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Oxford University Press, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO1: design and understand characteristics and calibration of various transducers.	Analyze (K4)
CO2: design and develop bridge circuits to find unknown variables.	Apply (K3)
CO3: select proper transducer for various applications.	Analyze (K4)
CO4: understand various read out and display devices.	Analyze (K4)
CO5: design a measurement system for various applications.	Apply (K3)

CO – PO & PSO Mapping

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

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

23BMP302	SENSORS AND MEASUREMENTS LABORATORY (Department of Biomedical Engineering)	Category: PCC			
		L	T	P	C
		0	0	3	1.5

Prerequisites

- NIL

Course Objectives:

- To provide hands-on experience in understanding and calibrating various sensors and transducers used in measurement systems.
- To enable students to design and test bridge circuits for precise measurement of unknown electrical quantities.
- To develop the ability to select appropriate transducers for specific physical and industrial applications.
- To familiarize students with different readout, display, and recording devices used in modern instrumentation.
- To equip students with the skills to design and implement complete measurement systems for diverse practical applications.

LIST OF EXPERIMENTS

1	Calibration of voltmeter and ammeter using shunt type Potentiometer
2	Characteristics of thermistor
3	Characteristics of thermocouple
4	Characteristics of LDR
5	Characteristics of Photo Diode
6	Characteristics of Photo transistor
7	Characteristics of RTD
8	Characteristics of LVDT
9	Measurement of unknown Resistance using Kelvin Double Bridge and Wheatstone bridge
10	Measurement of unknown Capacitance using Schering Bridge
11	Measurement of unknown Inductance using Maxwell’s & Hay’s Bridge
12	Characteristics of Hall effect transducer
13	Characteristics of strain gauge
14	Study of Electronic nose
15	Demonstration of CRO & DSO
16	Characteristics of Piezoelectric Transducer

Total periods:45 PERIODS

Text Books:

1. A.K. Sawhney, “Electrical & Electronics Measurement and Instrumentation”, 10th edition, Dhanpat Rai & Co, New Delhi, 19th Revised edition 2011, Reprint 2014.

2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.

3. Ernest O. Doebelin and Dhanesh N. Manik, “Measurement Systems: Application and Design”, 6th edition, McGraw-Hill, 2012.
References:
1. R.S. Khandpur, “Handbook of Biomedical Instrumentation”, 3rd edition, Tata McGraw-Hill, New Delhi, 2014.
2. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, 2nd edition, Prentice Hall of India, New Delhi, 2015.
3. Albert D. Helfrick and William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 1st edition, 2016.

Course Outcomes:	**Blooms Taxonomy**
CO1: design and understand characteristics and calibration of various transducers.	Analyze (K4)
CO2: design and develop bridge circuits to find unknown variables.	Apply (K3)
CO3: select proper transducer for various applications.	Analyze (K4)
CO4: understand various read out and display devices.	Understand (K2)
CO5: design a measurement system for various applications.	Apply (K3)

CO – PO & PSO Mapping

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

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

23CSP303	**OBJECT ORIENTED PROGRAMMING LABORATORY (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: ESC**			
		L	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Prerequisites

- NIL

Course Objectives:

- To build software development skills using java programming for real-world applications.
- To understand and apply the concepts of classes, packages, interfaces, inheritance, exception handling and file processing.
- To develop applications using generic programming and event handling
- To enhance problem-solving abilities using object-oriented programming concepts and Java language features.
- To enable students to develop real-time interactive applications using Java frameworks and tools.

LIST OF EXPERIMENTS	
1	Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2	Develop stack and queue data structures using classes and objects.
3	Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
4	Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.
5	Solve the above problem using an interface.
6	Implement exception handling and creation of user defined exceptions.
7	Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8	Write a program to perform file operations
9	Develop applications to demonstrate the features of generics classes.
10	Develop applications using JavaFX controls, layouts and menus.
11	Develop a mini project for any application using Java concept.
	Total periods:45 PERIODS

Text Books:

1.Herbert Schildt, *Java: The Complete Reference*, 12th Edition, McGraw Hill Education, 2022.

2.E. Balagurusamy, *Programming with Java – A Primer*, 6th Edition, McGraw Hill Education, 2019.

References:

1.Kathy Sierra & Bert Bates, Head First Java, 3rd Edition, O’Reilly Media, 2022.

2.Y. Daniel Liang, Introduction to Java Programming and Data Structures, 12th Edition, Pearson Education, 2020.

3.Paul Deitel and Harvey Deitel, Java: How to Program, 11th Edition, Pearson Education, 2018.

4.Cay S. Horstmann, Core Java Volume I & II, 12th Edition, Pearson Education, 2023.

Course Outcomes:	Blooms Taxonomy
CO1: Apply searching and sorting algorithms using Java**.**	Apply(K3)
CO2: Develop stack and queue data structures using classes and objects.	Create(K5)
CO3: Implement inheritance and polymorphism through real-world applications.	Create1(K5)
CO4: Apply abstract classes and interfaces to demonstrate abstraction.	Evaluate (K2)
CO5: Implement exception handling and multithreading concepts in Java.	Evaluate (K2)

CO – PO & PSO Mapping

Particular	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	1	1	1	1	-	-	-	3	2	-
CO2	3	2	3	2	3	1	1	1	1	-	-	-	3	3	-
CO3	3	2	3	2	3	1	1	1	1	-	-	-	3	3	-
CO4	2	2	3	2	3	1	1	1	1	-	-	-	3	3	-
CO5	2	2	2	2	3	1	1	1	1	-	-	-	2	3	-
AVG	2.4	2.2	2.4	2.8	3	1	1	1	1	-	-	-	3	3	-

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

SEMESTER IV

23MAT401	RANDOM PROCESSES AND LINEAR ALGEBRA (Department of Biomedical Engineering)	Category: BSC			
		L	T	P	C
		3	1	0	4

Prerequisites

- Nil

Course Objectives:

- To introduce the basic notions of vector spaces which will then be used to solve related problems.
- To understand the concepts of vector space, linear transformations, inner product spaces and orthogonalization.
- To provide necessary basic concepts in probability and random processes for applications such as random signals, linear systems in communication engineering.
- To provide necessary basics in probability that are relevant in applications such as random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one and two dimensional random

Unit I	PROBABILITY AND RANDOM VARIABLES	9

Axioms of probability – Conditional probability – Baye’s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions - Functions of a random variable.		
Unit II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**9**
Joint distributions – Marginal and conditional distributions – Covariance – correlation and linearregression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).		
Unit III	**RANDOM PROCESSES**	**9**
Classification – Stationary process – Markov process - Poisson process - Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) - Limiting distributions.		
Unit IV	**VECTOR SPACES**	**9**
Vector spaces – Subspaces – Linear combinations and linear system of equations – Linearindependence and linear dependence		
Unit V	**LINEAR TRANSFORMATION AND INNER PRODUCT SPACES**	**9**
Linear transformation - Null spaces and ranges - Dimension theorem - Matrix representation of a linear transformations - Inner product - Norms - Gram Schmidt orthogonalization process - Adjoint of linear operations - Least square approximation.		
	Total periods:45 PERIODS	
Text Books:		
1. Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M., “Fundamentals of Queueing Theory",Wiley Student 4th Edition, 2014.		
2. Ibe, O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier,1st IndianReprint, 2007.		
3.Friedberg. A.H., Insel. A.J. and Spence. L., “Linear Algebra”, Prentice Hall of India, New Delhi,4th Edition, 2004.		
References:		
1. Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and RandomProcesses", Tata McGraw Hill Edition, New Delhi, 2004.		
2. Trivedi, K.S., "Probability and Statistics with Reliability, Queueing and Computer ScienceApplications", 2nd Edition, John Wiley and Sons, 2002.		
3. Yates, R.D. and Goodman. D. J., "Probability and Stochastic Processes", 2nd Edition, WileyIndia Pvt. Ltd., Bangalore, 2012.		
4. Kolman. B. Hill. D.R., “Introductory Linear Algebra”, Pearson Education, New Delhi, FirstReprint, 2009.		
5. Kumaresan. S., “Linear Algebra – A Geometric Approach”, Prentice – Hall of India, New Delhi,Reprint, 2010. Strang. G., “Linear Algebra and its applications”, Thomson (Brooks/Cole), New Delhi, 2005.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand and apply the fundamental concepts of probability, random variables, and standard probability distributions to solve engineering-related problems.	Understand (K2)
CO2: Analyze two-dimensional random variables by determining joint, marginal, and conditional distributions, and apply correlation, regression, and the Central Limit Theorem in practical scenarios.	Analyze (K4)

CO3: Demonstrate knowledge of random processes, including Markov and Poisson processes, and analyze the behavior of discrete-time Markov chains using transition probabilities and limiting distributions.	Analyze (K4)
CO4: Apply vector space concepts such as linear independence, basis, dimension, and linear combinations to solve systems of linear equations and related algebraic problems.	Apply (K3)
CO5: Perform linear transformations, compute inner products and norms, apply Gram–Schmidt orthogonalization, and use least squares approximation to solve engineering and data-fitting problems.	Evaluate (K5)

CO - PO & PSO Mapping

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

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

23BMT401	BIOMEDICAL INSTRUMENTATION (Department Of Biomedical Engineering)	Category: PCC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- 23BMT304 Anatomy and Human Physiology

Course Objectives:

- To understand the origin of various biological signals and electrode configurations specific tobio-potential measurements.
- To understand the characteristics of Bio signals.
- To understand the design of bioamplifiers
- To explain the different techniques used for measurement of non-electrical bio- parameters.
- To explain the biochemical measurement techniques as applicable for diagnosis andtreatment.

Unit I	ELECTRODE CONFIGURATIONS	9

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode– skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

Unit II	BIOSIGNAL CHARACTERISTICS	9

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12lead system. EEG - EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode.

Unit III	BIOAMPLIFIERS	9
Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference		
Unit IV	**MEASUREMENT OF BIO SIGNALS**	**9**
Temperature, respiration rate and pulse rate measurements. Blood Pressure - indirect methods: auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements		
Unit V	**BIOCHEMICAL MEASUREMENTS**	**9**
Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter,flame photometer, spectrophotometer, blood cell counter, auto analyzer.		
		Total periods: 45 PERIODS
Text Books:		
1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, 2nd edition, Prenticehall of India, New Delhi, 2015.		
1. John Enderle, Susan Blanchard, Joseph Bronzino, “Introduction to Biomedical Engineering”, second edition, Academic Press,2005.		
2. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, WileyIndia Pvt Ltd, New Delhi, 2015.		
3. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, NewDelhi, 2003.		
References:		
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”,Pearson Education, 2004.		

Course Outcomes:	**Blooms Taxonomy**
CO1: Illustrate the origin of various biological signals and their characteristic**s.**	Understanding (K2)
CO2: Gain knowledge on characteristics of bio signals.	Understanding (K2)
CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals	Apply (K3)
CO4: Explain the different measurement techniques for non-electrical bio-parameters.	Apply (K3)
CO5: Explain the biochemical measurement techniques as applicable for diagnosis and furthertreatment**.**	Analyze (K4)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	1	-	-	-	-	-	-	1	3	2	-
CO2	3	2	-	1	2	-	-	-	-	-	-	1	2	3	-
CO3	3	2	2	1	3	-	-	-	-	-	-	1	3	3	-
CO4	2	3	2	3	2	-	-	-	-	-	-	1	3	3	-
CO5	2	2	2	2	1	-	-	-	-	-	-	2	2	3	-
AVG	2.6	2.4	1	1	1	-	-	-	-	-	-	1	2	2.4	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BMT402	**ANALOG AND DIGITAL INTEGRATED CIRCUITS (Department of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Analyze and design basic and advanced operational amplifier circuits for analog signal processing applications.
- Explain and apply DACs, ADCs, and phase-locked loop circuits for accurate signal conversion and frequency control.
- Understand and apply number systems, Boolean algebra, and logic gates to design and simplify digital circuits.
- Design and implement combinational logic circuits such as adders, encoders, decoders, and multiplexers/demultiplexers.
- Design and analyze sequential circuits including flip-flops, counters, and shift registers for digital data storage and transfer.

Unit I	**INTRODUCTION TO OPERATIONAL AMPLIFIER AND ITS APPLICATIONS**	**9**

Operational amplifier –ideal characteristics, Performance Parameters, Linear and Nonlinear Circuits and their analysis- voltage follower, Inverting amplifier, Non-inverting Amplifiers, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Low pass, High pass filter and band pass filters, Comparator, Multivibrator and Schmitt trigger, Triangular wave generator.

Unit II	**DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS AND PLL**	**9**

Analog switches, High speed sample and hold circuit and IC's, Types of D/A converter - Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, Voltage to Frequency converters. PLL-Closed loop analysis of PLL, Frequency multiplication/ division, FSK demodulator.

Unit III	**THE BASIC GATES ANDCOMBINATIONAL LOGIC CIRCUITS**	**9**

products and product of sums, Minterms and Maxterms, Karnaugh map and Tabulation methods. Logic families-TTL, MOS, CMOS, BiCMOS - Comparison of Logic families.		
UNIT IV	**COMBINATIONAL LOGIC CIRCUITS**	**9**
Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder,Encoder, Priority Encoder, Mux/Demux.		
Unit V	**SEQUENTIAL LOGIC CIRCUITS**	**9**
Flip flops – SR, JK, T, D, Master/Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – state minimization, state assignment, circuit implementation. Counters, Ripple Counters, RingCounters. Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out, Universal Shift Register		
Total periods:45		
Text Books:		
1. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Mc Graw HillEducation, 3rd Edition, 2017		
2.John.F.Wakerly, "Digital design principles and practices", Pearson Education, 5th Edition, 2018		
References:		
1. Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.		
2. Charles H.Roth, Jr, "Fundamentals of Logic Design", Jaico Books, 7th Edition, 2013.		
3. M. Morris Mano and Michael D.Ciletti, "Digital Design", Pearson, 5th Edition, 2013.		
4.S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw HillEducation, 3rd Edition, 2018		

Course Outcomes:	**Blooms Taxonomy**
CO1: design new analog linear circuits and develop linear IC based Systems.	Create (K6)
CO2: Apply the concept of ADC and DAC in real time systems and Phase Locked Loop with applications.	Apply (K3)
CO3: Use Boolean algebra and apply it to digital systems.	Apply (K3)
CO4: Design various combinational digital circuits using logic gates.	Create (K6)
CO5: Bring out the analysis and design procedures for synchronous and asynchronous sequential circuits.	Analyze (K4)
CO - PO & PSO Mapping	

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

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

23BMT403	**BIOCONTROL SYSTEMS** **(Department of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To introduce the fundamental concepts and components of control systems.
- To develop the ability to analyze system behavior in the time domain.
- To enable students to perform frequency domain analysis.
- To provide knowledge of system stability analysis techniques.
- To apply control system principles to physiological processes

Unit I	**INTRODUCTION TO CONTROL SYSTEMS**	**9**

Definition, Examples, Introduction to Physiological control systems, Control system design process, modeling of simple electrical, mechanical and electromechanical systems. Open and closed loop Systems, Concept of feedback, Block diagram and signal flow graph representation of systems. Difference between engineering and physiological control systems (Glucose and Blood pressure regulation).

Unit II	**TIME DOMAIN ANALYSIS**	**9**

Time domain analysis- Standard test signals, Time response specifications, Step and impulse responses of first order and second order systems - time domain specifications of first and second order systems. Performance and characteristics in the time domain, Steady state response- Steady state error and static error coefficients. Introduction of time-domain responses in pacemaker.

Unit III	**FREQUENCY DOMAIN ANALYSIS**	**9**

Frequency domain analysis, Frequency response techniques, Frequency domain specifications - Polar plots - Bode plots - Nyquist plot - Nyquist stability criterion, closed loop stability - Constant M and N circles - Nichol‘s chart. Overview of compensators for design improvement. Introduction to frequency response to enhance image quality in MRI and Ultrasound.

Unit IV	**STABILITY ANALYSIS**	**9**

Definition of stability, Methods to analyze the stability, Concept of system based stability, Routh- Hurwitz criteria of stability, Root locus technique - construction of root locus and study of stability.

Unit V	BIOLOGICAL CONTROL SYSTEM ANALYSIS	9
Introduction to Biological Control Systems: Definition, components (receptors, controllers, effectors), negative and positive feedback, open vs. closed-loop systems, homeostasis, stability, and adaptability. Muscle Stretch Reflex Models: Hill's muscle model, role in posture and movement. Circulatory Control Model: Windkessel model, arterial compliance, and vascular resistance. Pupillary Light Reflex: Physiological and biochemical model of the autonomic nervous system.		
Total periods:45 PERIODS		

Text Books:

1. I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International Publishers,1st September, 2018.
2. Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall India, 2005.

References:

1. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., Control Systems Engineering,Pearson Education India, 2015.
2. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, 1995. Ogata, Katsuhiko and Yanjuan Yang, Modern control engineering, Vol 4, Prentice-Hall, 2002.

Course Outcomes:	Blooms Taxonomy
CO1: Explain the fundamentals of control systems and distinguish between engineering and physiological control systems.	Understanding (K2)
CO2: Analyze the time-domain response of first and second order systems and determine performance parameters and steady-state errors.	Analyze (K4)
CO3: Evaluate the stability of systems using Routh–Hurwitz and Root Locus methods.	Evaluate (K5)
CO4: Interpret frequency-domain characteristics using Bode, Nyquist, and Polar plots for system design improvement.	Apply (K3)
CO5: Model and analyze biological control systems such as muscle reflex, circulatory control, and pupillary reflex using feedback principles	Apply (K3)

CO - PO & PSO Mapping															
Particular	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	-	-	-	-	2	-	-	2	-	-
CO2	3	3	2	2	-	-	-	-	-	2	-	-	3	-	-
CO3	3	3	3	2	-	-	-	-	-	2	-	-	3	-	-
CO4	3	3	3	2	2	-	-	-	-	2	-	-	2	-	-
CO5	3	3	3	2	2	-	-	-	-	2	-	-	3	3	-
AVG	3	3	2	2	1	-	-	-	-	2	-	-	2	3	-
1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation															

23BMT404	**SIGNAL PROCESSING (Department of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**2**	**4**

Prerequisites

- Nil

Course Objectives:

- Understand and classify different types of signals and systems, and apply sampling and quantization techniques while analyzing aliasing effects.
- Analyze continuous-time and discrete-time linear time-invariant (LTI) systems using Fourier series, Fourier transform, Z-transform, and DTFT.
- Apply discrete Fourier transform (DFT) and fast Fourier transform (FFT) techniques for signal analysis, convolution, and correlation in digital signal processing.
- Design and implement analog and digital IIR filters, including Butterworth and Chebyshev filters, using various transformation methods and realization structures.
- Design FIR filters using windowing and frequency sampling methods, understand filter realizations, and analyze multirate signal processing techniques like decimation and interpolation.

Unit I	**FUNDAMENTALS OF SIGNALS AND SYSTEMS**	**9**

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.

Unit II	**ANALYSIS OF LTI SYSTEMS**	**9**

Fourier Series - Fourier Transform and Properties, Analysis of Continuous Time LTI Systems - Z Transform - Properties of ROC– Inverse Z Transform – DTFT - Analysis of Discrete Time LTI Systems

Unit III	**DISCRETE FOURIER TRANSFORM**	**9**

DFT and its properties, magnitude and phase representation-Linear Convolution- Correlation-Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm. Use of FFT in Linear Filtering.

Unit IV	INFINITE IMPULSE RESPONSE FILTERS	9
Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade and parallel forms.		
Unit V	**FINITE IMPULSE RESPONSE FILTERS AND MULTIRATE SIGNAL PROCESSING**	**9**
Design of linear phase FIR filters - windowing and Frequency sampling methods. Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR and IIR. Introduction to DSP processors. Introduction to Multirate signal Processing – Decimation and Interpolation.		

LIST OF EXPERIMENTS

1	Construction of signals with different Frequencies.
2	Analyse the stability of a CT System with various inputs.
3	Analyse the stability of a DT System with various inputs.
4	Reconstruct a signal from samples and study the effect of Aliasing
5	Spectrum Analysis using FFT
6	Filter Design & Analysis.
7	Finite word length effect.
8	Multirate Signal Processing.
9	DSP Processor Implementation. (Linear and Convolution, FFT implementation, IIR and FIR filters implementation)

Lecture : 45 PERIODS Practical : 30 PERIODS Total periods:75 PERIODS

Text Books:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, Indian Reprint,2nd Edition, 2015.

2. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms andApplications", Pearson, 4th Edition, 2014.

References:

1. S. Haykin and B. Van Veen, "Signals and Systems", Wiley, 2nd Edition, 2007.

2. B. P. Lathi, "Principles of Linear Systems and Signals", Oxford, 2nd Edition, 2009.

3. Emmanuel Ifeachor, Barrie Jervis, "Digital Signal Processing- A practical approach", Pearson, 2nd Edition, 2002.

4. M. H. Hayes, "Digital Signal Processing, Schaum's outlines", Tata McGraw Hill, 2nd Edition,2011.

Course Outcomes:	Blooms Taxonomy
CO1: To classify the continuous time and discrete time signals and systems.	Understand (K2)
CO2: To analyze the signals in both continuous time and discrete time	Analyze (K4)
CO3: To apply DFT for the analysis of digital signals & systems	Apply (K3)
CO4: To design IIR filter to process real world signals.	Create (K6)
CO5: To design FIR filter to process real world signals.	Create (K6)

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	-
CO2	3	3	3	2	-	-	-	-	-	-	-	-	3	3	-
CO3	3	3	3	2	-	-	-	-	-	-	-	-	3	3	-
CO4	3	3	3	2	-	-	-	-	-	-	-	-	3	3	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-	3	3	-
AVG	3	3	3	2	-	-	-	-	-	-	-	-	3	3	-

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

23GET401	ENVIRONMENTAL SCIENCE AND SUSTAINABILITY (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	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/prevention 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. 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. Ecosystems: Forest ecosystem and grassland ecosystem.

Unit II	ENVIRONMENTAL POLLUTION	9

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 SOURCES OF ENERGY	9

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	SUSTAINABILITY AND MANAGEMENT	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	SUSTAINABILITY PRACTICES	9

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:45 Periods

Text Books:

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

References:

1. Cunningham, W.P. Cooper, T.H. Gorhani, ‘Environmental Encyclopedia, Jaico Publishing House, Mumbai, 2001.
2. Rajagopalan, R, ‘Environmental Studies-From Crisis to Cure, ‘Oxford University Press, 3rd edition, 2015.
3. Erach Bharucha, ‘Textbook of Environmental Studies for Undergraduate Courses, Orient Black swan Private limited, 2013.

Course Outcomes:	**Blooms Taxonomy**
CO1: To familiar the functions of ecosystems, environment and biodiversity.	Understand (K2)
CO2: To know well about the effects of environmental pollutions.	Understand (K2)
CO3: To inculcate the basic knowledge of renewable energy resources.	Understand (K2)
CO4: To differentiate various social problems.	Analyze (K4)
CO5: To know the importance/impacts of population growth.	Evaluate (K5)

CO - PO & PSO Mapping

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

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

23BMP401	**BIOMEDICAL INSTRUMENTATION LABORATORY** **(Department Of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Prerequisites

- Nil

Course Objectives:

- To understand the principles of biosignal acquisition and the importance of impedance matching in biomedical instrumentation.
- To design and implement various biopotential amplifiers (ECG, EMG, EEG, and EOG) with appropriate filters for noise and interference reduction.
- To develop circuits for signal conditioning, feature extraction, and physiological parameter measurement such as heart rate and QRS detection.
- To design and test interface circuits such as multiplexers, demultiplexers, isolation amplifiers, and feedback systems for reliable and safe biosignal processing.
- To perform measurements and analysis of physiological and biochemical parameters (e.g., blood pressure, pH, conductivity) for diagnostic and monitoring applications.

LIST OF EXPERIMENTS

1	Design and implementation of a preamplifier with impedance matching for Biosignal acquisition using suitable ICs.
2	Design and development of an ECG amplifier with filters to eliminate power line interference and noise.
3	Design and testing of an EMG amplifier for muscle signal detection.
4	Circuit design for QRS complex detection and heart rate measurement.
5	Development of a frontal EEG amplifier for brain signal acquisition.
6	Design and development of an EOG amplifier circuit for accurate eye blink detection.
7	Design and implementation of a right-leg driven ECG feedback amplifier for signal quality enhancement.
8	Design and implementation of an optical isolation amplifier for ensuring biosignal safety.
9	Design and development of a multiplexer (MUX) for dual biosignal processing.
10	Design and development of a demultiplexer (DEMUX) for dual biosignal signal separation.
11	Measurement and analysis of pH and conductivity in biological samples for physiological monitoring.
12	Measurement of Blood Pressure Using a Sphygmomanometer and Recording of Peripheral Blood Flow Dynamics.

Total periods:45 PERIODS

Text Books:

1. John G. Webster and Amit J. Nimunkar, “Medical Instrumentation: Application and Design”, 5th Edition, Wiley, New York, 2020.

2.R. S. Khandpur, “Handbook of Biomedical Instrumentation”, 3rd Edition, McGraw-Hill Education, New Delhi, 2014.

3. D. C. Reddy, “Biomedical Signal Processing: Principles and Techniques”, 1st Edition, McGraw-Hill Education, New Delhi, 2005.

4. Hugo Humberto Plácido da Silva, Hugo Filipe Silveira Gamboa, Rui Pedro Sousa Varandas, and Guilherme Ale, “Biosignal Acquisition and Processing: A Project-Based Learning Approach”, 1st Edition, Springer, Cham, 2023.

References:

1. Plácido da Silva, H. H., Gamboa, H. F. S., Varandas, R. P. S., & Espadanal Ramos, G. A. (2024). Biosignal Acquisition and Processing: A Project-Based Learning Approach. Springer, Cham

2. Siddiqi, M. A. (2019). “Amplification and Filtering in Biomedical Applications,” in Continuous-Time Active Analog Filters (Cambridge University Press).

3. Nagel, E. (2000). “Biosignal Amplifiers, Filters,” in Engineering (ebrary). (Chapter on biopotential amplifiers: criteria, design)

4. Tasaganva, B. G., & Bhat, G. V. (2014). “ECG Acquisition System.” International Journal of Engineering Research & Technology (IJERT), Vol. 03, Issue 03

5. Paper: “Analysis: Electroencephalography Acquisition System: Analog Design” – covers EEG front-end design including driven-right-leg circuit and isolation.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand and apply the principles of biosignal acquisition – Students will be able to design and implement preamplifiers with proper impedance matching and gain settings for ECG, EMG, EEG, and EOG signals using suitable ICs**.**	Understand (K2)
CO2: Design and analyze signal conditioning circuits – Students will develop and test amplifiers with filtering capabilities to remove power-line interference and noise, ensuring high-quality biosignal recording.	Analyze (K4)
CO3: Implement specialized biosignal processing techniques – Students will design circuits for QRS complex detection, heart rate measurement, and eye blink detection, integrating feedback and signal isolation techniques for improved measurement accuracy.	Analyze (K4)
CO4: Integrate and test multi-channel biosignal systems – Students will develop multiplexer (MUX) and demultiplexer (DEMUX) circuits to handle dual or multiple biosignals, demonstrating safe and efficient signal acquisition.	Apply (K3)
CO5: Perform physiological measurements and data analysis – Students will measure and analyze physiological parameters such as pH, conductivity, blood pressure, and peripheral blood flow, interpreting results in the context of biomedical applications.	Understand (K2)

CO – PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	3	-	-	-	-	-	-	-	3	3	1
CO2	3	3	3	-	3	-	-	-	-	-	-	-	3	3	1
CO3	-	3	3	2	3	-	-	-	-	-	-	-	3	3	3
CO4	-	-	3	2	3	-	-	-	3	-	-	-	3	-	3
CO5	3	3	-	2	3	3	-	-	-	-	-	-	-	3	-
AVG	1	2	2.2	1.2	3	0.3	-	-	0.6	-	-	-	3	3	1

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

23BMP402	ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY (Department Of Biomedical Engineering)	Category: PCC			
		L	T	P	C
		0	0	3	1.5

Prerequisites

- NIL

Course Objectives:

- To design digital logic and circuits
- To learn the function of different ICs
- To understand the applications of operation amplifier.
- To learn the working of multivibrators
- To design circuits for generating waveforms using ICs

LIST OF EXPERIMENTS

1	Inverting, non-inverting amplifier and comparator
2	Integrator and Differentiator
3	Design and analysis of active filters using opamp
4	Schmitt trigger using operational amplifier
5	Instrumentation amplifier using operational amplifier
6	RC and LC oscillators
7	Multivibrators using IC555 Timer
8	Study of logic gates, Half adder and Full adder
9	Encoder and BCD to 7 segment decoder
10	Multiplexer and demultiplexer using digital ICs
11	Universal shift register using flip flops
12	Design of mod-N counter
13	Simulation and analysis of circuits using software

Total periods:45 PERIODS

Text Books:

1.**“Op-Amps and Linear Integrated Circuits”** by Ramakant A. Gayakwad, Pearson Education, 4th Edition.

2.**“Digital Electronics: Principles, Devices and Applications”** by S. Salivahanan and N. S. Kumar, Tata McGraw Hill.

References:

1.**“Electronic Devices and Circuit Theory”** by Robert L. Boylestad and Louis Nashelsky, Pearson.

2.**“Microelectronic Circuits”** by Adel S. Sedra and Kenneth C. Smith, Oxford University Press.

3.**“Digital Logic and Computer Design”** by M. Morris Mano, Pearson Education.

Course Outcomes:	Blooms Taxonomy

CO1: Design Combinational Circuits using logic gates	Create (K6)
CO2: Design and implement arithmetic circuits for different applications using opamp	Create (K6)
CO3: Design Sequential Circuits using logic gates	Create (K6)
CO4: Design wave form generators and analyse their characteristics	Analyze (K4)
CO5: Simulate and analyse circuits using ICs.	Analyze (K4)

CO – PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	3	3	1	1	1	1	3	2	-
CO2	3	2	3	3	2	1	3	3	1	1	1	1	3	2	-
CO3	3	2	3	3	2	1	3	3	1	1	1	1	3	3	-
CO4	2	3	2	2	2	1	3	3	1	1	1	1	3	3	-
CO5	2	2	2	2	3	1	2	3	1	1	1	1	2	3	-
AVG	2	2.4	2.4	2.4	2.2	1	3	3	1	1	1	1	3	2	-

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

SEMESTER V

23BMT501	EMBEDDED SYSTEMS AND IOMT (Department of Biomedical Engineering)	Category: PCC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Acquire knowledge and understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
- Understand the hardware architecture and features of embedded microcontrollers and peripherals.
- Understand programming aspects of embedded system design.
- Understand IoT architecture and Build simple IoT Systems using embedded target boards
- Understand IoMT infrastructure for healthcare applications.

Unit I	**INTRODUCTION TO EMBEDDED SYSTEM DESIGN**	**9**

Introduction to embedded processors- Application Areas- Categories of embedded processors- Challenges in Embedded System Design, Design Process- Requirements- Specifications Hardware architecture- Software architecture -Introduction to Harvard & Von Neuman architectures- CISC & RISC Architectures. CPU Bus- Bus Protocols- Bus Organisation, Memory Devices, and their Characteristics- RAM, EEPROM-Flash Memory- DRAM. BIOS, POST, Device Drivers

Unit II	PERIPHERAL INTERFACING	9
I/O Devices-Timers and Counters- Watchdog Timers, Interrupt Controllers- A/D and D/A, Interfacing- Memory interfacing with a case study- I/O Device Interfacing with case Study- Programmed IO-Memory Mapped IO, Interfacing Protocols-SPI, I2C, USB, CAN, Ethernet/ WiFi, Bluetooth		
Unit III	**EMBEDDED SYSTEM SOFTWARE DESIGN**	**9**
Application Software, System Software, Design techniques – State diagrams, sequence diagrams, flowcharts, etc., Model-based system engineering (MBSE), Use of High-Level Languages- embedded C / C++ Programming, Integrated Development Environment tools- Editor- Compiler- Linker- Automatic Code Generators- Debugger- Board Support Library- Chip Support Library, Analysis and Optimization-Execution Time- Energy & Power.		
Unit IV	**DESIGN AND DEVELOPMENT OF IOT**	**9**
Definition and characteristics of IoT, Technical Building blocks of IoT, Communication Technologies, Physical design of IoT - system building blocks - sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Benefits and impact of IoMT. Cybersecurity – vulnerability, penetration & encryption technologies		
Unit V	**INTERNET OF MEDICAL THINGS**	**9**
Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An loT Model for Neuro sensors, AdaBoost with feature selection using loT for somatic mutations evaluation in Cancer, A Fuzzy Based expert System to diagnose Alzheimer's Disease, Secured architecture for loT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments.		
Total periods:45 PERIODS		
Text Books:		
1. Embedded Systems – A Contemporary Design Tool, James K Peckol, , John Weily, 2008, ISBN: 0- 444-51616-6.		
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "loT Fundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things, Cisco Press, 2017.		
3. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, "lnternet of Things and Personalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.		
References:		
1. Introduction to Embedded Systems, Shibu K V, Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790		
2. Embedded Software Primer, David E.Simon, Addison Wesley, ISBN-13: 978-0201615692		
3. The Intel Microprocessors, Architecture, Programming and Interfacing" Barry B.Brey, 6th Edition, Pearson Education.		
4. Arshdeep Bahga, Vijay Madisetti, "lnternet of Things – A hands-on approach", Universities Press, 2015		
5. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.		
6. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.		
7. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.		

8. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects", OReilly Media, 2nd Edition.

Course Outcomes:	Blooms Taxonomy
CO 1: Explain fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.	(K1-Remember)
CO2: Describe the hardware architecture and features of embedded microcontrollers and peripherals.	(K2-Understand)
CO3: Explain software design tools and embedded system design programming phases.	(K2-Apply)
CO4: Describe IoT Architectures and Build simple IoT Systems using embedded target boards.	(K2-Apply)
CO5: Exhibit understanding of IoMT infrastructure for healthcare applications.	(K4-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	1	-	-	-	-	-	-	1	1	1	-
CO2	3	2	1	1	1	-	-	-	-	-	-	1	1	1	-
CO3	3	2	1	1	1	-	-	-	-	-	-	1	1	1	-
CO4	3	2	1	1	1	-	-	-	-	-	-	1	1	1	-
CO5	3	2	1	1	1	-	-	-	-	-	-	1	1	1	-
AVG	3	2	1	1	1	-	-	-	-	-	-	1	1	1	-

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

23BMT502	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT (Department of Biomedical Engineering)	Category: PCC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Human Anatomy and Physiology

Course Objectives:

- Understand the devices for measurement of parameters related to cardiology.
- Illustrate the recording and measurement of EEG
- Demonstrate EMG recording unit and its uses.
- Explain diagnostic and therapeutic devices related to respiratory parameters.
- Understand the various sensory measurements that hold clinical importance.

Unit I	CARDIAC EQUIPMENT	9

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.

Unit II	NEUROLOGICAL EQUIPMENT	9

Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.		
Unit III	**MUSCULAR AND BIOMECHANICAL EQUIPMENT**	**9**
Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph. Dynamic Measurement – Velocity, Acceleration, GAIT, Limb position.		
Unit IV	**RESPIRATORY MEASUREMENT AND ASSIST SYSTEM**	**9**
wPressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.		
Unit V	**SENSORY DIAGNOSTIC EQUIPMENT**	**9**
Psychophysiological Measurements – polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.		
Total periods:45 periods		
Text Books:		
1. John G. Webster, “Medical Instrumentation Application and Design”, 4th edition, Wiley India PvtLtd,New Delhi, 2015		
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical Equipment Technology”, Pearson education, 2012		
References:		
1. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition, 2008.		
2. Khandpur. R.S.,“Handbook of Biomedical Instrumentation”. Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.		
3. Antony Y.K.Chan,”Biomedical Device Technology, Principles and design”, Charles Thomas Publisher Ltd, Illinois, USA, 2008.		
4. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Pearson Education, New Delhi, 2007.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Describe the working and recording setup of all basic cardiac equipment.	Apply (K3)
CO2: Understand the working and recording of all basic neurological equipment’s	Apply (K3)
CO3: Discuss the recording of diagnostic and therapeutic equipment’s related to EMG.	Apply (K3)
CO4: Explain about measurements of parameters related to respiratory system.	Analyze (K4)
CO5: Describe the measurement techniques of sensory responses.	Analyze (K4)

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

23BMP501	**EMBEDDED SYSTEMS AND IOMT LAB (Department Of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Prerequisites

- Nil

Course Objectives:

- Acquire knowledge and understand the hardware architecture and programming aspects of embedded system design.
- Understand IoT architecture and Build simple IoT Systems using embedded target boards.
- Understand IoMT infrastructure for healthcare applications.
- To learn different communication methods used in IoT.
- To interface LED and buzzer and control them using simple programs.

LIST OF EXPERIMENTS

1	Explore AVR/ARM based controllers using Embedded C.
2	Write Basic and arithmetic Programs Using Embedded C.
3	Write Embedded C program to test interrupt and timers.
4	Develop Real time applications – clock generation, waveform generation, counter using embedded C.
5	Explore different communication methods with IoT devices.
6	To interface LED/Buzzer with platform/ Aurdino /Raspberry Pi. and write an embedded C program to turn on / off LED/Buzzer with specified delay.
7	To interface DC/stepper motor using relay with open platform/ Aurdino /Raspberry Pi. and write an embedded C program to turn on motor if push button is pressed.
8	Develop simple application – testing infrared sensor – IoT Applications – using open platform/Raspberry Pi.
9	Develop simple application to interface DHT11 sensor with and write a program to display temperature humidity readings in LCD.
10	Develop IoMT Application using open platform/ Aurdino. /Raspberry Pi. and sensors such as temperature, ECG, Pulse etc.
11	Deploy IoMT applications using platforms.

12	Mini Project.
Total periods: 45 PERIODS	
Text Books:	
1. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", 2nd Edition, Pearson Education, 2011.	
2. Michael J. Pont, "Embedded C", 1st Edition, Pearson Education, 2002.	
3. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, "AVR Microcontroller and Embedded Systems", 1st Edition, Pearson Education, 2014.	
4. Andrew N. Sloss, Dominic Symes and Chris Wright, "ARM System Developer's Guide", 1st Edition, Morgan Kaufmann Publishers, 2004.	
References:	
1. Dhananjay V. Gadre, "Programming and Customizing the AVR Microcontroller", 1st Edition, McGraw-Hill Education, 2001.	
2. Ajay V. Deshmukh, "Microcontrollers: Theory and Applications", 1st Edition, McGraw-Hill Education, 2005.	
3. Eben Upton and Gareth Halfacree, "Raspberry Pi User Guide", 4th Edition, Wiley, 2016.	
4. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-On Approach", 1st Edition, Universities Press, 2015.	

Course Outcomes:	**Blooms Taxonomy**
CO1: To familiar the functions of ecosystems, environment and biodiversity.	Remembering (K1)
CO2: To know well about the effects of environmental pollutions.	Understanding (K2)
CO3: To inculcate the basic knowledge of renewable energy resources.	Applying (K3)
CO4: To differentiate various social problems.	Analyzing (K4)
CO5: To know the importance/impacts of population growth.	Evaluating (K5)

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	-	-	-	1	1	-	-	1	-	-
CO2	3	3	1	1	1	-	-	-	1	1	-	-	1	-	-
CO3	3	3	1	1	1	-	-	-	1	1	1	-	1	-	-
CO4	3	3	1	1	1	-	-	-	1	1	1	-	1	-	-
CO5	2	3	1	1	1	-	-	-	1	1	1	-	1	-	-
AVG	3	3	1	1	1	-	-	-	1	1	1	-	1	-	-

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

23BMP502	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LAB (Department of Biomedical Engineering)	Category: PCC			
		L	T	P	C
		0	0	4	2

Prerequisites

- Human Anatomy and Physiology

Course Objectives:

- To understand the principles and techniques involved in recording various bioelectrical and physiological signals.
- To provide hands-on experience in operating diagnostic equipment such as ECG, EEG, EMG, audiometry and biomedical electrodes.
- To familiarize students with therapeutic equipment including diathermy units, stimulators, ESU, ventilators, and ultrasound scanners.
- To enable students to perform and evaluate electrical safety tests on biomedical instruments.
- To analyze, interpret, and troubleshoot bio-signals and therapeutic outputs using appropriate tools and methodologies.

LIST OF EXPERIMENTS

1	Measurement of visually and auditory evoked potential.
2	Galvanic skin resistance (GSR) measurement.
3	Measurement of output intensity from shortwave and ultrasonic diathermy.
4	Measurement of various physiological signals using biotelemetry.
5	Electrical safety measurements.
6	Measurement of various physiological signals using biotelemetry.
7	Measurement of stimulation current waveforms used in medical stimulator.
8	Analyze the working of ESU–cutting and coagulation modes.
9	Recording of Audiogram.
10	Study the working of Defibrillator and pacemakers.
11	Study of ECG, EEG and EMG electrodes.
12	Study of ventilators and Ultrasound Scanners.
13	Study of speech signals using speech signal trainer kit.
14	Measurement of Oxygen Saturation and Heart Rate using Pulse-oximeter.
15	Study of heart lung machine model.

Total periods:60 PERIODS

Text Books:

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, 3rd Edition, Tata McGraw-Hill, New Delhi, 2014.

2. John G. Webster, Medical Instrumentation: Application and Design, 4th Edition, Wiley India Pvt. Ltd., 2015.

3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, 2nd Edition, Prentice Hall of India, New Delhi, 2015.

References:

1. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, 2015.

2. Leif Sörnmo and Pablo Laguna, Bioelectrical Signal Processing in Cardiac and Neurological Applications, Elsevier Academic Press, 2005.

3. Barbara Christe, Introduction to Biomedical Equipment Technology and Healthcare Safety, Pearson, 2002.

4. K. Krishna Kumar, Biomedical Instrumentation: Technology and Applications, I.K. International Publishing, 2018.

Course Outcomes:	**Blooms Taxonomy**
CO1: Measure the different bioelectrical signals.	Apply (K3)
CO2: Record the various physiological signals using telemetry.	Apply (K3)
CO3: Demonstrate various diagnostic and therapeutic techniques.	Apply (K3)
CO4: Examine the electrical safety measurements.	Analyze (K4)
CO5: Analyse the different bio signals using suitable tools.	Analyze (K4)

CO – PO & PSO Mapping

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

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

SEMESTER VI

23CST402	**ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**2**	**4**

Prerequisites

- Nil

Course Objectives:

- Study about uninformed and Heuristic search techniques.
- Learn techniques for reasoning under uncertainty.
- Introduce Machine Learning and supervised learning algorithms.
- Study about ensembling and unsupervised learning algorithms.
- Learn the basics of deep learning using neural networks.

Unit I	**PROBLEM SOLVING**	**9**

Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

Unit II	PROBABILISTIC REASONING	9
Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.		
Unit III	**SUPERVISED LEARNING**	**9**
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.		
Unit IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9**
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.		
Unit V	**NEURAL NETWORKS**	**9**
Perceptron- Mulilayer perceptron, functions, network training – gradient descentoptimization – stochastic gradient descent, error backpropagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.		

LIST OF EXPERIMENTS

1	Implementation of Uninformed search algorithms (BFS, DFS).
2	Implementation of Informed search algorithms (A*, memory-bounded A*).
3	Implement naïve Bayes models.
4	Implement Bayesian Networks.
5	Build Regression models.
6	Build decision trees and random forests.
7	Build SVM models.
8	Implement ensembling techniques.
9	Implement clustering algorithms.
10	Implement EM for Bayesian networks.
11	Build simple NN models.
12	Build deep learning NN models.

Lecture : 45 PERIODS Practical :30 PERIODS Total periods:75 PERIODS

Text Books:	
1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.	
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.	
References:	
1. Dan W. Patterson, “Introduction to AI and ES”, Pearson Education,2007.	
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008.	
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006.	
4. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013 (http://nptel.ac.in/).	
5. Christopher M. Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.	
6. Tom Mitchell, “Machine Learning”, McGraw Hill, 3rd Edition,1997.	
7. Charu C. Aggarwal, “Data Classification Algorithms and Applications”, CRC Press, 201	
8. Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, “Foundations of Machine Learning”, MIT Press, 2012.	
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2016.	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Use appropriate search algorithms for problem solving.	Apply (K3)
CO2: Apply reasoning under uncertainty.	Analyze (K4)
CO3: Build supervised learning models.	Apply (K3)
CO4: Build ensembling and unsupervised models.	Analyze (K4)
CO5: Build deep learning neural network models.	Analyze (K4)

CO - PO & PSO Mapping

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

1 - Low, 2 - Medium, 3 - High , ‘-‘ No correlation3

23BMT601	FUNDAMENTALS OF HEALTHCARE ANALYTICS (Department of Biomedical Engineering)	Category: PCC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- Understand the statistical methods for the design of biomedical research
- Comprehend the fundamental of mathematical and statistical theory in the application of healthcare.
- Apply the regression and correlation analyze in the healthcare data.
- Understand the Meta analysis and variance analysis.
- Interpret the results of the investigational methods.

Unit I	INTRODUCTION	9
Introduction, Computers and bio statistical analysis, Introduction to probability, likelihood & odds, distribution variability. Finding the statistical distribution using appropriate software tool like R/ Python.		
Unit II	**STATISTICAL PARAMETERS**	**9**
Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing -single population proportion, difference between two population proportions, single population variance, tests of homogeneity. Testing of statistical parameters using appropriate software R / Python.		
Unit III	**REGRESSION AND CORRELATION ANALYSIS**	**9**
Regression model, evaluating the regression equation, correlation model, correlation coefficient. Finding regression, correlation for the data using appropriate software like R / Python.		
Unit IV	**ANALYSIS OF VARIANCE**	**9**
META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design, factorial experiment. Testing the variance using appropriate software tool like R / Python.		
Unit V	**CASE STUDIES**	**9**
Epidemical reading and interpreting of epidemical studies, application in community health, Case study on Medical Imaging like MRI, CT. Case study on respiratory data, Case study on ECG data.		
	Total periods:45 PERIODS	

Text Books:

1. Wayne W. Daniel and Chad L. Cross, “Biostatistics: A Foundation for Analysis in the Health Sciences”, 11th Edition, Wiley, 2018.
2. Bernard Rosner, “Fundamentals of Biostatistics”, 8th Edition, Cengage Learning, 2015.
3. Chap T. Le, “Introductory Biostatistics”, 2nd Edition, Wiley, 2003.
4. Douglas G. Altman, “Practical Statistics for Medical Research”, 1st Edition, Chapman & Hall/CRC, 1990

References:
1. John Neter, Michael H. Kutner, Christopher J. Nachtsheim and William Wasserman, "Applied Linear Statistical Models", 5th Edition, McGraw-Hill, 2005
2. Sheldon M. Ross, "Introduction to Probability and Statistics for Engineers and Scientists", 6th Edition, Academic Press, 2020
3. Mark W. Lipsey and David B. Wilson, "Practical Meta-Analysis", 1st Edition, SAGE Publications, 2001.
4. Jennifer Peat, Belinda Barton and Elizabeth Elliott, "Medical Statistics: A Guide to Data Analysis and Critical Appraisal", 1st Edition, Wiley-Blackwell, 2009.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Apply the fundamentals of probability, variability, and statistical distributions to analyze biomedical and health-related data.	Understand (K2)
CO2: Compute and interpret key statistical parameters such as p-values, chi-square statistics, population proportions, and variance using analytical methods and software tools (R/Python).	Apply (K3)
CO3: Develop and evaluate regression and correlation models to understand relationships among biological and clinical variables	Apply (K3)
CO4: Perform Analysis of Variance (ANOVA) and Meta-analysis for experimental and research-based datasets using appropriate statistical techniques and software.	Apply (K3)
CO5: Analyze and interpret real-world biomedical case studies—including epidemiological data, MRI/CT imaging data, respiratory datasets, and ECG signals—to draw meaningful clinical conclusions	Analyze (K4)

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

23BMT602	**MEDICAL IMAGE PROCESSING** **(Department Of Biomedical Engineering)**	**Category: PCC**			
		L	**T**	**P**	**C**
		3	**0**	**2**	**4**

Prerequisites

- Nil

Course Objectives:

- Learn the fundamental concepts of medical Image Processing techniques.
- Understand the concepts of various image intensity transformation and filtering operations.
- Be familiar in the techniques of segmentation and restoration of medical images.
- Gain knowledge in medical image registration and visualization.
- Be familiar with the application of medical image analysis.

Unit I	**FUNDAMENTALS OF MEDICAL IMAGE PROCESSING AND TRANSFORMS**	**9**

Overview of Image Processing system and human Visual system- Image representation pixel and voxels, Gray scale and color models- Medical image file formats- DICOM, ANALYZE 7.5, NIFTI and INTERFILE- Discrete sampling model and Quantization- Relationship between the pixels, Arithmetic and logical operations- Image quality and Signal to Noise ratio- Image Transforms- 2D DFT, DCT, KLT. Interpret the basics of image models, Digitization of images and the transformations of medical images using Matlab.

Unit II	**ENHANCEMENT TECHNIQUES**	**9**

Gray level transformation- Log transformation, Power law transformation, Piecewise linear transformation. Histogram processing- Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering- Smoothing filters, Sharpening filters- Homomorphic filtering - Medical image enhancement using Hybrid filters Performance measures for enhancement techniques. Experiment with various filtering techniques for noise reduction and enhancement in medical images using Matlab.

Unit III	**SEGMENTATION AND RESTORATION TECHNIQUES**	**9**

Region based ROI definition Detection of discontinuities-Edge linking and boundary detection segmentation-Morphological processing, Active contour models. Image Restoration- Noise models-Restoration in the presence of Noise spatial filtering, Periodic noise reduction by frequency domain filtering- linear position- Invariant degradation-Estimation of degradation function, Inverse filter, Weiner filtering. Analyze the segmentation techniques to extract the region of interest and restoration of degraded images using Matlab.

Unit IV	REGISTRATION AND VISUALISATION	9
Registration-Rigid body transformation, principal axes registration, and feature based. Visualisation Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical image. Explain the significance of registration of various imaging modalities and appraise the concepts of image visualization in healthcare using Matlab		
Unit V	**APPLICATIONS OF MEDICAL IMAGE ANALYSIS**	**9**
Medical Image compression- DCT and Wavelet transform based image compression, Preprocessing of medical images -Retinal images. Ultrasound-liver, kidney, Mammogram. Segmentation of ROI -blood vessels, lesions, tumour, lung nodules, feature extraction-shape and texture, Computer aided diagnosis system performance measures (confusion matrix, ROC, AUC).		

LIST OF EXPERIMENTS

1	Image sampling and quantization.
2	Analysis of spatial and intensity resolution of images.
3	Intensity transformation of images.
4	DFT analysis of images.
5	Transforms a) Walsh b) Hadamard c) DCT d) Haar
6	Histogram Processing and Basic Thresholding functions.
7	Image Enhancement-Spatial filtering.
8	Image Enhancement- Filtering in frequency domain
9	Image segmentation a) Edge detection b) Line detection c) Point detection.
10	Basic Morphological operations
11	Region based Segmentation
12	Segmentation using watershed transformation.
13	Analysis of images with different color models.
14	Study of DICOM standards.
15	Image compression techniques.
16	Image restoration.

Lecture : 45 PERIODS Practical : 30 PERIODS Total periods: 75 PERIODS

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education, 98 3rd edition. 2016.

2. Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, 2nd Edition, Elsevier, 2009.

3. Wolfgang Birkfellner, Applied medical Image Processing: A Basic course, CRC Press, 2011

References:

1. Atam P.Dhawan, Medical Image Analysis, Wiley-Interscience Publication, NJ, USA 2003

2. Rangaraj M. "Rangayyan, Biomedical Image Analysis", 1st Edition, CRC Press, Published December 30, 2004.

3. Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, "Medical image registration", Biomedical Engineering series, CRC press, 2001

4. Milan Sonka, Image Processing. Analysis And Machine Vision, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999.

5. Anil Jain K, Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011..

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain and apply the fundamental concepts of image processing techniques for the analysis of medical images.	Apply (K3)
CO2: Identify and apply suitable filtering and intensity transformation techniques for given medical applications.	Apply (K3)
CO3: Identify and segment the Region of Interest from the given medical image	Analyze (K4)
CO4: Explore and apply current research in registration and visualization for medical image analysis.	Apply (K3)
CO5: Explain and apply the image compression techniques.	Apply (K3)

CO - PO & PSO Mapping

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

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

SEMESTER VII

23GET701	**HUMAN VALUES AND ETHICS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: HSMC**			
		L	**T**	**P**	**C**
		2	**0**	**0**	**2**

Prerequisites

- Nil

Course Objectives:

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To instill the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and understanding of the duties of citizen.

Unit I	**DEMOCRATIC VALUES**	**6**

Understanding Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World 6 Democracies: French Revolution, American Independence, Indian Freedom Movement. Reading Text: Excerpts from John Stuart Mills' On Liberty		
Unit II	**SECULAR VALUES**	**6**
Understanding Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices. Reading Text: Excerpt from Secularism in India: Concept and Practice by Ram Puniyani		
Unit III	**SCIENTIFIC VALUES**	**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. Reading Text: Excerpt from The Scientific Temper by Antony Michaelis R		
Unit IV	**SOCIAL ETHICS**	**6**
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices. Reading Text: Excerpt from 21 Lessons for the 21st Century by Yuval Noah Harari		
Unit V	**SCIENTIFIC ETHICS**	**6**
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society. Reading Text: Excerpt from American Prometheus: The Triumph and Tragedy of J.Robert Oppenheimer by Kai Bird and Martin J. Sherwin.		
Total periods:30 PERIODS		
References:		
1. The Nonreligious: Understanding Secular People and Societies, Luke W. Galen Oxford University Press, 2016.		
2. Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.		
3. The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.		
4. The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,		
5. Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Identify the importance of democratic, secular and scientific values in harmonious functioning of social life	Understand (K2)
CO2: Practice democratic and scientific values in both their personal and professional life.	Apply (K3)
CO3: Find rational solutions to social problems.	Analyze (K4)
CO4: Behave in an ethical manner in society	Apply (K3)
CO5: Practice critical thinking and the pursuit of truth.	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	2	-	1	2	-	-	-	1	-	-	2	2	-
CO2	2	3	2	2	2	2	-	-	-	1	-	-	2	2	-
CO3	2	2	3	2	2	2	-	-	-	2	-	-	3	2	-
CO4	2	2	2	2	2	2	-	-	-	2	-	-	2	2	-
CO5	2	3	3	3	2	2	-	-	-	2	-	-	3	2	-
AVG	2	3	3	2	1	2	-	-	-	1	-	-	2	2	-

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

23BMP701	**HOSPITAL TRAINING (Department of Biomedical Engineering)**	**Category: EEC**			
		L	**T**	**P**	**C**
		0	**0**	**0**	**2**

Prerequisites

- Nil

Course Objectives:

- Understand the functioning of hospital departments such as ICU, OT, Radiology, Laboratory, and Biomedical Engineering units.
- Develop professional communication skills for interacting effectively with patients, clinicians, nurses, and administrative staff.
- Learn basic biomedical equipment handling and safety protocols, including routine checks, troubleshooting, and maintenance awareness.
- Gain awareness of hospital workflow and documentation, including patient records, consent forms, and standard operating procedures (SOPs).
- Recognize the importance of ethical practices and patient confidentiality**,** following guidelines such as informed consent and privacy standards.

LIST OF EXPERIMENTS

1	Cardiology
2	ENT
3	Ophthalmology

4	Orthopaedic and Physiotherapy
5	ICU/CCU
6	Operation Theatre
7	Neurology
8	Nephrology
9	Radiology
10	Nuclear Medicine
11	Pulmonology
12	Urology
13	Obstetrics and Gynaecology
14	Emergency Medicine
15	Biomedical Engineering Department
16	Histo Pathology
17	Biochemistry
18	Paediatric/Neonatal
19	Dental
20	Oncology
21	PAC's
22	Medical Records / Telemetry
	Total periods:60

Course Outcomes:	**Blooms Taxonomy**
CO1: Advocate a patient-centred approach in healthcare.	Apply (K3)
CO2: Communicate with other health professionals in a respectful and responsible manner.	Apply (K3)
CO3: Recognize the importance of inter-professional collaboration in healthcare.	Understand (K2)
CO4: Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived needs.	Create (K6)
CO5: Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.	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	2	1	2	3	1	2
CO2	2	2	1	-	1	3	2	3	1	2	1	2	3	-	2
CO3	2	3	2	2	3	-	-	-	-	1	1	2	2	3	2
CO4	1	-	-	-	1	2	-	1	3	3	2	1	2	1	3
CO5	2	3	3	2	2	-	-	-	1	2	2	3	2	2	3
AVG	2	2	1	1	1	1	1	1	1	2	2	3	3	1	2

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

23BMP702	PROJECT WORK I (Department of Biomedical Engineering)	Category: EEC			
		L	T	P	C
		0	0	8	4

Prerequisites

- NIl

Course Objectives:

- Students develop the ability to identify a problem, review literature, and create an effective solution.
- They are trained to prepare project reports and face reviews and viva-voce examinations.
- A group of 3 to 4 students works on an approved topic under the guidance of a faculty supervisor.
- The project progress is evaluated through a minimum of three reviews by a department-appointed committee.
- At the end of the semester, students submit a project report and give an oral presentation evaluated by internal and external examiners.

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

Total Periods: 120 PERIODS

Course Outcomes:	Blooms Taxonomy
CO1: Students will be able to identify and define real-world engineering or healthcare problems.	Understand (K2)
CO2: Students will formulate appropriate methodologies to solve real-world issues.	Apply (K3)
CO3: Students will apply technical knowledge to design and implement effective solutions.	Analyze (K4)
CO4: Students will demonstrate problem-solving skills through systematic project work.	Evaluate (K5)
CO5: Students will gain confidence to handle complex tasks independently in professional practice.	Create (K6)

CO – PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	1	2	-	2	3	1	1
CO2	2	3	3	2	2	-	-	-	1	2	1	2	3	2	2
CO3	2	3	3	3	2	-	-	-	1	2	1	2	3	2	3
CO4	1	2	2	3	2	-	-	1	1	2	1	2	2	2	3
CO5	1	2	3	2	2	-	-	1	2	2	2	2	2	2	3
AVG	1.8	2.6	2.6	2.4	1.8	-	-	0.4	1.2	2	1	2	2.6	1.8	2.2

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

SEMESTER VIII

<table>
<tr><td rowspan="3">23BMP801</td><td rowspan="3">PROJECT WORK II
(Department of Biomedical Engineering)</td><td colspan="4">Category: EEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>0</td><td>0</td><td>12</td><td>6</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- Students develop the ability to identify a problem, review literature, and create an effective solution.
- They are trained to prepare project reports and face reviews and viva-voce examinations.
- A group of 3 to 4 students works on an approved topic under the guidance of a faculty supervisor.
- The project progress is evaluated through a minimum of three reviews by a department-appointed committee.
- At the end of the semester, students submit a project report and give an oral presentation evaluated by internal and external examiners.

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

Total Periods: 120 PERIODS

Course Outcomes:	Blooms Taxonomy
CO1: Students will be able to identify and define real-world engineering or healthcare problems.	Understand (K2)
CO2: Students will formulate appropriate methodologies to solve real-world issues.	Apply (K3)
CO3: Students will apply technical knowledge to design and implement effective solutions.	Analyze (K4)
CO4: Students will demonstrate problem-solving skills through systematic project work.	Evaluate (K5)
CO5: Students will gain confidence to handle complex tasks independently in professional practice.	Create (K6)

CO – PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	1	-	-	-	1	2	-	2	3	1	1
CO2	2	3	3	2	2	-	-	-	1	2	1	2	3	2	2
CO3	2	3	3	3	2	-	-	-	1	2	1	2	3	2	3
CO4	1	2	2	3	2	-	-	1	1	2	1	2	2	2	3
CO5	1	2	3	2	2	-	-	1	2	2	2	2	2	2	3
AVG	1.8	2.6	2.6	2.4	1.8	-	-	0.4	1.2	2	1	2	2.6	1.8	2.2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

ELECTIVE – MANAGEMENT COURSES

23EMT001	**PRINCIPLES OF MANAGEMENT**	**Category: HSMC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- A basic understanding of business, economics, or organizational functions is helpful for learning core management concepts.

Course Objectives:

- Sketch the Evolution of Management.
- Extract the functions and principles of management.
- Learn the application of the principles in an organization.
- Study the various HR related activities.
- Analyze the position of self and company goals towards business.

Unit I	**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**	**9**

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

Unit II	**PLANNING**	**9**

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

Unit III	**ORGANISING**	**9**

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

Unit IV	DIRECTING	9

Foundations of individual and group behaviour– Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

Unit V	CONTROLLING	9

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

Total periods:45 PERIODS

Text Books:

1. Harold Koontz and Heinz Weihrich "Essentials of management" Tata McGraw Hill,1998.
2. Stephen P. Robbins and Mary Coulter, " Management", Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.

References:

1. Robert Kreitner and MamataMohapatra, " Management", Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Upon completion of the course, students will be able to have clear understanding of managerial functions like planning, organizing, staffing, leading & controlling.	(K2 – Understand)
CO2: Have same basic knowledge on international aspect of management.	(K2 – Understand)
CO3: Ability to understand management concept of organizing.	(K2 – Understand)
CO4: Ability to understand management concept of directing.	(K2 – Understand)
CO5: Ability to understand management concept of controlling.	(K2 – Understand)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	1	-	-	-	-	-	-	2	1	1
CO2	-	1	1	-	-	-	-	-	-	-	-	-	2	1	-
CO3	1	-	-	2	-	-	1	-	2	-	1	1	-	-	2
CO4	-	1	1	1	2	-	-	1	2	-	-	-	1	1	1
CO5	1	-	-	-	1	1	-	-	-	3	-	1	1	-	1
AVG	1	1	1	1	0.6	0.4	0.4	0.2	0.6	0.6	1	1	2	1	1

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

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

Prerequisites

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

Course Objectives:

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

Unit I	INTRODUCTION	9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

Unit II	TQM PRINCIPLES	9

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction – Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal-- Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, 183 Supplier selection, Supplier Rating and Relationship development.

Unit III	TQM TOOLS & TECHNIQUES I	9

The seven traditional tools of quality - New management tools - Six-sigma Process Capability- Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understanding Current Performance, Planning, Studying Others, Learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent , Documentation, Stages: Design FMEA and Process FMEA.

Unit IV	TQM TOOLS & TECHNIQUES II	9

Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM – Concepts, improvement needs – Performance measures- Cost of Quality - BPR.

Unit V	QUALITY MANAGEMENT SYSTEM	9

Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.

Total periods:45 PERIODS

Text Books:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Bester field,MaryB.Sacre, HemantUrdhwareshe and RashmiUrdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.

References:

1. Joel.E. Ross, “Total Quality Management – Text and Cases”,Routledge.,2017.
2. Kiran.D.R, “Total Quality Management: Key concepts and case studies, Butterworth – Heinemann Ltd, 2016.
3. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, Third Edition, 2003.
4. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd., 2006.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Ability to apply TQM concepts in a selected enterprise.	(K3 – Apply)
CO2: Ability to apply TQM principles in a selected enterprise.	(K3 – Apply)
CO3: Ability to understand Six Sigma and apply Traditional tools, New tools, Benchmarking and FMEA.	(K3 – Apply)
CO4: Ability to understand Taguchi's Quality Loss Function, Performance Measures and apply QFD, TPM, COQ and BPR.	(K3 – Apply)
CO5: Ability to apply QMS and EMS in any organization.	(K3 – Apply)

CO - PO & PSO Mapping

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

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

23EMT003	ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING	Category: HSMC			
		L	T	P	C
		3	0	0	3

Prerequisites

A basic understanding of mathematics and logical reasoning is required to analyze economic problems and financial data.

Course Objectives:

- Understanding the concept of Engineering Economics.
- Implement various micro economics concept in real life.
- Gaining knowledge in the field of macro economics to enable the students to have better.
- understanding of various components of macro economics.
- Understanding the different procedures of pricing.
- Learn the various cost related concepts in micro economics.

Unit I	DEMAND & SUPPLY ANALYSIS	9

Managerial Economics - Relationship with other disciplines - Firms: Types, objectives and goals - Managerial decisions - Decision analysis.Demand - Types of demand - Determinants of demand - Demand function – Demand elasticity - Demand forecasting - Supply - Determinants of supply - Supply function -Supply elasticity.

Unit II	PRODUCTION AND COST ANALYSIS	9

Production function - Returns to scale - Production optimization - Least cost input - Isoquants - Managerial uses of production function. Cost Concepts - Cost function - Determinants of cost - Short run and Long run cost curves - Cost Output Decision - Estimation of Cost.

Unit III	PRICING	9

Determinants of Price - Pricing under different objectives and different market structures - Price discrimination - Pricing methods in practice.

Unit IV	FINANCIAL ACCOUNTING (ELEMENTARY TREATMENT)	9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis - Comparative financial statements - Analysis & Interpretation of financial statements.

Unit V	CAPITAL BUDGETING (ELEMENTARY TREATMENT)	9

Investments - Risks and return evaluation of investment decision - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

Total periods:45 PERIODS

Text Books:

1. Panneer Selvam, R, “Engineering Economics”, Prentice Hall of India Ltd, New Delhi,2001.

2. Managerial Economics: Analysis, Problems and Cases - P. L. Mehta, Edition, 13. Publisher, Sultan Chand, 2007.

References:

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

Course Outcomes:	**Blooms Taxonomy**
CO1: Upon successful completion of this course, students will acquire the skills to apply the basics of economics and cost analysis to engineering and take economically sound decisions	(K3 – Apply)
CO2: Evaluate the economic theories, cost concepts and pricing policies	(K5 – Evaluate)
CO3: Understand the market structures and integration concepts	(K2 – Understand)
CO4: Understand the measures of national income, the functions of banks and concepts of globalization	(K2 – Understand)
CO5: Apply the concepts of financial management for project appraisal.	(K3 – 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	3	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-	-	2	3	-
CO5	3	3	3	-	2	-	-	-	-	-	-	-	2	-	2
AVG	1	3	2	-	1	-	-	-	-	1	-	-	1	2	1

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

23EMT004	**HUMAN RESOURCE MANAGEMENT**	**Category: HSMC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

Basic knowledge of management principles and organizational behavior.

Course Objectives:

- To provide knowledge about management issues related to staffing,
- To provide knowledge about management issues related to training,
- To provide knowledge about management issues related to performance
- To provide knowledge about management issues related to compensation
- To provide knowledge about management issues related to human factors consideration and compliance with human resource requirements.

Unit I	**INTRODUCTION TO HUMAN RESOURCE MANAGEMENT**	**9**

The importance of human resources – Objective of Human Resource Management - Human resource policies - Role of human resource manager.

Unit II	**HUMAN RESOURCE PLANNING**	**9**
Importance of Human Resource Planning – Internal and External sources of Human Resources - Recruitment - Selection – Socialization		
Unit III	**TRAINING AND EXECUTIVE DEVELOPMENT**	**9**
Types of training and Executive development methods – purpose – benefits.		
Unit IV	**EMPLOYEE COMPENSATION**	**9**
Compensation plan – Reward – Motivation – Career Development - Mentor – Protege relationships.		
Unit V	**PERFORMANCE EVALUATION AND CONTROL**	**9**
Performance evaluation – Feedback - The control process – Importance – Methods – grievances – Causes – Redressal methods		
	Total periods:45	

Text Books:

1.Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007

2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, N

References:

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, “Managing Human Resources", 7 th Edition, PHI, 2012.

2. Dessler, "Human Resource Management", Pearson Education Limited, 2007

Course Outcomes:	**Blooms Taxonomy**
CO 1: Students would have gained knowledge on the various aspects of HRM	(K2 – Understand)
CO2: Students will gain knowledge needed for success as a human resources professional.	(K2 – Understand)
CO3: Students will develop the skills needed for a successful HR manager.	(K3 – Apply)
CO4: Students would be prepared to implement the concepts learned in the workplace.	(K3 – Apply)
CO5: Students would be aware of the emerging concepts in the field of HRM	(K4 – Analyze)

CO - PO & PSO Mapping

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

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

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

Prerequisites Basic understanding of organizational processes and information systems.		
Course Objectives: • Learn the Evolution of Knowledge management. • Be familiar with tools. • Be exposed to Applications. • Be familiar with some case studies • To implement strategies for capturing and sharing organizational knowledge.		
Unit I	**INTRODUCTION**	**9**
Introduction: An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.		
Unit II	**I CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING**	**9**
Organization and Knowledge Management - Building the Learning Organization. Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance		
Unit III	**KNOWLEDGE MANAGEMENT-THE TOOLS**	**9**
Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.		
Unit IV	**KNOWLEDGE MANAGEMENT APPLICATION**	**9**
Components of a Knowledge Strategy - Case Studies (From Library to Knowledge Center, Knowledge Management in the Health Sciences, Knowledge Management in Developing Countries).		
Unit V	**FUTURE TRENDS AND CASE STUDIES**	**9**
Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life -cycles of an organization.		
Total periods:45 PERIODS		
Text Books:		
1. Srikantaiah, T.K., Koenig, M., “Knowledge Management for the Information Professional” Information Today, Inc., 2000		
References:		
1. Nonaka, I., Takeuchi, H., “The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation”, Oxford Unive		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand the process of acquiry knowledge from experts	(K2: Understand)
CO2: Understand the learning organization.	(K2: Understand)
CO3: Use the knowledge management tools.	(K3: Apply)
CO4: Develop knowledge management Applications.	(K6: Create)
CO5: Design and develop enterprise applications	(K6: Create)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	2	-	-	-	-	-	-	-	-	2	-
CO4	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-
CO5	-	-	-	1	1	-	-	-	1	-	-	-	-	1	-
AVG	-	-	-	1	1	-	-	-	1	-	-	-	0.4	1	-

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

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

Prerequisites

Basic knowledge of management principles and industrial operations.

Course Objectives:

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

Unit I	**INTRODUCTION TO MANAGEMENT**	**9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.		
Unit II	**FUNCTIONS OF MANAGEMENT - I**	**9**
Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design		
Unit III	**FUNCTIONS OF MANAGEMENT - II**	**9**
Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.		
Unit IV	**ORGANIZATION THEORY**	**9**
Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.		
Unit V	**PRODUCTIVITY AND MODERN TOPICS**	**9**
Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).		
		Total periods:45
Text Books:		
1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009		
2. Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.		
References:		
1. Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.		
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.		
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.		
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012		
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018		

Course Outcomes:	Blooms Taxonomy
CO 1: Explain basic concepts of management; approaches to management; contributors to management studies; various forms of business organization and trade unions function in professional organizations.	(K2: Understand)
CO2: Discuss the planning; organizing and staffing functions of management in professional organization	(K2: Understand)

CO3: Apply the leading; controlling and decision making functions of management in professional organization.	(K3: Apply)
CO4: Discuss the organizational theory in professional organization	(K2: Understand)
CO5: Apply principles of productivity and modern concepts in management in professional organization	(K3: Apply)

CO - PO & PSO Mapping

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

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

MANDATORY COURSES I

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

Prerequisites

- Basic understanding of social issues and ability to read simple academic content.
- Openness to discuss gender-related topics respectfully and critically

Course Objectives:

- To provide students with foundational knowledge of gender, feminism, and social inequalities, enabling them to critically examine how gender shapes individual experiences, institutions, and cultural practices in society.

Unit I	CONCEPTS	9

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

Unit II	FEMINIST THEORY	9

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

Unit III	WOMEN’S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL	9
Rise of Feminism in Europe and America. Women’s Movement in India.		
Unit IV	**GENDER AND LANGUAGE**	**9**
Linguistic Forms and Gender. Gender and narratives.		
Unit V	**GENDER AND REPRESENTATION**	**9**
Advertising and popular visual media. Gender and Representation in Alternative Media. Gender and social media.		
		Total periods: 45

Text Books:

1. **Introducing Gender and Women’s Studies** — Linda Diane Richardson q
2. **Introduction to Women’s & Gender Studies** (Open Textbook) — Colleen Lutz Clemens

References:

1. **Handbook of Gender and Women’s Studies** — Edited by Kathy Davis, Mary Evans, Judith Lorber
2. **Feminist Studies: An Introductory Reader** — Hemangini Gupta, Kelly Sharron, Carly Thomsen, Abraham Weil
3. **Freedom and Destiny: Gender, Family and Popular Culture in India** — Patricia Uberoi

Course Outcomes:	Blooms Taxonomy
CO 1: Define and explain core gender concepts such as sex vs. gender, patriarchy, hegemony, stereotypes, and gender roles.	Understand (K2)
CO2: Describe major feminist theories including Liberal, Marxist, Radical, Psychoanalytic, Postmodernist, and Ecofeminist.	Understand (K2)
CO3: Summarize the historical development of women’s movements at global, national, and local levels.	Understand (K2)
CO4: Identify how language, discourse, and narratives shape gender identity and power dynamics.	Apply (K3)
CO5: Examine gender representation in popular, alternative, and social media.	Analyze (K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	2	3	1	3	1	2	1	2	3	2	2
CO2	2	2	1	1	2	3	1	2	1	2	1	2	2	3	2
CO3	2	2	1	2	2	3	2	3	1	2	1	2	2	3	2
CO4	2	2	1	2	2	3	1	3	1	2	1	2	2	3	2
CO5	2	2	1	2	2	3	1	3	1	2	1	2	2	2	3
AVG	2	2	1	1.6	2	2	3	1.3	1	2	1	2	2.2	2.6	2.2

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

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

Prerequisites

- Nil

Course Objectives:

- To make the students aware about the finer sensibilities of human existence through an art
- form.
- The students will learn to appreciate different forms of literature as suitable modes of expressing human experience

Unit I	Relevance of literature	9

a) Enhances Reading, thinking, discussing and writing skills.

b) Develops finer sensibility for better human relationship.

c) Increases understanding of the problem of humanity without bias.

d) Providing space to reconcile and get a cathartic effect.

Unit II	Elements of fiction	9

a) Fiction, fact and literary truth.

b) Fictional modes and patterns.

c) Plot character and perspective.

Unit III	Elements of poetry	9

a) Emotions and imaginations.

b) Figurative language.

c) (Simile, metaphor, conceit, symbol, pun and irony).

d) Personification and animation. e) Rhetoric and trend.

Unit IV	Elements of drama	9

a) Drama as representational art.

b) Content mode and elements.

c) Theatrical performance. d) Drama as narration, mediation and persuasion.

e) Features of tragedy, comedy and satire.

Total periods: 45 PERIODS

Text Books:

1.*An Introduction to the Study of English Literature* — **W. H. Hudson**

2.*An Introduction to Literary Studies* — **Mario Klarer**

3.*The Experience of Poetry* — **Graham Mode**

4. *The Elements of Fiction: A Survey* — **Ulf Wolf**

References:

1. An Introduction to the Study of English Literature, W.H. Hudson, Atlantic, 2007.

2. An Introduction to Literary Studies, Mario Klarer, Routledge, 2013.

3. The Experience of Poetry, Graham Mode, Open college of Arts with Open Unv Press, 1991.

4. The Elements of Fiction: A Survey, Ulf Wolf (ed), Wolfstuff, 2114.

5. The Elements of Drama, J.L.Styan, Literary Licensing, 2011.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Recognize the relevance of literature in enhancing reading, thinking, discussion, and writing skills and in understanding human values.	Understand (K2)
CO2: Explain the elements of fiction including plot, character, perspective, and the distinction between fact, fiction, and literary truth.	Understand (K2)
CO3: Analyze the elements of poetry including figurative language, emotions, imagination, and rhetorical devices such as simile, metaphor, symbol, pun, irony, and personification.	Analyze (K4)
CO4: Recall the basic elements of drama, its modes, content, theatrical performance, and features of tragedy, comedy, and satire.	Remember (K1)
CO5: Apply literary knowledge to appreciate, interpret, and discuss literature with clarity and sensitivity.	Apply (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	3	2	1	2	2	2	2	1	2	2	2
CO2	2	3	2	2	2	2	1	2	1	2	2	1	2	3	2
CO3	2	3	3	3	2	2	1	2	2	2	2	1	2	3	2
CO4	3	2	1	1	2	2	1	2	1	2	2	1	3	2	1
CO5	2	3	3	2	3	2	1	2	3	3	2	1	3	2	3
AVG	2.4	2.6	2	1.8	2.4	2	1	2	1.8	2.2	2	1	2.4	2.5	2

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

23MCT003	**FILM APPRECIATION**	**Category: MC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**0**

Prerequisites

- -Nil-

Course Objectives:

- In this course on film appreciation, the students will be introduced broadly to the development of film as an art and entertainment form.
- It will also discuss the language of cinema as it evolved over a century.
- The students will be taught as to how to read a film and appreciate the various nuances of a film as a text.
- The students will be guided to study film joyfully.
- To introduce students to film as an art form and its language.

Unit I	**The Component of Films**	**9**
The material and equipment The story, screenplay and script The actors, crew members, and the director The process of film making… structure of a film		
Unit II	**Evolution of Film Language**	**9**
Film language, form, movement etc. Early cinema… silent film (Particularly French) The emergence of feature films: Birth of a Nation Talkies		
Unit III	**Film Theories and Criticism/Appreciation**	**9**
Realist theory; Auteurists Psychoanalytic, Ideological, Feminists How to read films? Film Criticism / Appreciation		
Unit IV	**Development of Films**	**9**
Representative Soviet films Representative Japanese films Representative Italian films Representative Hollywood film and the studio system		
Unit V	**Indian Films**	**9**

The early era The important films made by the directors The regional films The documentaries in India
Total periods: 45 PERIODS
Text Books:
1.Film Art: An Introduction — David Bordwell & Kristin Thompson
2. **How to Read a Film: Movies, Media, and Beyond** — James Monaco
References:
1. *Film Art: An Introduction* by **David Bordwell & Kristin Thompson** — Very widely used for understanding film form, editing, mise-en-scène.
2. *A Biographical Dictionary of Film* by **David Thomson** — Reference for history of cinema and important filmmakers.
3. *Movies and Methods* (Vol. I & II) edited by **Bill Nichols** — Deep dive into film theory and methodology.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand the fundamental components of films, including materials, equipment, actors, crew, director, and the process of filmmaking.	Understand (K2)
CO2 :Understand the evolution of film language, including form, movement, silent cinema, and early feature films.	Understand (K2)
CO3: Apply film theories such as Realist, Auteurist, Psychoanalytic, Ideological, and Feminist approaches for criticism and appreciation	Apply (K3)
CO4: Interpret and critically read films, including representative films from Soviet, Japanese, Italian, Hollywood, and Indian cinema.	Analyze (K4)
CO5: Understand the development of Indian cinema, including early era films, regional cinema, documentaries, and works of important directors.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	2	2	2	1	2	1	2	1	2	2	2	2
CO2	3	2	2	2	2	2	1	2	1	2	1	2	2	3	2
CO3	2	3	3	2	3	2	1	2	2	2	1	2	3	3	3
CO4	2	3	3	3	2	2	1	2	2	2	1	2	3	3	2
CO5	3	2	2	2	2	3	1	2	2	2	2	2	2	2	3
AVG	2.6	2.4	2.4	2.2	2.4	2.4	1	2	1.6	2	1.2	2	2.4	2.6	2.4

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

23MCT004	**DISASTER RISK REDUCTION AND MANAGEMENT**	**Category: MC**

		L	T	P	C
		3	0	0	0

Prerequisites

- Nil-

Course Objectives:

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response
- To provide knowledge on disaster concepts, types, risks, and vulnerability
- To develop skills for disaster preparedness, mitigation, and emergency response.
- To understand disaster management policies, tools, technologies, and institutional frameworks.

Unit I	**HAZRADS, VULNERABILITY AND DISASTER RISKS**	**9**

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

Unit II	**DISASTER RISK REDUCTION (DRR)**	**9**

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

Unit III	**DISASTER MANAGEMENT**	**9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

Unit IV	**TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT**	**9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

Unit V	DISASTER MANAGEMENT: CASE STUDIES	9
Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters- Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -		
Total periods: 45 PERIODS		

Text Books:

1. Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2. Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

References:

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

Course Outcomes:	**Blooms Taxonomy**
CO 1: To impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR)	Remember (K1)
CO2: To enhance understanding on Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction	Understand (K2)
CO3: To develop disaster response skills by adopting relevant tools and technology	Analyze (K4)
CO4: Enhance awareness of institutional processes for Disaster response in the country and	Understand (K2)
CO5: Develop rudimentary ability to respond to their surroundings with potential Disaster response in areas where they live, with due sensitivity	Apply (K3)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	3	-	-	2	2	-	-	2	-	2	-	1
CO2	3	3	3	3	-	-	2	1	-	-	2	-	2	-	1
CO3	3	3	3	3	-	-	2	2	-	-	-	-	2	-	1
CO4	3	3	2	3	-	-	2	1	-	-	2	-	2	-	1
CO5	3	3	2	3	-	-	2	2	-	-	2	-	3	-	1
AVG	3	3	2.4	3	-	-	2	1.6	-	-	1.6	-	2.2	-	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

MANDATORY COURSES II

23MCT006	**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA**				**Category: MC**
		L	**T**	**P**	**C**
		3	**0**	**0**	**0**

Prerequisites

- Basic awareness of health, wellness, and human body functions, with the ability to follow guided physical or reflective practices.
- Openness to learn traditional healing systems like Yoga, Ayurveda, and Siddha with a respectful and disciplined approach.

Course Objectives:

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

Unit I	**HEALTH AND ITS IMPORTANCE**	**9**

Health: Definition - Importance of maintaining health - More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health - Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health - Environmental health - Occupational/Professional heath. Present health status - The life expectancy-present status - mortality rate - dreadful diseases - Non communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer – diabetes - chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities. Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - Cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues. Causes of the above diseases / disorders

<table>
<tr><td colspan="3">- Importance of prevention of illness - Takes care of health - Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) - Maintaining BMI Importance and actions to be taken</td></tr>
<tr><td>Unit II</td><td>DIET</td><td>9</td></tr>
<tr><td colspan="3">Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD – infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong. Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water. Food additives and their merits & demerits - Effects of food additives - Types of food additives - Food additives and processed foods - Food additives and their reactions Definition of BMI and maintaining it with diet Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM Common cooking mistakes Different cooking methods, merits and demerits of each method</td></tr>
<tr><td>Unit III</td><td>ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH</td><td>9</td></tr>
<tr><td colspan="3">AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy. Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life. Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal Prevention of illness with our traditional system of medicine Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and - Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the amount of disability associated with an existing disorder.</td></tr>
<tr><td>Unit IV</td><td>MENTAL WELLNESS</td><td>9</td></tr>
<tr><td colspan="3">Emotional health - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health - Role of emotions in daily life -Short term and long term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions. Stress management - Stress definition - Stress in daily life - How stress affects one’s life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training, professional help) - Complications of stress mismanagement. Sleep - Sleep and its importance for mental wellness - Sleep and digestion. Immunity - Types and importance - Ways to develop immunity.</td></tr>
<tr><td>Unit V</td><td>YOGA</td><td>9</td></tr>
</table>

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

Total periods: 45 PERIODS

Text Books:

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

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

References:

1.WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts

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

Course Outcomes:	**Blooms Taxonomy**
CO 1: Learn the importance of health, preventive care, the ten dimensions of health, and the present health status including major non-communicable diseases and their risk factors.	K2 (Understand)
CO2: Analyze the role of diet in maintaining overall health, identify components of a balanced diet, classify food additives with their effects, and apply dietary principles for maintaining an optimal BMI	K3 (Analyze)
CO3: Learn the principles of Ayurveda and Siddha systems, traditional health practices, preventive approaches (primary, secondary, tertiary), and their contribution to holistic wellbeing.	K2 (Understand)
CO4: Evaluate emotional health, stress, sleep, and immunity; identify symptoms and causes; and apply suitable practices and strategies to maintain mental wellness.	K5 (Evaluate)
CO5:Demonstrate an understanding of yoga, its types, eight limbs, and simple yogasanas, and relate their importance in preventing and managing various health disorders.	K2 (Understand)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	1	3	3	2	1	1	2	2	2	1	1
CO2	3	2	2	2	1	3	3	2	1	1	2	1	2	2	1
CO3	2	1	1	1	1	3	3	2	1	1	2	2	2	2	1
CO4	2	1	1	1	1	3	3	2	2	2	3	2	2	2	1
CO5	2	1	1	1	1	3	3	2	1	1	2	2	2	2	1
AVG	2.2	1.4	1.2	1.2	1	3	3	2	1.2	1.2	2.2	1.8	2	1.8	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MCT007	**HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA**	**Category: MC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**0**

Prerequisites

- Basic understanding of Indian history and general scientific concepts at the school level.
- Interest in exploring the evolution of science and technology within India's cultural and historical context.

Course Objectives:

- To familiarize students with the evolution of scientific and technological advancements in India from ancient to modern times, and to develop an understanding of their impact on society, culture, and national development.
- To understand the historical development of science and technology in India from ancient to modern periods.
- To explore major scientific achievements in fields such as mathematics, astronomy, medicine, engineering, and agriculture.
- To analyze the social, cultural, and technological impact of scientific advancements in India.
- To recognize the contributions of Indian scientists and institutions during pre-independence and post-independence periods.

Unit I	**CONCEPTS AND PERSPECTIVES**	**9**

Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

Unit II	**HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA**	**9**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others

Unit III	**SCIENCE AND TECHNOLOGY IN ANCIENT INDIA**	**9**

Technology in pre-historic period Beginning of agriculture and its impact on technology Science and Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200.

Unit IV	**SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA**	**9**

Legacy of technology in Medieval India, Interactions with Arabs Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences Science and Technology on the eve of British conquest

Unit V	**SCIENCE AND TECHNOLOGY IN COLONIAL INDIA**	**9**

Science and the Empire Indian response to Western Science Growth of techno-scientific institutions

Unit VI	**SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA**	**9**

Science, Technology and Development discourse Shaping of the Science and Technology Policy Developments in the field of Science and Technology Science and technology in globalizing India Social implications of new technologies like the Information Technology and Biotechnology

Total periods: 45 Periods

Course Outcomes:After completing the course, the students will be able to:	**Blooms Taxonomy**
CO 1: Explain the evolution of science and technology in ancient, medieval, and modern India, highlighting major milestones and contributions.	K2 (Understand)
CO2: Describe significant scientific achievements in mathematics, astronomy, medicine, metallurgy, agriculture, architecture, and engineering in Indian civilization.	K3 (Analyze)
CO3: Analyze the impact of Indian scientific and technological developments on global knowledge systems and modern advancements.	K2 (Understand)
CO4:. Recognize the role of Indian scientists and technologists during the freedom struggle and post-independence nation-building and appreciate their contributions.	K5 (Evaluate)
CO5: Explain and analyze the evolution and significance of science and technology in India across different historical periods.	K3 (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	2	1	3	2	2	1	2	1	3	2	1	-
CO2	3	3	2	2	1	3	2	2	1	2	1	3	3	1	1
CO3	3	3	2	2	2	3	3	2	2	3	2	3	3	1	1
CO4	2	2	1	2	1	3	3	2	2	3	2	3	2	1	-
CO5	-	-	-	2	-	3	-	2	-	-	-	3	-	1	-
AVG	2.2	1	1.2	2	1	3	2	2	1.2	2	1.2	3	2	1	0.4

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

23MCT008	POLITICAL AND ECONOMIC THOUGHT FOR A HUMANE SOCIETY	Category: MC			
		L	T	P	C
		3	0	0	0

Prerequisites

- Basic understanding of social, political, and economic concepts studied at the school level.
- Interest in exploring ethical, humane approaches to political and economic thought.

Course Objectives:

- This course will begin with a short overview of human needs and desires and how different political-economic systems try to fullfill them.
- In the process, we will end with a critique of different systems and their implementations in the past, with possible future directions.
- To understand different political and economic systems and their approaches to human needs and social welfare.
- To analyze and compare ideologies such as capitalism, communism, fascism, welfare state, and Gandhian thought.
- To promote humane, ethical, and sustainable perspectives for building a just and harmonious society.

TOPICS:

1. Considerations for humane society, holistic thought, human being's desires, harmony in self, harmony in relationships, society, and nature, societal systems. (9 lectures, 1 hour each)
2. Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism. Liberal democracy. (5 lectures)
3. Fascism and totalitarianism. World war I and II. Cold war. (2 lectures)
4. Communism – Mode of production, theory of labour, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models.
5. Welfare state. Relation with human desires. Empowered human beings, satisfaction. (3 lectures)
6. Gandhian thought. Swaraj, Decentralized economy & polity, Community. Control over one's lives. Relationship with nature. (6 lectures)
7. Essential elements of Indian civilization. (3 lectures)
8. Technology as driver of society, Role of education in shaping of society. Future directions. (4 lectures)

Total periods: 45 Periods

Textbooks:

1. Bharghava, Rajeev & Acharya, Ashok – *Political Theory: An Introduction*, Pearson Education, 2018.

2.Agarwal, A.N. – *Indian Economy: Problems of Development and Planning*, New Age International Publishers, 2019.
Reference:
1.O.P. Gauba – *An Introduction to Political Theory*, Macmillan Publishers, 2016.
2.K. J. Mukherjee – *Human Values and Ethics*, PHI Learning, 2015.

Course Outcomes:After completing the course, the students will be able to:	**Blooms Taxonomy**
CO 1: Explain foundational political and economic concepts that shape modern societies, including governance, justice, rights, equity, and welfare	K2 (Understand)
CO2: Analyze major political thinkers and economic philosophers and relate their ideas to contemporary Indian and global contexts.	K3 (Analyze)
CO3: Evaluate political and economic systems in terms of inclusiveness, human dignity, and social justice.	K5 (Evaluate)
CO4:Apply humane, ethical, and sustainable perspectives when examining public policies and socio-economic issues.	K4 (Apply)
CO5: Develop responsible citizenship attitudes by understanding the roles of democracy, participation, economic equality, and social harmony.	K4 (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	3	3	2	1	2	1	2	1	1	1
CO2	3	3	2	1	1	3	3	2	1	2	1	3	1	1	1
CO3	3	3	2	1	1	3	3	2	1	3	1	3	1	1	1
CO4	2	2	1	1	1	3	3	2	1	3	1	3	1	1	1
CO5	2	1	1	1	1	3	3	2	1	3	1	3	1	1	1
AVG	2.4	2.2	1.4	1	1	3	3	2	1	2.6	1	2.8	1	1	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

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

Prerequisites

- Basic understanding of Indian history, society, and constitutional fundamentals.
- Interest in learning how political institutions, state structures, and nation-building processes function in India.

Course Objectives:

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

TOPICS:

Understanding the need and role of State and politics.

Development of Nation-State, sovereignty, sovereignty in a globalized world.

Organs of State – Executive, Legislature, Judiciary. Separation of powers, forms of government unitary-federal, Presidential-Parliamentary, The idea of India.

1857 and the national awakening.

1885 Indian National Congress and development of national movement – its legacies. Constitution making and the Constitution of India. Goals, objective and philosophy.

Why a federal system?

National integration and nation-building.

Challenges of nation-building – State against democracy (Kothari)

New social movements.

The changing nature of Indian Political System, the future scenario. What can we do?

Total periods: 45 Periods

References:

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

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

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

4. Sumantra Bose, Transforming India: Challenges to the World's Largest Democracy, Picador India, 2013.

5. Atul Kohli, Democracy and Discontent: India's Growing Crisis of Governability, Cambridge University Press, Cambridge, U. K., 1991.

6. M. P. Singh and Rekha Saxena, Indian Politics: Contemporary Issues and Concerns, PHI, New Delhi, 2008, latest edition.

7.Rajni Kothari, Rethinking Democracy, Orient Longman, New Delhi, 2005.

Course Outcomes:	**Blooms Taxonomy**
It is expected that this course will make students aware of the theoretical aspect of the state, its organs, its operationalization aspect, the background and philosophy behind the founding of the present political system, broad streams and challenges of national integration and nation-building in India. It will equip the students with the real understanding of our political system/ process in correct perspective and make them sit up and think for devising ways for better participation in the system with a view to making the governance and delivery system better for the common man who is often left unheard and unattended in our democratic setup besides generating a lot of dissatisfaction and difficulties for the system.	K2 (Understand)

23MCT010	**INDUSTRIAL SAFETY**	**Category: MC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**0**

Prerequisites

- Basic understanding of workplace environments and general science concepts.
- Willingness to follow safety rules, observe hazards, and participate in practical safety activities.

Course Objectives:

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques**.**

Unit I	**SAFETY TERMINOLOGIES**	**9**

Hazard-Types of Hazard- Risk-Hierarchy of Hazards Control Measures-Lead indicators- lag Indicators- Flammability- Toxicity Time-weighted Average (TWA) - Threshold LimitValue (TLV) - Short Term Exposure Limit (STEL)- Immediately dangerous to life or health (IDLH)- acute and chronic Effects- Routes of Chemical Entry-Personnel Protective Equipment- Health and Safety Policy-Material Safety Data Sheet MSDS

Unit II	**STANDARDS AND REGULATIONS**	**9**

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006		
Unit III	**SAFETY ACTIVITIES**	**9**
Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment		

Unit IV	**WORKPLACE HEALTH AND SAFETY**	**9**
Noise hazard- Particulate matter- musculoskeletal disorder improper sitting poster and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release		
Unit V	**HAZARD IDENTIFICATION TECHNIQUES**	**9**
Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment		
		Total periods: 45
Text Books:		
1.R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER		
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education		
References:		
1.Frank Lees (2012) ‘Lees’ Loss Prevention in Process Industries.Butterworth-Heinemann publications, UK, 4th Edition.		
2.John Ridley & John Channing (2008)Safety at Work: Routledge, 7th Edition.		
3.Dan Petersen (2003) Techniques of Safety Management: A System Approach.		
4.Alan Waring.(1996).Safety management system: Chapman &Hall,England		
5.Society of Safety Engineers, USA		

Course Outcomes: On completion of this course the student will be able:	**Blooms Taxonomy**
CO 1: Understand the basic concept of safety.	K2 (Understand)
CO2: Obtain knowledge of Statutory Regulations and standards.	K1 (Remember)
CO3: Know about the safety Activities of the Working Place**.**	K2 (Understand)
CO4: Analyze on the impact of Occupational Exposures and their Remedies	K4 (Analyze)
CO5: Obtain knowledge of Risk Assessment Techniques.	K1 (Remember)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	3	2	2	3	2	1	3	3	3	3
CO2	2	3	2	2	1	3	2	2	3	2	1	3	3	3	3
CO3	2	2	2	2	1	2	2	2	3	2	1	3	3	3	3
CO4	3	3	3	2	2	3	2	2	3	2	1	3	3	3	3
CO5	3	2	3	2	2	3	2	2	3	2	1	3	3	3	3
AVG	2.4	2.4	2.4	1.8	1.4	2.8	2	2	3	2	1	3	3	3	3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

PROFESSIONAL ELECTIVE COURSES VERTICALS VERTICAL 1: BIO ENGINEERING

23BME001	BIOMATERIALS (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Learn characteristics and classification of Biomaterials
- Understand different metals, ceramics and its nanomaterial's characteristics as biomaterials
- Learn polymeric materials and its combinations that could be used as a tissue replacement implants
- Get familiarized with the concepts of Nano Science and Technology
- Understand the concept of biocompatibility and the methods for biomaterials testing

Unit I	**INTRODUCTION TO BIO-MATERIALS**	**9**

Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena.

Unit II	**METALLIC AND CERAMIC MATERIALS**	**9**

Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

Unit III	**POLYMERIC IMPLANT MATERIALS**	**9**

Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.

Unit IV	**TISSUE REPLACEMENT IMPLANTS**	**9**

Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Softtissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

engineering using Nano biomaterials.		
Unit V	**TESTING OF BIOMATERIALS**	**9**
Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.		
Total periods: 45 Periods		
Text Books:		
1. Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.		
2. JoonB.Park Joseph D. Bronzino, "Biomaterials - Principles and Applications", CRC press, 2003		
References:		
1. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "Biomaterials: A Nano Approach", CRC Press, 2010.		
2. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. "Implant biomaterials: A comprehensive review", World Journal of Clinical Cases, 2015.		
3. Biomaterials- Basic Theory with Engineering Applications C.Mauli Agarwal, Joo L.Ong, Mark R. Appleford, Gopinath Mani. Cambrige University Press, New York- 2016.		

Course Outcomes:	**Blooms Taxonomy**
CO1: Analyze different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.	Analyze (K4)
CO2: Identify significant gap required to overcome challenges and further development in metallic and ceramic materials	Evaluate (K5)
CO3: Identify significant gap required to overcome challenges and further development in polymeric materials	Evaluate (K5)
CO4: Create combinations of materials that could be used as a tissue replacement implant.	Create (K6)
CO5: Understand the testing standards applied for biomaterials.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**

CO1	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
CO2	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
CO3	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
CO4	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
CO5	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
AVG	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME002	**ARTIFICIAL ORGANS AND IMPLANTS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To have an overview of artificial organs & transplants
- To describe the principles of implant design with a case study
- To explain the implant design parameters and solution in use
- To study about various blood interfacing implants
- To study about soft tissue replacement and hard tissue replacement

Unit I	**ARTIFICIAL ORGANS & TRANSPLANTS**	**9**

ARTIFICIAL ORGANS: -Introduction, outlook for organ replacements, design consideration, evaluation process.

TRANSPLANTS: -Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

Unit II	**PRINCIPLES OF IMPLANT DESIGN**	**9**

Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.

Unit III	IMPLANT DESIGN PARAMETERS AND ITS SOLUTION	9
Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.		
Unit IV	**BLOOD INTERFACING IMPLANTS**	**9**
Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.		
Unit V	**IMPLANTABLE MEDICAL DEVICES AND ORGANS**	**9**
Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.		
Total periods:45 PERIODS		
Text Books:		
1. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976		
References:		
1. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.		
2. R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003		
3. Yannas, I. V, “Tissue and Organ Regeneration in Adults”, New York, NY: Springer, 2001. ISBN:9780387952147.		
4. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, “”Introduction to Biomedical Engineering”, Elsevier, 2005.		

Course Outcomes:	Blooms Taxonomy
CO1: Gain adequate knowledge about artificial organs & transplants	Understand (K2)
CO2: Get clear idea about implant design and its parameters and solution	Apply (K3)
CO3: Have in-depth knowledge about blood interfacing implants	Analyze (K4)
CO4: Explain different types of soft tissue replacement and hard tissue replacement	Understand (K2)
CO5: Assess compatibility and functioning of artificial organs inside the living system	Evaluate (K5)

CO - PO & PSO Mapping															
Particular	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	1	-	-	-	-	-	-	-	1	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	1	-	-	-
CO3	3	3	1	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
CO5	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
AVG	3	3	1	1	1	-	-	-	-	-	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME003	**BIOMEDICAL OPTICS AND BIOPHOTONICS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**

Prerequisites

- Nil

Course Objectives:

- To acquire knowledge about the physical properties of light and optical properties of tissues.
- Learn the design and working principle of various optical components.
- Understand the principles and applications of optical biosensors.
- Understand the engineering and practical applications of optics related to diagnostic and surgical applications.
- Understand the phenomenon of laser tissue interaction and practical applications of optics related to therapeutic applications.

Unit I	**OPTICAL PROPERTIES**	**9**

Basic principles of light - Reflection - Refraction - Absorption - Polarization - Interference - Coherence, Basic laws of light - Beer Lambert law - Snell's law, Optical properties of tissues - Absorption - Scattering - Anisotropy.

Unit II	**OPTICAL INSTRUMENTATION**	**9**

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

Unit III	OPTICAL BIOSENSORS	9
Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance - Advantages and disadvantages - Applications.		
Unit IV	**APPLICATIONS OF LASERS**	**9**
Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photoacoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyperspectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology.		
Unit V	**LASER TISSUE INTERACTION**	**9**
Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.		

LIST OF EXPERIMENTS

1	Study the basic optical properties of tissues
2	Verify Beer–Lambert Law using absorption spectroscopy for various biological samples.
3	Analyze refraction and reflection properties of optical lenses and biomedical samples.
4	Conduct Young's Double-Slit Interferometry and analyze fringe pattern variation.
5	Perform Michelson Interferometry for optical path difference measurements.
6	Characterize optical filters and fiber optics — transmission, attenuation and coupling efficiency.
7	Work with optical biosensors — fiber-optic based sensor to detect glucose/protein concentration.
8	Demonstrate Surface Plasmon Resonance (SPR) sensing for biomolecular detection (simulation allowed).
9	Study Fluorescence Spectroscopy and measure fluorescence intensity for biological dyes.
10	Study Fluorescence Spectroscopy and measure fluorescence intensity for biological dyes.
11	Raman Spectroscopy Experiment — Identify chemical signatures of biomaterials
12	Analyze thermal effects of low-power laser irradiation on samples & demonstrate Photodynamic Therapy concept (safe setup).

Lecture : 30 PERIODS Practical :30 PERIODS Total periods:60 PERIODS

Text Books:

1. Tuan Vo Dinh, "Biomedical Photonics –Handbook, CRC Press, Bocaraton, 2014.
2. Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, Handbook of Biophotonics, Vol 2: Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

References:

1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.
2. Splinter R and Hooper B. A., "An Introduction to Biomedical Optics", Taylor and Francis, 2006.

3. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.
4. Paras N. Prasad, “Introduction to Biophotonics”, A. John Wiley and sons, Inc. Publications, 2003.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain the various physical properties of light and optical properties of tissues**.**	Understand (K2)
CO2: Consolidate the working principles of optical components.	Understand (K2)
CO3: Discuss the various applications of biosensors in medicine.	Apply (K3)
CO4: Summarize the diagnostic and surgical applications of lasers in medicine.	Analyze (K4)
CO5: Explain the laser tissue interaction and various therapeutic applications of lasers.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
CO3	3	2	3	1	-	-	-	1	1	-	-	1	-	-	-
CO4	3	2	3	1	-	-	-	1	1	-	-	1	-	-	-
CO5	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
AVG	3	2	3	1	-	-	-	0.6	0.6	-	-	1	-	-	-

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

23BME004	**NEURAL ENGINEERING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the fundamentals of nervous system development, neuron structure, and neural communication.
- To gain knowledge about various neuronal diseases, degeneration mechanisms, and nervous system disorders.
- To familiarize students with neurophysiology, brain imaging, and methods used to visualize and assess neural functions.
- To introduce concepts of neural tissue engineering, nerve repair, and reconstruction strategies.
- To understand rehabilitation techniques including neuromotor recovery, robotics, virtual reality, and neural stimulation methods.

Unit I	BASICS OF NEURON STRUCTURE AND FUNCTIONS	9
Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.		
Unit II	**BRAIN, BRAIN STEM AND SPINAL CORD**	**9**
Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.		
Unit III	**NEURONAL DISEASES AND DISORDERS**	**9**
Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer's, Parkinson's and Prion diseases		
Unit IV	**NEUROPHYSIOLOGY & NEURORADIOLOGY**	**9**
Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machine interface: human voluntary motor control system.		
Unit V	**NERVE RECONSTRUCTION AND REHABILITATION**	**9**
Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation		
	Total periods:45 PERIODS	
Text Books:		
1. Mathews G.G., "Neurobiology", 2nd edition, Blackwell Science, UK, 2000		
2. Malcom Carpenter, "Textbooks of Neuroanatomy", Mc. Graw hill Edition, 1996		
References:		
1. W. Mark Saltzman, "Tissue Engineering – Engineering principles for design of replacement organs and tissue'', Oxford University Press Inc New York, 2004.		
2. Park J.B., "ACS Biomaterials Science and Engineering", Plenum Press, 2014. Saunders, 2006.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain the basic structure and functions of human nervous system.	Understand (K2)
CO2: Understand diseases and degeneration related to nervous system.	Understand (K2)
CO3: Analyze visualization and radiological assessment of nervous system.	Apply (K3)
CO4: Apply neural tissue engineering for rehabilitation.	Apply (K3)

CO5: Discuss about Regeneration of nervous system.												Evaluate (K5)		
CO - PO & PSO Mapping														
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	1	2	-	-	-	1	1	-	1	3	2	1
CO2	2	1	2	2	3	-	-	-	1	1	-	1	3	2	1
CO3	2	1	3	2	3	1	-	-	2	1	1	1	3	3	2
CO4	2	2	2	3	2	2	1	-	1	1	1	2	2	3	2
CO5	2	3	3	3	3	-	-	-	1	2	-	2	3	3	3
AVG	2	2	2	3	2	1	1	-	1	1	0.4	1	3	2	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME005	**PRINCIPLES OF TISSUE ENGINEERING (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To study the cell types, cell growth, and differentiation.
- To understand the fundamentals of tissue engineering, including tissue organization and extracellular matrix.
- To study the basics of stem cells, their sources, and applications.
- To learn the engineering methods and design techniques used in tissue engineering.
- To understand the applications of tissue engineering in organ replacement and regenerative medicine.

Unit I	**INTRODUCTION TO CELL BIOLOGY**	**9**

Cell types - Progenitor cells - Cell growth and differentiation - Cell culture: Expansion - Transfer - Storage and Characterization - Cell signalling molecules - Growth factors - Cell attachment: Differential cell adhesion, Receptor- ligand binding - Cell surface markers.

Unit II	**FUNDAMENTALS OF TISSUE ENGINEERING**	**9**

History and scope of tissue engineering - Tissue organization - Tissue types: Epithelial, Connective - Vascularity and angiogenesis - Wound healing - Extra Cellular Matrix: Matrix molecules and their ligands - Tissue culture – Materials in tissue engineering.

Unit III	**STEM CELLS**	**9**

Definition of stem cells – Types of stem cells – Differentiation, dedifferentiation maturation, proliferation, pleuripotency and immortalization - Sources of stem cells: Haematopoetic – Fetal - cord blood – Placenta - Bone marrow - Primordial germ cells - Cancer stem cells - Induced pleuripotent stem cells.

Unit IV	**ENGINEERING METHODS AND DESIGN**	**9**

Soft lithography - Self-assembled monolayer, Micro contact printing, Micro fluidic patterning - Laminar flow patterning - Cell interaction with Polymer scaffolds and gels - Polymer scaffolds fabrications: Electro spinning - Solvent casting and particulate leaching - Micro fabrication of cell seeded scaffolds.

Unit V	**APPLICATION OF TISSUE ENGINEERING**	**9**
Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver - Regenerative engineering: Peripheral Nerve regeneration, Cardiac tissue regeneration, Muscle regeneration – Regulation, Commercialization and Patenting.		
	Total periods:45	

Text Books:
1. Robert P lanza, Robert Langer, Joseph Vacanti, "Principles of Tissue Engineering", Academic Press, United States, 2020.
2. Donglu Shi, Qing Liu, “Tissue Engineering and Nanotheranostics”, World Scientific Publications, Singapore, 2018.
References:
1. Gary E. Wnek, Gary L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering”, Marcel Dekker Inc, New York, 2008.
2. R. Lanza, Anthony Atala (Eds), “Essential of Stem Cell Biology”, Academic Press, USA, 2013.
3. R. Lanza, Anthony Atala,“Handbook of Stem Cells’’, Academic Press, USA, 2012.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand the basic concepts of tissue engineering	Understand (K2)
CO2: Acquire ability to function on multi-disciplinary teams	Apply (K3)
CO3: Apply the knowledge of professional and ethical responsibility in use of stem cells and gene therapy in creating tissue engineered therapies	Apply(K3)
CO4: Design and develop different biomaterial in tissue engineering application	Analyze(K4)
CO5: Gain knowledge in research or clinical application on tissue repair/ engineering	Analyze(K4)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
CO2	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
CO3	3	2	3	1	-	-	-	1	1	-	-	1	-	-	-
CO4	3	2	3	1	-	-	-	1	1	-	-	1	-	-	-
CO5	3	2	3	1	-	-	-	-	-	-	-	1	-	-	-
AVG	3	2	3	1	-	-	-	0.6	0.6	-	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME006	**GENETIC ENGINEERING** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Understand the fundamental principles of recombinant DNA technology and the tools used in gene manipulation.
- Learn the methods involved in gene cloning, genome analysis, and genomic organization.
- Explore DNA sequencing, PCR techniques, and site-directed mutagenesis for genetic analysis.
- Gain knowledge about genome sequencing technologies, mapping strategies, and functional genomics tools.
- Develop the ability to apply genetic engineering concepts in real-world applications like recombinant protein production and comparative genomics.

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 - Introduction of recombinant DNA in to host cells and selection methods.

Unit II	**DNA LIBRARIES**	**9**

Construction of genomic and cDNA libraries, Artificial chromosomes – Bacteria, Yeast - Chromosomal walking.

Unit III	**SEQUENCING AND AMPLIFICATION OF DNA**	**9**

Maxam Gilbert's and Sanger's methods of DNA sequencing – PCR: Inverse PCR, Nested PCR, Allele specific PCR, Hot start 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, Hybridization mapping, Optical mapping.		
Unit V	**CURRENT STATUS OF GENOME SEQUENCING PROJECTS**	**9**
Introduction to Functional genomics – Microarrays - Serial Analysis of Gene expression (SAGE), Subtractive hybridization, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.		
	Total periods:45 PERIODS	
Text Books:		
1. Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Blackwell Science Publications, 1993.		
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing).		
References:		
1. Isil Aksan Kurnaz, "Techniques in Genetic Engineering", CRC Press, 2015.		
2. Oksana Ableitner, "Introduction to Molecular Biology: Working with DNA and RNA (essentials)", Springer International, 2022.		
3. Arun K. Shukla, "Proteomics in Biology", Academic Press, 2017.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Would be aware of how to clone commercially important genes.	Understand (K2)
CO2: The students would be aware of how to produce the commercially important recombinant proteins.	Apply (K3)
CO3: Will be familiarized with gene and genome sequencing techniques	Analyze (K4)
CO4: Will be aware of microarrays, Analysis of Gene expression and proteomics.	Analyze (K4)
CO5: Acquire ability to function on multi-disciplinary teams	Apply (K3)

CO - PO & PSO Mapping

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

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

VERTICAL 2: MEDICAL DEVICE INNOVATION AND DEVELOPMENT

<table>
<tr><td rowspan="3">23BME007</td><td rowspan="3">FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT
(Department of Biomedical Engineering)</td><td colspan="4">Category: PEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>L</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

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**
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 (K4)

CO2: Solve specific problems independently or as part of a team	Apply (K3)
CO3: Gain knowledge of the Innovation & Product Development process in the Business Context	Understand (K2)
CO4: Work independently as well as in teams	Apply (K3)
CO5: Manage a project from start to finish	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	3	1	-	-	-	-	-	1	-	1	-	-	-
CO2	3	2	3	1	-	-	-	-	-	1	-	1	-	-	-
CO3	3	2	3	1	1	1	-	1	1	1	-	1	-	-	-
CO4	3	2	3	1	1	1	-	1	1	1	-	1	-	-	-
CO5	3	2	3	1	1	1	-	1	1	1	-	-	-	-	-
AVG	3	2	3	1	1	1	-	1	1	1	-	1	-	-	-

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

23BME008	**MEDICAL DEVICE DESIGN** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Introduce the Medical device standards and requirements.
- Illustrate the design procedure of medical devices.
- Outline the quality assessment in design.
- Describe about the design realization.
- Understand the validation and verification of various medical devices

Unit I	**NEEDS FINDING AND CONCEPT GENERATION**	**9**

Strategic Focus – observation and problem identification – Need statement development. Ideation and Brainstorming – concept screening, concept selection: intellectual property basics – reimbursement basics – business models – prototyping – final concept selection. Safety and Risk Management - Tools, Documents and Deliverables.

Unit II	**MEDICAL DEVICES STANDARDS AND REQUIREMENTS**	**9**
FDA, Medical devices classification, Medical Devices Directive Process – Harmonized Standards, ISO13485, ISO 14971, IEC60601-1, IEC 62304. Reliability, Concept of failure, Product Design and Development Process.		
Unit III	**DESIGN ENGINEERING**	**9**
Hardware Design, Hardware Risk Analysis, Design and Project Metrics, Design for Six Sigma, Software Design, Software Coding, Software Risk Analysis, Software Metrics.		
Unit IV	**TESTING AND VALIDATION**	**9**
Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.		
Unit V	**DESIGN TRANSFER AND MANUFACTURING**	**9**
Transfer to Manufacturing, Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets. Case Study.		
	Total periods: 45 PERIODS	

Text Books:

1. Zenios, Makower and Yock, ―Biodesign – The process of innovating medical technologies‖, Canbridge University Press, 2009
2. Theodore R. Kucklick , The Medical Device R&D Handbook, Second Edition, CRC Press, 2012
3. Peter Ogrodnik,Medical Device Design Innovation from Concept to Market, Elsevier, 2013

References:

1. Richard C. Fries and Marcel Dekker AG, Handbook of Medical Device Design,2ndedition, 2005.
2. Gail Baura, Medical Device Technologies: A Systems Based Overview Using Engineering, Elsevier science, 2012.
3. Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner-Bonneau‘Handbook of Human Factors in Medical Device Design‘,CRC press,2010.
4. Jagdish Chaturvedi, Inventing medical devices: A perspective from India, Create Space Independent Publishing Platform, 1st edition, 2015.

Course Outcomes:	**Blooms Taxonomy**
CO1: Define the medical devices standards and requirements.	Understand (K2)
CO2: Summarise the concept of medical device development.	Apply (K3)
CO3: Recall the engineering design and project metrics.	Create (K6)
CO4: Demonstrate the testing and validation of medical equipment.	Understand (K2)
CO5: Interpret the various design transfer and manufacturing methods.	Create (K6)

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	-	-	-	-	3	2	-
CO2	3	2	-	-	3	-	-	2	-	-	-	-	3	2	-

CO3	3	3	-	-	3	-	-	2	-	-	-	-	3	2	-
CO4	2	2	-	-	2	-	-	1	-	-	-	-	2	2	-
CO5	3	3	-	-	3	-	-	2	-	-	-	-	3	2	1

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

23BME009	**PATIENT SAFETY, STANDARDS AND ETHICS (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the importance of patient safety against electrical hazards
- To explain the patient safety laws and regulations
- To understand the standards and testing of patient
- To know the patient safety specialities in clinical
- To know about the health care organization

Unit I	**EFFECTS OF ELECTRICITY**	**9**

Physiological effects of electricity - important susceptibility parameters - microshock - macroshock hazards - patients electrical environment - isolated power system - conductive surfaces

Unit II	**PATIENT SAFETY LAWS AND REGULATIONS**	**9**

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

Unit III	**STANDARDS AND TESTING**	**9**

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system

Unit IV	**PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES**	**9**

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

Unit V	**MEDICAL ETHICS**	**9**

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.

Total periods:45

Text Books:

1. John G.Webster, “Medical Instrumentation Application and design”, 4th edition, Wiley India PvtLtd, New Delhi, 2015.
2. Liam Donaldson,Walter Ricciardi, “Textbook of patient safety and clinical Risk management”, Springer.
3. Fay A. Rozovsky, James R. Woods, Jr, “ The Handbook of Patient Safety Compliance”, 2016
References:
1. John G. Webster, *Medical Instrumentation: Application and Design*, 4th Edition, Wiley, 2010.
2. Charles Vincent, *Patient Safety*, 2nd Edition, Wiley–Blackwell, 2010.
3. B. Chatterjee & S. K. Sengupta, *Electrical Safety in the Medical Environment*, 1st Edition, CRC Press, 2012.
4. Kieran Walshe & Ruth Boaden, *Patient Safety: Research Into Practice,* Open University Press, 2006

Course Outcomes:	**Blooms Taxonomy**
CO1: Outline the importance of patient safety against electrical hazards.	Analyze (K4)
CO2: Brief out the patient safety laws and regulations	Apply (K3)
CO3: explain the standards and testing of patient	Understand (K2)
CO4: Understand the concept of the patient safety specialities in clinical	Analyze (K4)
CO5: know about various health care organization	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	-	-	2	-	1	-	1	-	-	-
CO2	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO3	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO4	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO5	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
AVG	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-

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

23BME010	**MEDICAL DEVICE REGULATIONS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To study the regulation of medical devices, process of development, ethical and quality considerations.
- To learn the various ISO standards of quality and risk management for regulatory purposes
- To explore the process of approval and marketing of medical devices.
- To comprehend the regulatory process for medical devices in India, US, and EU.
- To familiarize with clinical evaluation and investigation of medical devices.

Unit I	**MEDICAL DEVICE REGULATIONS**	**9**
History of medical device regulation, regulatory affairs professional's roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labeling of medical devices: definition, elements, risk management, clinical evaluation and labeling, language level and intended users. differentiating medical devices IVDs and combination products from that of pharmaceuticals.		
Unit II	**ISO STANDARDS**	**9**
ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.		
Unit III	**IEC, REGULATORY SYSTEMS IN USA & EU**	**9**
IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.		
Unit IV	**INDIAN REGULATORY SYSTEM**	**9**
India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labeling requirements, commercial aspects, upcoming regulation changes.		
Unit V	**CLINICAL TRIALS AND DIGITAL REGULATIONS**	**9**
Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with in-silico clinical trials		
Total periods:45 PERIODS		

Text Books:

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021

References:	
1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021	
2. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.	
3. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUVRheinlandAkademia, 2008.	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Define and explain the basic concepts of medical device regulations.	Understand (K2)
CO2: Decipher the meaning of ISO standards from a regulatory perspective.	Analyze (K4)
CO3: Explain US-FDA, IEC and European regulations.	Analyze (K4)
CO4: Discuss regulations in India	Apply (K3)
CO5: Explain the regulatory aspects of clinical trials and digital alternatives	Analyze (K4)
CO - PO & PSO Mapping	

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

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

23BME011	**MEDICAL INNOVATION AND ENTREPRENEURSHIP** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To learn fundamentals of entrepreneurship
- To apply the methods of entrepreneurship in medical field
- To evaluate the medical devices and market trends
- Learn how to create a business model, do market research, and choose the right type of business.
- Learn how to study the market, competitors, collect data, and use marketing methods for a new venture.

Unit I	**CREATIVITY, INNOVATION AND IPR**	**9**
The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process. Patents – Copyright - Trademark- Geographical indications – Ethical and social responsibility and challenges.		
Unit II	**SCOPE FOR BIOMEDICAL ENGINEERING ENTREPRENEURSHIP**	**9**
Definition– Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs. Fundamentals and models, Advancements in biomedical field, Supporting societies and professional activities. Impact of innovation in medical devices. Case study.		
Unit III	**NEW VENTURE**	**9**
Developing an Effective Business Model: The Importance of a Business Model – Starting a small- scale industry - Components of an Effective Business Model. Assessing the venture, establish venture invention, market research, presenting the business plan. Forms of Business Organization: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. case study.		
Unit IV	**FINANCING THE NEW VENTURE AND GLOBALIZATION**	**9**
Evaluating Various options and future investments – Medical Device entrepreneurship incentives and subsidies – Determining Financial Needs – Sources of Financing: support for product development, funding agencies, collaborative initiatives, and angel investors. Impact of Globalization: Medical product manufacturing, marketing, leadership, quality management. Case studies.		
Unit V	**MARKETING FUNCTION**	**9**
Industry Analysis – Competitor Analysis – Marketing Research for the New Venture – Defining the Purpose or Objectives – Gathering Data from Secondary Sources – Gathering Information from Primary Sources – Analyzing and Interpreting the Results – The Marketing Process. Case study.		
Total periods: 45 Periods		
Text Books:		
1. Jen-Shih Lee “Biomedical Engineering Entrepreneurship”, World Scientific Publishing, USA. 2010		
2. Vasant Desai, ―The Dynamics of Entrepreneurial Development and Management‖, Himalaya Publishing House, 2010.		
References:		
1. Brant Cooper, Patrick Vlaskovits, “The Lean Entrepreneur”, Wiley, 2nd edition, New Jersy, 2016.		
2. Nathan Furr, Jeff Dyer, “The Innovator's Method: Bringing the Lean Start-up into Your Organization”, Harvard Business Press, Boston, 2014.		
3. Donald F.Kuratko and Richard M. Hodgetts, “Entrepreneurship”, South-Western.		
4. Gupta S.L., Arun Mittal, “Entrepreneurship Development”, International Book House, 2012.		
5.Prasanna Chandra, “Projects- Planning, Analysis, Financing, Implementation and review‖, TATA McGraw Hill, 2012.		
6. Sudha G. S., “Management and Entrepreneurship Development”, Indus Valley Publication, 2009.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Describe the role of biomedical engineers in entrepreneurship	Understand (K2))
CO2: Interpret the background for biomedical engineers in entrepreneurship	Understand (K2)
CO3: Acquire the skills and techniques required towards innovation	Apply (K3)
CO4: Categorize the resources and funding agencies and judge the right product based on market needs	Analyze (K4)
CO5: Compile and quantify the opportunities and challenges	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	1	1	-	-	2	-	1	-	1	-	-	-
CO2	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO3	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO4	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
CO5	3	2	1	1	1	-	-	2	-	1	-	1	-	-	-
AVG	3	2	1	1	1	-	-	1	-	1	-	1	-	-	-

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

23BME012	**RAPID PROTOTYPING (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Learn the need and fundamentals of rapid prototyping
- Understand the concepts of design and assembling of various parts
- Study the process and material selection for UV and Laser based AM
- Investigate the process of fused deposition moulding and sheet lamination
- Explore droplet formation and beam deposition process

Unit I	**INTRODUCTION**	**9**

Overview –Need -Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification –Rapid Prototyping-Rapid Tooling –Rapid Manufacturing – Applications- Benefits –Case studies.

Unit II	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**
Design tools: Data processing -CAD model preparation –Part orientation and support structure generation –Model slicing –Tool path generation-Design for Additive Manufacturing: Concepts and objectives-AM unique capabilities – DFAM for part quality improvement-Customised design and fabrication for medical applications.		
Unit III	**PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES**	**9**
Photo polymerization: SLA-Photo curable materials –Process -Advantages and Applications. Powder Bed Fusion: SLS-Process description –powder fusion mechanism –Process Parameters – Typical Materials and Application. Electron Beam Melting.		
Unit IV	**EXTRUSION BASED AND SHEET LAMINATION PROCESSES**	**9**
Extrusion Based System: FDM-Introduction –Basic Principle –Materials –Applications and Limitations –Bio extrusion. Sheet Lamination Process: LOM-Gluing or Adhesive bonding –Thermal bonding.		
Unit V	**PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES**	**9**
Droplet formation technologies –Continuous mode –Drop on Demand mode –Three Dimensional Printing – Advantages –Bioplotter -Beam Deposition Process: LENS-Process description –Material delivery –Process parameters –Materials –Benefits –Applications.		
	Total periods:45 PERIODS	
Text Books:		
1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, World Scientific Publishers, Third edition, 2010.		
2. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.		
3. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2006.		
References:		
1. Ian Gibson, David W.Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.		
2. Tom Page Design for Additive Manufacturing, LAP Lambert Academic Publishing, 2012.		
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.		
Course Outcomes:		**Blooms Taxonomy**
CO 1: Demonstrate the basics of Additive manufacturing.		Analyze (K4)

CO2: Design and assembly of various parts for the desired task.	Apply (K3)
CO3: Explain the process involved in laser and UV based AM	Understand (K2)
CO4: Illustrate the process of fused deposition moulding and sheet lamination	Apply (K3)
CO5: Support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools.	Evaluate (K5)
CO - PO & PSO MappingS	

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

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

VERTICAL 3: MANAGEMENT (HEALTHCARE)

23BME013	**CLINICAL ENGINEERING (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- This course will provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations.
- This course will enhance students to practice medical equipment and analyze challenges with their healthcare technology.
- This course will engage the students to work as a team to address problems and errors in medical devices.
- This course will engage the students to work as a team to address problems and errors in medical devices.
- This course will expose students to explore the Health Technology Management systems with medical devices and supportive services with advanced application.

Unit I	**INTRODUCTION**	**9**

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.		
Unit II	**MEDICAL TECHNOLOGY MANAGEMENT PRACTICES**	**9**
Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequist for medical technology assessment – Management Practice for Medical Equipment - Device evaluation, Risk reduction, Asset management, ESHTA.		
Unit III	**ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)**	**9**
Introduction – Health care technology management – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix – EHTP advantages – Impact Analysis.		
Unit IV	**CLINICAL ENGINEERING PROGRAM INDICATOR**	**9**
Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators – Indicator management process.		
Unit V	**ADVANCED TECHNOLOGY FOR PATIENT SAFETY**	**9**
Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model: Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories – Process analysis, Methodology. Computerized medical equipment management systems.		
Total periods:45		
Text Books:		
1. Ernesto Iadanza, Joseph Dyro, "Clinical Engineering Handbook", Elsevier Academic Press, 2014		
2. Robert Miniati, "Clinical Engineering from Devices to Systems", Academic Press, 23-Dec- 2015 - Technology & Engineering		
References:		
1. Joseph F. Dyro, *Clinical Engineering Handbook*, Academic Press, 2004		
2. AAMI, *Health Technology Management Manual*, AAMI Publications, 2017		
3. World Health Organization, *Medical Device Technical Series: Health Technology Assessment*, WHO Press, 2011.		
4. Luis Fernandez, *Healthcare Technology Management Systems: Models and Strategies for Improved Care,* CRC Press, 2015		
5. Amitai Ziv, Paul Barach, Steven Kravitz, *Patient Safety and Simulation in Clinical Settings*, Springer, 2010		

Course Outcomes:	Blooms Taxonomy
CO1: State the role of clinical engineers and discuss the basic concepts of medical and healthcare technology	Understand (K2)
CO2: Give the program and framework to recognize the errors of medical equipment	Analyze (K4)
CO3: State the issues or errors in patient safety and formulate patient safety package system	Apply (K3)
CO4: Define the problem precisely and examine the possible issues using program indicators.	Understand (K2)
CO5: Demonstrate computer-based equipment with automated system by using CPOE method**.**	Analyze (K4)

CO - PO & PSO Mapping

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

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

23BME014	HOSPITAL PLANNING AND MANAGEMENT (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To understand the principles, practices, and areas of application in hospital management.
- To study hospital planning, equipment planning, and functional planning in healthcare organizations.
- To comprehend human resource management, recruitment, training, and performance evaluation in hospitals.
- To understand hospital information systems, supportive services, and their role in patient care.
- To learn about quality management, safety measures, and compliance with national and international standards in hospitals.

Unit I	OVERVIEW OF HOSPITAL ADMINISTRATION	9

Distinction between Hospital and Industry, Challenges in Hospital Administration –Hospital Planning – Equipment Planning- AMC – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management		
Unit II	**HUMAN RESOURCE MANAGEMENT IN HOSPITAL**	**9**
Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.		
Unit III	**MARKETING RESEARCH & CONSUMER BEHAVIOUR**	**9**
Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - Consumer Markets & Consumer Buyer behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of buying situations - global marketing in the medical sector - WTO and its implications.		
Unit IV	**HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES**	**9**
Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.		
Unit V	**QUALITY AND SAFETY ASPECTS IN HOSPITAL**	**9**
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.		
Total periods:45 PERIODS		
Text Books:		
1. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI–4th Edition,2006.		
2.G.D.Kunders, “Hospitals – Facilities Planning and Management”, TMH, New Delhi – 5th edition Reprint 2007.		
3. Cesar A.Caceres and Albert Zara, “The Practice of Clinical Engineering”, Academic Press, New York,1977		
References:		
1. Peter Berman, “Health Sector Reform in Developing Countries”, Harvard University Press, 1995.		
2. Norman Metzger , “Handbook of Health Care Human Resources Management”, Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.		

3. Arnold D. Kalcizony & Stephen M.Shortell, "Health Care Management", 6th Edition, 2011.
4. Blane, David, Brunner, Eric , "Health and Social organization: Towards a health policy for the 21st century", Calrendon Press, 1994.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain the principles, practices and areas of application in Hospital Management.	Understand (K2)
CO2: Understand the biomedical waste disposal concept.	Understand (K2)
CO3: Explain the importance of supportive services.	Understand (K2)
CO4: Comprehend the quality aspect specified by the international standards.	Analyze (K4)
CO5: Knowledge on Hospital safety.	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	-	-	-	-	-
CO2	3	2	1	-	-	1	-	1	-	1	-	-	-	-	-
CO3	3	2	1	-	-	1	-	1	-	1	-	-	-	-	-
CO4	3	2	1	-	-	1	-	1	-	1	1	-	-	-	-
CO5	3	2	1	-	-	1	-	1	-	1	1	-	-	-	-
AVG	3	2	1	-	-	1	-	1	-	1	0.6	-	-	-	-

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

23BME015	**MEDICAL WASTE MANAGEMENT** **(Department of biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To enable students to understand the fundamentals of healthcare hazard control, accident causation theories, and safety management practices within clinical environments.
- To provide comprehensive knowledge on biomedical waste management, including waste classification, handling, treatment, and disposal in compliance with regulatory guidelines.

- To familiarize students with hazardous materials used in healthcare settings and the safety regulations governing their storage, transportation, and emergency response.
- To develop the ability to evaluate facility safety requirements, including physical infrastructure safety, environmental controls, equipment safety, and occupational protection
- To impart knowledge on infection control, prevention strategies, immunization, disinfection, and sterilization methods essential for maintaining patient and worker safety in healthcare settings.

Unit I	**HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS**	**9**
Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.		
Unit II	**BIOMEDICAL WASTE MANAGEMENT**	**9**
Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal.		
Unit III	**HAZARDOUS MATERIALS**	**9**
Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.		
Unit IV	**FACILITY SAFETY**	**9**
Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.		
Unit V	**INFECTION CONTROL, PREVENTION AND PATIENT SAFETY**	**9**
Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.		
	Total periods:45 PERIODS	

Text Books:	
1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)	
2. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).	
References:	
1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006	
2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991	
Course Outcomes:	**Blooms Taxonomy**
CO1: Analyse various hazards, accidents and its control	Analyze (K4)
CO2: Design waste disposal procedures for different biowastes	Evaluate (K5)
CO3: Categorise different biowastes based on its properties	Understand (K2)
CO4: Design different safety facility in hospitals	Evaluate (K5)
CO5: Propose various regulations and safety norms	Analyze (K4)
CO - PO & PSO Mapping	

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

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

<table>
<tr><td rowspan="3">23BME016</td><td rowspan="3">ECONOMICS AND MANAGEMENT FOR ENGINEERS

(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: PEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">Prerequisites
• NIL</td></tr>
<tr><td colspan="6">Course Objectives:
• Understand basic economic concepts and methods.
• Analyze demand, supply, and elasticity.
• Comprehend production and cost relationships.
• Understand core management principles and roles.
• Apply planning, forecasting, and strategic decision-making.</td></tr>
<tr><td>Unit I</td><td colspan="4">INTRODUCTION TO ECONOMICS</td><td>9</td></tr>
<tr><td colspan="6">Introduction to Economics – Scope of Economics – Positive and Normative Science – Methodology of Economics – Economic Laws - Economy and its basic problems: Economy and its working – Kinds of economy systems – Basic problems of economy.</td></tr>
<tr><td>Unit II</td><td colspan="4">DEMAND AND SUPPLY ANALYSIS</td><td>9</td></tr>
<tr><td colspan="6">The Law of Demand – The Law of Supply – Elasticities of Demand and Supply: Price Elasticity of Demand - Price Elasticity and Consumption Expenditure- Cross Elasticity of Demand – Income Elasticity of Demand – The Elasticity of Price Expectations – The uses of Elasticity– Price Elasticity of Supply.</td></tr>
<tr><td>Unit III</td><td colspan="4">THEORY OF PRODUCTION AND ANALYSIS OF COST</td><td>9</td></tr>
<tr><td colspan="6">Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short- Run Cost Output Relations – Long Run Cost output relations – Economics of Scale.</td></tr>
<tr><td>Unit IV</td><td colspan="4">INTRODUCTION TO MANAGEMENT PLANNING</td><td>9</td></tr>
<tr><td colspan="6">Management: Overview – Management Defined – Managerial skills – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives.</td></tr>
<tr><td>Unit V</td><td colspan="4">PLANNING</td><td>9</td></tr>
<tr><td colspan="6">Planning and Forecasting: Importance of Planning – Principles of effective Planning – Planning process – Types of Plans. Strategic Planning: Strategic Planning process – Rational decision making.</td></tr>
<tr><td colspan="6">Total periods:</td></tr>
<tr><td colspan="6">Text Books:</td></tr>
<tr><td colspan="6">1. D.N.Dwivedi, “Principles of Economics”, Second Edition, Vikas Publishing House (P) Limited, New Delhi, 2012.</td></tr>
</table>

2. J.S.Chandan, “Management Concepts and Strategies”, Vikas Publishing House (P) Limited, New Delhi, 2003.
References:
1. RanbirSingh,“Principles of Engineering Economics and Management”, S.K.Kataria& Sons, New Delhi, 2013.
2. Manish Varshney and VidhanBanerjee,“Engineering and Managerial Economics”,First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.

Course Outcomes:	**Course Outcomes:**
CO 1: Summarize how to solve economics principles to solve economic problems in engineering discipline by satisfying the economic laws.	Understand (K2)
CO2: Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity	Understand (K2)
CO3: Interpret short run and long run costs in the process of production for carrying out a business.	Analyze (K4)
CO4: Apply managerial skills to make decisions and solve problems for achieving organizational objectives	Apply (K3)
CO5: Express the principles of effective planning for survival and success of all organizations using standing and single use planning methods.	Understand (K2)

CO - PO & PSO Mapping

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

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

23BME017	**BIOSTATISTICS (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**

Prerequisites • NIL		
Course Objectives: • Understand the statistical methods for the data. • Comprehend the fundamental of mathematical and statistical theory in the application of biomedical field. • Apply the regression and correlation analyze in the physiological data. • Understand the source of Medical data • Understand the Visual analytics of Healthcare data.		
Unit I	**INTRODUCTION**	**9**
Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and medical data analysis, Introduction to probability, likelihood & odds, distribution variability.		
Unit II	**STATISTICAL PARAMETERS**	**9**
Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing - single population proportion, difference between two population proportions, single population variance, ratio of two population variances and tests of goodness of fit, tests of independence, tests of homogeneity.		
Unit III	**REGRESSION AND CORRELATION ANALYSIS**	**9**
Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient.		
Unit IV	**INTERPRETING DATA**	**9**
Interpreting life tables clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.		
Unit V	**ANALYSIS OF VARIANCE**	**9**
META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design, factorial experiment.		

LIST OF EXPERIMENTS	
1	Identify quantitative, ordinal, and categorical measurements from the data
2	Construct and interpret stem plots and histograms,
3	Construct and interpret frequency tables, calculate and interpret means, standard deviations, medians, and quartiles
4	Calculate and interpret Normal probabilities and values.
5	Calculate and interpret confidence intervals for means
6	Calculate hypothesis test means and power or sample size estimates when testing means.
7	Tests of goodness of fit tests of independence, tests of homogeneity
8	Calculate the regression equation
9	Calculate correlation coefficient
10	Interpreting life tables clinical trials
11	Calculate and interpret relative risks and confidence intervals for relative risks
12	Data can be downloaded from following or from any known data source
	Lecture :30 Practical :30 Total periods:60

Text Books:
1. Wayne W. Daniel, Biostatistics-A Foundation for Analysis in the Health Sciences, John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J.N.S.Mathews, Statistical methods in Medical Research, Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner. Fundamentals of biostatistics. Nelson Education, 8th Edition 2015 ISBN: 978-1-305-26892-0
4. Editors: Chandan K. Reddy, Charu C. Agarwal, Healthcare Data Analytics, CRC Press,
References:
1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2ndEdition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

Course Outcomes:	**Blooms Taxonomy**
CO1: Define the new and existing statistical methodology for their research problem.	Remember (K1)
CO2: Explain p- values for different statistical tests.	Understand (K2)
CO3: Analyze the biomedical research data and be able to report the study results.	Analyze (K4)
CO4: Describe the various sources of medical data	Understand (K2)
CO5: Demonstrate the visual analytical procedure of Medical Data.	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	1	-	-	-
CO2	3	2	-	-	-	1	-	1	1	-	1	1	-	-	-
CO3	3	2	-	-	-	1	-	1	1	-	1	1	-	-	-
CO4	3	2	-	-	-	1	-	1	1	-	1	1	-	-	-
CO5	3	2	-	-	-	1	-	1	1	-	1	1	-	-	-
AVG	3	2	-	-	-	1	-	1	1	-	1	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME018	FORENSIC SCIENCE IN HEALTHCARE (Department of Biomedical Engineering)	Category: PEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the significance and scope of forensic sciences in healthcare and legal investigations.
- To develop observational skills and accurately document crime scenes.
- To learn the use of forensic microscopes and anthropological methods for analyzing human remains.
- To identify and analyze blood stains, body fluids, and their genetic markers for forensic applications.

To apply fingerprint analysis techniques, including automated systems, for criminal identification

Unit I	BASICS OF FORENSIC SCIENCE	9

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

Unit II	OBSERVATION AND CRIME SCENE	9
Observational Skills - Sherlock Holmes and Deductive Reasoning - Observations by Witnesses. Case Studies. The Crime Scene -Locard's Exchange Principle, Securing and Recording the Crime Scene, Legal Considerations at the Crime Scene, Evidence Collection and Recordation Techniques. Mock Crime Scene: Processing and Documenting a Crime Scene		
Unit III	**FORENSIC MICROSCOPE AND ANTHROPOLOGY**	**9**
Forensic Use of the Microscope -The Compound, Comparison, and Stereoscopic Microscope, The Scanning Electron Microscope (SEM). Forensic Anthropology- Introduction, Human Anatomy–The Skeletal System, Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease from Skeletal Remains, Case Studies.		
Unit IV	**BLOOD STAIN IDENTIFICATION**	**9**
Detection and identification of Blood stains, Determination of species of origin, Blood Group systems, Techniques of Determination of Blood groups of Blood stains, Determination of seminal and other fluids and their Blood Grouping, DNA, DNA Phenotyping and RNA Profiling & their applications. Wildlife forensics.		
Unit V	**FINGERPRINT APPLICATION**	**9**
Fingerprints -Fundamental Principles of Fingerprint Analysis, Classification of Fingerprints, Collection of Fingerprint Evidence, Automated Fingerprint Identification Systems (AFIS), Track marks, Case Studies.		
Total periods:45 PERIODS		
Text Books:		
1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.		
2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,		
References:		
1.Saferstein : Criminalistics (1976) Prentice Hall Inc., USA.		
2. Deforest, Gansellen & Lee : Introduction to Criminalistics.		
3. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Define the significance of forensic sciences	Understand (K2)
CO2: Observe and document crime scenes	Apply (K3)
CO3: Determine Trauma and Diseases.	Analyze (K4)
CO4: Describe the various sources of medical data related to forensic science.	Understand (K2)
CO5: Demonstrate the visual analytical procedure of finger print application.	Apply (K3)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
CO2	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
CO3	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
CO4	3	1	1	-	1	1	-	1	-	-	-	-	1	-	-
CO5	3	1	1	-	1	1	-	1	-	-	-	-	1	-	-
AVG	3	1	1	-	0.6	1	-	1	-	-	-	-	1	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

VERTICAL 4: MECHANICS

23BME019	**BIOMECHANICS (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**

Prerequisites

- NIL

Course Objectives:

- Learn the fundamental concepts of the principles of mechanics.
- Understand the basics of biofluid mechanics.
- Review the mechanical properties of musculoskeletal elements.
- Study the biomechanics of joints and implants.
- Learn the application of biomechanics into modelling and ergonomic design.

Unit I	**INTRODUCTION TO MECHANICS**	**9**

Introduction – Scalars and vectors, Statics –Resolution and composition of forces, Moments, couple, Resultant, equilibrium of coplanar forces, Dynamics – Linear motion, Newton's laws of motion, Velocity and acceleration, Kinematics – Models, Transducers Constitutive equations –Non- viscous fluid, Newtonian Viscous fluid and Hookean Elastic solid

Unit II	**BIOFLUID MECHANICS**	**9**

Intrinsic fluid properties, Rheological properties of blood, Pressure-flow relationship for Non- Newtonian Fluids, Fluid mechanics in straight tube, Structure of blood vessels, Material properties and modelling of Blood vessels, Heart – Cardiac muscle characterization, Native heart valves, Prosthetic heart valve fluid dynamics.

Unit III	MUSCULOSKELETAL MECHANICS	9
Constitutive equation of viscoelasticity – Maxwell, Voight and Kelvin models, anisotropy, Hard Tissues – Structure, viscoelastic properties, functional adaptation, Soft Tissues – Structure, functions, material properties and modelling of Soft Tissues – Cartilage, Tendons and Ligaments Skeletal Muscle, Bone fracture mechanics, Implants for bone fractures.		
Unit IV	**BIOMECHANICS OF JOINTS AND IMPLANTS**	**9**
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.		
Unit V	**MODELLING AND ERGONOMICS**	**9**
Introduction to Finite Element Analysis, finite element analysis of lumbar spine; models for voice biomechanics, Ergonomics –Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted and whole-body vibrations.		

LIST OF EXPERIMENTS

1	MATLAB implementation of Vector algebra, force and moment calculation
2	Program used in conjunction with the EMG system to analyse muscle activation patterns.
3	Biomechanical analysis of voice.
4	Cardiovascular models.
5	Musculoskeletal models.
6	Finite element analysis.

Lecture :30 PERIODS Practical :30 PERIODS Total periods:45 PERIODS

Text Books:

1. Y.C. Fung, Bio-Mechanics- Mechanical Properties of Tissues, Springer-Verlag, 1998.

2. Subrata Pal, Textbook of Biomechanics, Viva Books Private Limited, 2009

3. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, Biofluid Mechanics:The Human Circulation,
Taylor and Francis, 2007.

4. Özkaya, Nihat, Dawn Leger, David Goldsheyder, and Margareta Nordin. Fundamentals of biomechanics: equilibrium, motion, and deformation. Springer, 2016.

References:

1. Sheraz S. Malik and Shahbaz S. Malik, Orthopaedic Biomechanics Made Easy,Cambridge University Press, 2015.
2. Jay D. Humphrey, Sherry De Lange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design,
Springer Science Business Media, 2004.
3. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.
4. Neil J. Mansfeild, Human Response to Vibration, CRC Press, 2005.
5. Carl J. Payton, Biomechanical Evaluation of movement in sports and Exercise, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand and apply the principles of mechanics, kinetics and kinematics in the context of biological systems Appraise the basics of biofluid mechanics as applied to heart valve design and blood vessel models.	Apply (K3)
CO2: Describe the basics of biofluid mechanics as applied to heart valve design and blood vessel models.	Understand (K2)
CO3: Describe the mechanical properties of musculoskeletal elements to develop the mathematical models of joints and implants**.**	Understand (K2)
CO4: Apply the knowledge of biomechanics into analysis of human joints and motion	Analyze (K4)
CO5: Apply Biomechanics principles to “real-world” problem and describe their impact on health, safety, society, environment as well as underlying legal and ethical considerations.	Evaluate (K5)

CO - PO & PSO Mapping

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

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

<table>
<tr><td rowspan="3">23BME020</td><td rowspan="3">REHABILITATION ENGINEERING</td><td colspan="4">Category: PEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">Prerequisites
• NIL</td></tr>
<tr><td colspan="6">Course Objectives:
• Explain the need for medical aids.
• Understand the sensory rehabilitation systems.
• Learn the use of orthopedic prosthetics and orthotics in rehabilitation.
• Understand virtual reality in rehabilitation
• Have an understanding of rehabilitation medicine and advocacy.</td></tr>
<tr><td>Unit I</td><td colspan="4">INTRODUCTION TO REHABILITATION</td><td>9</td></tr>
<tr><td colspan="6">Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions.
Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.</td></tr>
<tr><td>Unit II</td><td colspan="4">ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION</td><td>9</td></tr>
<tr><td colspan="6">Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution</td></tr>
<tr><td>Unit III</td><td colspan="4">ORTHOPEDIC PROSTHETICS AND ORTHOTICS</td><td>9</td></tr>
<tr><td colspan="6">Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems- Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).</td></tr>
<tr><td>Unit IV</td><td colspan="4">VIRTUAL REALITY</td><td>9</td></tr>
<tr><td colspan="6">Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.</td></tr>
<tr><td>Unit V</td><td colspan="4">REHABILITATION MEDICINE AND ADVOCACY</td><td>9</td></tr>
<tr><td colspan="6">Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.</td></tr>
</table>

Total periods: 45 PERIODS	
Text Books:	
1.Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.	
2. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.	
References:	
1. Sashi S Kommu, "Rehabilitation Robotics", 1st edition, CRC Press, 2007.	
2. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.	
3. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December 2000	
4.Etienne Grandjean, Harold Oldroyd, "Fitting the task to the man", Taylor & Francis, 1988.	
5. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer Verlag, New York, 1982.	
6.Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002.	
7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Summarize the key terminologies used by the rehabilitation team.	K2 – Understand
CO2: Illustrate Engineering Concepts in Sensory & Motor rehabilitation.	K3 – Apply
CO3: Design different orthotics and prosthetics for rehabilitation applications.	K4/K5 – Analyze / Evaluate
CO4: Summarize the need of virtual reality tools for different aids.	K2 – Understand
CO5: Appraise the legal aspects for building rehabilitation aids for the needed people.	K5 – Evaluate
CO - PO & PSO Mapping	

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

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

23BME021	PHYSIOLOGICAL MODELLING (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To explain the application of Physiological models and vital organs.
- To Formulate the methods and techniques for analysis and synthesis of dynamic models
- To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.
- To describe nonlinear models of physiological systems
- To compute the Simulation of physiological systems

Unit I	INTRODUCTION TO PHYSIOLOGICAL MODELING	9

Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling. Introduction to physiology (homeostasis, cell biology) Modelling physical systems, linear models of physiological systems, the Laplace transform, Transfer functions and block diagram analysis Physiology.

Unit II	MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM	9

Dynamic systems and their control, modelling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.

Unit III	NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS	9

Nonparametric Modelling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modelling - Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

Unit IV	COMPARTMENTENTAL PHYSIOLOGICAL MODEL	9

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modelling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modelling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

Unit V	SIMULATION OF PHYSIOLOGICALSYSTEMS	9

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

Total periods:45 PERIODS

Text Books:

1. Michel C Khoo, "Physiological Control Systems -Analysis, simulation and estimation", Prentice Hall of India, 2001.
2. Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press,2004.

References:

1. Benjamin C Kuo, "Automatic control systems", Tenth Edition, McGraw-Hill Education, 2017.
2. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,"Advanced Computational Methods in Life System Modeling and Simulation", Springer,2017
3. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.

Course Outcomes:	Blooms Taxonomy
CO 1: Explain the application of Physiological models	Understand (K2)
CO2: Describe the methods and techniques for analysis and synthesis of Linear and dynamic system	Understand (K2)
CO3: Develop differential equations to describe the compartmental physiological model	Apply (K3)
CO4: Describe Nonlinear models of physiological systems	Analyze (K4)
CO5: Illustrate the Simulation of physiological systems	Apply (K3)

CO - PO & PSO Mapping

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

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

<table>
<tr><td rowspan="3">23BME022</td><td rowspan="3">ASSISTIVE TECHNOLOGY
(Department of Biomedical Engineering)</td><td colspan="4">Category: PEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- NIL

Course Objectives:

- Understand the principles and working of cardiac assist devices.
- Comprehend the concepts of hemodialysis and the functional parameters of dialyser systems.
- Understand the basic hearing assessment methods and the technology behind modern hearing aids.
- Describe the principles and applications of prosthetic and orthotic devices.
- Understand recent biomedical device trends such as TENS and biofeedback.

Unit I	**CARDIAC ASSIST DEVICES**	**9**

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

Unit II	**HEMODIALYSERS**	**9**

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

Unit III	**HEARING AIDS**	**9**

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 orthodic system, functional electrical stimulation, sensory assist devices.

Unit V	**RECENT TRENDS**	**9**

Transcutaneous electrical nerve stimulator, bio-feedback

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**
CO1: Interpret the various mechanical techniques that will help in assisting the heart functions.	Analyze (K4)
CO2: Describe the underlying principles of hemodialyzer machine.	Understand (K2)
CO3: Indicate the methodologies to assess the hearing loss.	Understand (K2)
CO4: Evaluate the types of assistive devices for mobilization.	Evaluate (K5)
CO5: Explain about TENS and biofeedback system.	Understand (K2)

CO - PO & PSO Mapping

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

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

23BME023	**ERGONOMICS (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To get exposed to principles of visual capabilities.
- To learn the mechanics of muscle physiology and significance of rest cycle.
- To learn spatial compatibility and the relation between control orders and control response.
- To know about the measurements and proportions of the human body.
- To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

Unit I	VISUAL AND AUDITORY ERGONOMICS	9
Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.		
Unit II	**MUSCLE PHYSIOLOGY**	**9**
Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in- efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.		
Unit III	**CONTROLS AND DISPLAYS**	**9**
Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task		
Unit IV	**ANTHROPOMETRY**	**9**
Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.		
Unit V	**CASE STUDIES**	**9**
Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc. Case Study 2: Biomedical Application, Design optimization of Medical Equipment.		
Total periods:45 Periods		

Text Books:

1. Pascale Carayon, “Handbook of Human Factors and Engineering”, Second Edition, CRC Press, 2011
2. Martin Helander, “Guide to Human Factors and Ergonomics”, Second Edition, CRC Press,2005
3. Benjamin W.Niebel, “Motion and Time Study”, Richard, D. Irwin Inc., Seventh Edition, 2002

References:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.
2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work,
CRC Press, 2005.

Course Outcomes:	Blooms Taxonomy
CO1: Understand principles of ergonomics.	Understand (K2)
CO2: Understand the significance of posture.	Understand (K2)
CO3: Learn about tracking tasks.	Create (K6)
CO4: Learn about ergonomics and its implications to various domain	Understand (K2)
CO5: Perform case studies on electronic instruments and medical equipment.	Evaluate (K5)
CO - PO & PSO Mapping	

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

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

23BME024	HAPTICS (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	30

Prerequisites

- NIL

Course Objectives:

- Expose to basic principles of Haptics and their property.
- Give knowledge on machines in haptics.
- Learn types of sensors and actuators.
- Understand basic concepts of human locomotion, biomechanical analysis using Finite Element Analysis.
- To develop the ability to interpret and utilize processed biomedical signals for clinical and research applications.

Unit I	HUMAN HAPTICS	9
Somatosensory System; Motor System, Muscle Physiology; Haptics Psychophysical experiments.		

Unit II	MACHINE HAPTICS	9
Design Haptic devices; Human factors involved;		

Unit III	HAPTIC SENSORS AND ACTUATORS	9
barriers in human haptics; Ergonomics.		
Unit IV	**COMPUTATIONAL HAPTICS**	**9**
Haptic Rendering; Rigid bodies, Deformable bodies, Stability 9 9 Rendering effects, Human performance and evaluation; Biomechanics of manipulation; Neuromuscular Models.		
Unit V	**HAPTICS FOR MEDICAL APPLICATIONS**	**9**
Applications: Telemedicine; Rehabilitation; Medical Simulations for education		
Total periods:45 PERIODS		

Text Books:

1. Kay M.Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, Lawrence Erlbaum Associates, Publications. N. I. Durlach and A. S. Mavor, eds., Virtual Reality: Scientific and Technological Challenges, National Academy Press, Washington, D.C., 1994.
2. G.C. Burdea, Force and Touch Feedback for Virtual Reality, John Wiley & Sons, 1996.
3. Kandel, Eric R., et al., eds. Principles of neural science. Vol. 4. New York: McGraw-hill, 2000.

References:

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Marc J. Madou, Fundamentals of Micro fabrication: the Science of miniaturization,CRC Press, 2002.
3. Nadim Maluf and Kirt Williams, An introduction to Microelectro Mechancial Systems Engineering, Second Edition, Artech House Inc, MA,2004.
4. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey,USA,2006.
5. Nitaigour Premch and Mahalik, MEMS, Tata McGraw Hill Publishing Company, New Delhi, 2007.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain the laws of principles of haptics for human	Understand (K2)
CO2: Discuss the behavior of machines in haptics	Apply (K3)
CO3: Analyse the suitable sensor and actuator for haptics	Analyze (K4)
CO4: Identify suitable computation for haptics	Apply (K3)
CO5: Describe the finite element analysis, design the work station depending upon the haptics	Evaluate (K5)

CO - PO & PSO Mapping

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

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

VERTICAL 5: SIGNAL AND IMAGE PROCESSING

23BME025	**BIOSIGNAL PROCESSING (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Understand biomedical signal characteristics and noise.
- Apply time-series and spectral estimation methods to physiological signals.
- Use adaptive filtering and wavelet techniques for ECG analysis.
- Perform biosignal classification using statistical and neural methods.
- Analyze signals using time–frequency and multivariate techniq

Unit I	**BIOSIGNAL AND SPECTRAL CHARACTERISTICS**	**9**

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

Unit II	**TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION**	**9**

Time series analysis – linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation –Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

Unit III	**ADAPTIVE FILTERING AND WAVELET DETECTION**	**9**

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

Unit IV	BIOSIGNAL CLASSIFICATION AND RECOGNITION	9

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

Unit V	TIME FREQUENCY AND MULTIVARIATE ANALYSIS	9

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA,ICA.

Total periods:45

Text Books:

1. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.
2. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
3. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.

References:

1. Kayvan Najarian and Robert Splerstor, "Biomedical signals and Image processing'', CRC – Taylor and Francis,
New York, 2nd Edition, 2012.
2. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3rd Edition, 2010.
3. D.C.Reddy, "Biomedical Signal Processing – Principles and Techniques'', Tata McGraw-Hill Publishing Co. Ltd,
2005.
4. John L.Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications'', Taylor& Francis Inc, 2004.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Preprocess the Biosignals.	Understand(K2)
CO2: Analyze biosignals in time domain & to estimate the spectrum	Understand(K2)
CO3: Apply wavelet detection techniques for biosignal processing.	Analyze(K4)
CO4: Classify Biosignals using neural networks and statistical classifiers.	Understand(K2)
CO5: Extract the features using multivariate component analysis.	Apply (K3)

CO - PO & PSO Mapping

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

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

23BME026	**COMPUTER VISION** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To review image processing techniques for computer vision.
- To understand various features and recognition techniques
- To learn about histogram and binary vision
- Apply three-dimensional image analysis techniques
- • Study real world applications of computer vision algorithms

Unit I	**INTRODUCTION**	**9**

Computer Vision ,What is Computer Vision - Low-level, Mid-level, High-level ; Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective.

Unit II	**FEATURE EXTRACTION**	**9**

Feature Extraction -Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space 69 Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters.

Unit III	**COLOR IMAGES, BINARY VISION**	**9**

Simple pinhole camera model – Sampling – Quantisation – Colour images – Noise – Smoothing – 1D and 3D histograms- Back-projection - k-means Clustering – Thresholding - Threshold Detection Methods - Variations on Thresholding - Mathematical Morphology – Connectivity.

Unit IV	**3D VISION**	**9**

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction

Unit V	**MOTION**	**9**

Introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion– spline- based motion- optical flow – layered motion.

23BME026	COMPUTER VISION (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To review image processing techniques for computer vision.
- To understand various features and recognition techniques
- To learn about histogram and binary vision
- Apply three-dimensional image analysis techniques
- • Study real world applications of computer vision algorithms

Unit I	INTRODUCTION	9

Computer Vision ,What is Computer Vision - Low-level, Mid-level, High-level ; Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective.

Unit II	FEATURE EXTRACTION	9

Feature Extraction -Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space 69 Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters.

Unit III	COLOR IMAGES, BINARY VISION	9

Simple pinhole camera model – Sampling – Quantisation – Colour images – Noise – Smoothing – 1D and 3D histograms- Back-projection - k-means Clustering – Thresholding - Threshold Detection Methods - Variations on Thresholding - Mathematical Morphology – Connectivity.

Unit IV	3D VISION	9

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction

Unit V	MOTION	9

Introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion– spline- based motion- optical flow – layered motion.

Total periods:45 Periods

Text Books:

1. Pascale Carayon, “Handbook of Human Factors and Engineering”, Second Edition, CRC Press, 2011
2. Martin Helander, “Guide to Human Factors and Ergonomics”, Second Edition, CRC Press,2005
3. Benjamin W.Niebel, “Motion and Time Study”, Richard, D. Irwin Inc., Seventh Edition, 2002

References:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.

2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001

3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work,
CRC Press, 2005.

Course Outcomes:	Blooms Taxonomy
CO1: Understand principles of ergonomics.	Understand (K2)
CO2: Understand the significance of posture.	Understand (K2)
CO3: Learn about tracking tasks.	Create (K6)
CO4: Learn about ergonomics and its implications to various domain	Understand (K2)
CO5: Perform case studies on electronic instruments and medical equipment.	Evaluate (K5)

CO - PO & PSO Mapping

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

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

23BME027	SPEECH AND AUDIO SIGNAL PROCESSING (Department of Biomedical Engineering)	Category: PEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Provide students with basic knowledge about speech production and hearing.
- Understand time-frequency analysis concepts.
- Learn fundamentals of audio coding and transform coders.
- Understand time and frequency domain methods for speech processing.
- Study linear predictive analysis of speech.

Unit I	MECHANICS OF SPEECH AND AUDIO	9

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Nonsimultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.		
Unit II	**TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS**	**9**
Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree- Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Pre- echo Control Strategies.		
Unit III	**AUDIO CODING AND TRANSFORM CODERS**	**9**
Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advanced, 4AudioCoding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder -Brandenburg-Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding -Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization		
Unit IV	**TIME AND FREQUENCY DOMAIN**	**9**
Time domain parameters of Speech signal – Methods for extracting the parameters: Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods HOMOMORPHIC SPEECH ANALYSIS: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.		
Unit V	**LINEAR PREDICTIVE ANALYSIS**	**9**
Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.		
Total periods:45		
Text Books:		
1. Rabiner. L. R and Schaffer. R. W., "Digital Processing of Speech signals", Prentice Hall, 1978		

2. Andreas Spanias, Ted Painter, Venkatraman AttiWayne Tomasi, "Audio signal processing and coding", John Wiley & Sons, 2007
References:
1. Udo Zölzer , Digital Audio Signal Processing, A John Wiley& sons Ltd Publication, Second Edition, 2008.
2. Mark Kahrs, Karlheinz Brandenburg, "Applications of Digital Signal Processing to Audio And Acoustics", KLUWER ACADEMIC PUBLISHERS NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW, 2002.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. Martin S. Roden, "Analog and Digital Communication System", Prentice Hall of India, 3rd Edition, 2002.
5. Sklar. B, "Digital Communication Fundamentals and Applications" Pearson Education, 2nd Edition, 2007.

Course Outcomes:	**Blooms Taxonomy**
CO1: Examine auditory models to design perceptual audio quality measure.	Apply (K3)
CO2: Design analysis-by-synthesis model for speech perception.	Understand (K2)
CO3: Analyze and design algorithms for speech and audio coding.	Analyze (K4)
CO4: Analyze and design algorithms for extracting parameters from the speech signal.	Analyze (K4)
CO5: Implement pitch detection and formant analysis in speech signals.	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	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1

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

23BME028	**MEDICAL IMAGING SYSTEMS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:		
• To understand the generation of X-ray and its uses in Medical imaging • To describe the principle of Computed Tomography. • To know the techniques used for visualizing various sections of the body. • To learn the principles of different radio diagnostic equipment in Imaging. • To discuss the radiation therapy techniques and radiation safety		
Unit I	**X RAYS**	**9**
Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X- Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography - discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.		
Unit II	**COMPUTED TOMOGRAPHY**	**9**
Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques – back projection and iterative method.		
Unit III	**MAGNETIC RESONANCE IMAGING**	**9**
Fundamentals of magnetic resonance- properties of electromagnetic waves : speed , amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.		
Unit IV	**NUCLEAR IMAGING**	**9**
Radioisotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET		
Unit V	**RADIATION THERAPY AND RADIATION SAFETY**	**9**
Radiation therapy – linear accelerator, Telegamma Machine. SRS – SRT – Recent Techniques in radiation therapy – 3D CRT – IMRT – IGRT and Cyber knife – radiation measuring instruments Dosimeter, film badges, Thermo Luminescent dosimeters – electronic dosimeter – Radiation protection in medicine – radiation protection principles		

	Total periods:45
Text Books:	
1. Isaac Bankman, I. N. Bankman , Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering),Academic Press,2000	
2. Jacob Beutel (Editor), M. Sonka (Editor), Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis , SPIE Press 2000	
3. Khin Wee Lai, DyahEkashantiOctorinaDewi "Medical Imaging Technology", Springer Singapore, 2015	
References:	
1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, New Delhi, 2003.	
2. Dougherty, Geoff (Ed.), "Medical Image Processing - Techniques and Applications ",Springer-Verlag New York, 2011	

Course Outcomes:	**Blooms Taxonomy**
CO1: Describe the working principle of the X-ray machine and its application.	Understand (K2)
CO2: Illustrate the principle computed tomography	Understand (K2)
CO3: Interpret the technique used for visualizing various sections of the body using Magnetic Resonance Imaging.	Analyze (K4)
CO4: Demonstrate the applications of radionuclide imaging.	Apply (K3)
CO5: Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis and outline the methods of radiation safety.	Analyze (K4)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	0.6	-	-	-	-	1	-	1

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

23BME029	**BRAIN COMPUTER INTERFACE AND APPLICATIONS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the fundamental concepts and architecture of Brain-Computer Interface (BCI) systems.
- To learn various electrophysiological signal acquisition techniques and preprocessing methods used in BCI.
- To study feature extraction methods from EEG and other neural signals for BCI applications.
- To explore different classification and feature translation techniques used in BCI systems.

To apply BCI systems for practical applications, including neuroprosthetics, device control, and rehabilitation

Unit I	INTRODUCTION TO BCI	9
Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.		
Unit II	**ELECTROPHYSIOLOGICAL SOURCES**	**9**
Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.		
Unit III	**FEATURE EXTRACTION METHODS**	**9**
Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.		
Unit IV	**FEATURE TRANSLATION METHODS**	**9**
Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.		
Unit V	**APPLICATIONS OF BCI**	**9**
Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.		
	Total periods:45 PERIODS	

Text Books:

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human- Computer Interaction", Springer, 2010.

References:

1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
3. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

Course Outcomes:	Blooms Taxonomy
CO 1: Describe BCI system and its potential applications.	Understand (K2)
CO2: Analyze event related potentials and sensory motor rhythms.	Analyze (K4)
CO3: Implement BCI for various applications.	Apply (K3)
CO4: Design classifier for a BCI system.	Create (K6)

CO5: Implement BCI for various applications.	Apply (K3)
CO - PO & PSO Mapping	

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

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

23BME030	**BIOMETRIC**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues.
- To understand the general principles of design of biometric systems and the underlying trade-offs.
- To study the technologies of fingerprint, iris, face and speech recognition.
- To study of evaluation of biometrics systems.

To study the technologies of fingerprint, iris, face and speech recognition

Unit I	**INTRODUCTION TO BIOMETRICS**	**9**

Introduction and back ground – biometric technologies – passive biometrics – active biometrics Biometric characteristics, Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non match rate- Failure to enroll rate- Derived metrics- Biometrics and Privacy.

Unit II	FINGERPRINT TECHNOLOGY	9

History of fingerprint pattern recognition - General description of fingerprints- fingerprint sensors, fingerprint enhancement, Feature Extraction- Ridge orientation, ridge frequency, fingerprint matching techniques- correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan- strengths and weaknesses, Evaluation of fingerprint verification algorithms.

Unit III	FACE RECOGNITION AND HAND GEOMETRY	9

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks f

Unit IV	IRIS RECOGNITION	9

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization- Daugman and Wilde‘s approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.

Unit V	VOICE SCAN AND MULTIMODAL BIOMETRICS	9

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction – matching location – local host -
authentication server – match on card (MOC).

Total periods: 45 PERIODS

Text Books:

1. James Wayman& Anil Jain, “Biometric Systems- Technology Design and Performance Evaluation”, SPRINGER (SIE), 1st Edition, 2011

2. Paul Reid, “Biometrics for Network Security”, Pearson Education, 2004

3. S.Y. Kung, S.H. Lin, M.W., “Biometric Authentication: A Machine Learning Approach”, Prentice Hall, 2004

References:

1. Nalini K Ratha, Ruud Bolle, “Automatic fingerprint recognition system’’, Springer, 2003.

2. L C Jain, I Hayashi, S B Lee, U Halici, “Intelligent Biometric Techniques in Fingerprint and

Course Outcomes:	**Blooms Taxonomy**
CO 1: Demonstrate the principles of biometric systems.	Understand (K 2)
CO2: Develop fingerprint recognition technique.	Apply (K3)
CO3: Design face recognition and hand geometry system.	Create (K6)
CO4: Design iris recognition system.	Create (K6)
CO5: Develop speech recognition and multimodal biometric systems.	Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO1	PO1	PSO1	PSO2	PSO3

										1	**2**				
CO1	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

VERTICAL 6: COMMUNICATION

23BME031	**COMMUNICATION SYSTEMS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Understand various analog modulation techniques and their applications in communication systems.
- Explain digital modulation schemes and their role in modern communication.
- Understand the principles of information theory and source coding techniques.
- Analyze receiver characteristics, noise effects, and signal detection mechanisms.
- Understand and apply various error control coding techniques to improve communication reliability.

Unit I	**ANALOG MODULATION**	**9**
Amplitude Modulation – AM, DSBSC, SSBSC, VSB – Angle modulation – PM and FM –Modulators and Demodulators		
Unit II	**RECEIVER CHARACTERISTICS**	**9**
Noise sources and types – Noise figure and noise temperature – Noise in cascaded systems – Single tuned receivers – Super heterodyne receivers.		

Unit III	INFORMATION THEORY	9
Measure of information – Entropy – Source coding theorem – Discrete memoryless channels – lossless, deterministic, noiseless, BEC, BSC – Mutual information – Channel capacity – Shannon- Fano coding, Huffman Coding, run length coding, LZW algorithm.		
Unit IV	**BANDPASS SIGNALING**	**9**
Geometric representation of signals – Correlator and matched filter – ML detection – generation and detection, PSD, BER of coherent BPSK, BFSK, QPSK – Principles of QAM – Structure of non- coherent receivers – BFSK, DPSK		
Unit V	**ERROR CONTROL CODING TECHNIQUES**	**9**
Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes (CRC) – Convolutional codes – Viterbi decoding (Soft/Hard decision decoding).		
Total periods:45 PERIODS		
Text Books:		
1. B.P.Lathi, "Modern Digital and Analog Communication Systems'', Oxford University Press, 3rd Edition, 2007		
2. H Taub, D L Schilling, G Saha, "Principles of Communication Systems", TMH, 3rd Edition, 2007		
3. S. Haykin , "Digital Communications", John Wiley, 2005		
References:		
1. H P Hsu, Schaum "Outline Series, Analog and Digital Communications", TMH, 2006		
2. B.Sklar, "Digital Communications Fundamentals and Applications", Pearson Education, 2nd Edition, 2007.		

Course Outcomes:	**Blooms Taxonomy**
CO1: comprehend and appreciate the significance and role of this course in the present contemporary world.	Understand (K2)
CO2: Apply analog modulation techniques.	Understand (K2)
CO3: Apply digital modulation techniques.	Apply (K3)
CO4: Knowledge on various types of noises during transmission.	Analyze (K4)
CO5: Analyze various error control coding techniques.	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	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
AVG	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23ECO009	**WEARABLE DEVICES (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the fundamental concepts, need, and architecture of wearable systems and their sensing components.
- To learn signal processing requirements and energy-harvesting techniques essential for wearable device operation.
- To study wireless health monitoring systems with emphasis on Body Area Networks (BAN) and their communication protocols.
- To familiarize students with smart textiles, their fabrication techniques, and applications in physiological monitoring.
- To explore various medical applications of wearable systems for diagnosis, monitoring, and rehabilitation.

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, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor.

Unit II	**SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES**	**9**

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.		
Unit III	**WIRELESS HEALTH SYSTEMS**	**9**
Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.		
Unit IV	**SMART TEXTILE**	**9**
Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques- Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study- smart fabric for monitoring biological parameters - ECG, respiration.		
Unit V	**APPLICATIONS OF WEARABLE SYSTEMS**	**9**
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.		
Total periods:45 PERIODS		
Text Books:		
1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011		
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013		
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014		
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012		
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.	Apply (K3)
CO4: Illustrate the concept of smart textile	Understand (K2)
CO5: Compare the various wearable devices in healthcare system	Analyze (K4)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	2	-	-	-	-	1	-	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME032	**BODY AREA NETWORKS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To know the hardware requirement of BAN
- To understand the communication and security aspects in the BAN
- To know the applications of BAN in the field of medicine
- Learn about interference problems, security issues, and regulations in BAN.
- Know the different applications of BAN in healthcare and monitoring.

Unit I	**INTRODUCTION**	**9**
Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture – Introduction.		
Unit II	**HARDWARE FOR BAN**	**9**
Unit IV	**COEXISTENCE ISSUES WITH BAN**	**9**

Unit III	WIRELESS COMMUNICATION AND NETWORK	9
RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.		
Unit IV	**COEXISTENCE ISSUES WITH BAN**	**9**
Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.		
Unit V	**APPLICATIONS OF BAN**	**9**
Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.		
	Total periods: 45 Periods	

Text Books:
1. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability’’, Cambridge University Press, 2013
2. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation, and Applications”, Pan Stanford Publishing Pte. Ltd., Singapore, 2012
References:
1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems’’, Springer, 2013.
2. Guang-Zhong Yang(Ed.), “Body Sensor Networks’’, Springer, 2006.
3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

Course Outcomes:	**Blooms Taxonomy**
CO1: Comprehend and appreciate the significance and role of this course in the present contemporary world.	Understand (K2)
CO2: Design a BAN for appropriate application in medicine.	Create (K6)
CO3: Assess the efficiency of communication and the security parameters.	Evaluate (K5)
CO4: Understand the need for medical device regulation and regulations followed in various regions.	Understand (K2)
CO5: Extend the concepts of BAN for medical applications.	Apply (K3

CO - PO & PSO Mapping

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

CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

<table>
<tr><td rowspan="3">23BME033</td><td rowspan="3">VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE
(Department of Biomedical Engineering)</td><td colspan="4">Category: PEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
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Prerequisites

- NIL

Course Objectives:

- Introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio-economic impact and issues .
- Understand virtual reality, augmented reality and using them to build Biomedical engineering applications
- Learn the various applications of VR.
- Know the intricacies of these platform to develop PDA applications with better optimality.
- Learn the possibilities of implementing target-specific VR applications on mobile.

Unit I	**INTRODUCTION**	**9**

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

Unit II	**VR DEVELOPMENT PROCESS**	**9**

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model management.

Unit III	**CONTENT CREATION CONSIDERATIONS**	**9**

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

Unit IV	VR ON THE WEB & VR ON THE MOBILE	9
JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics		
Unit V	**APPLICATIONS**	**9**
Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy		
	Total periods:45 PERIODS	

Text Books:

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons,
Inc.,2008

2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

References:

1. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN:
9780321883575

2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR
(Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.

3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert
Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.

4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile,
Tony Parisi, O'Reilly Media; 1 edition, 2015.

5. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony
Parisi, O'Reilly Media; 1 edition, 2014.

6. Learning Three.js: The JavaScript 3D Library for WebGL - Second Edition, Jos Dirksen, Packt Publishing - ebooks Account; 2nd Revised ed. Edition 2015.

Course Outcomes:	**Blooms Taxonomy**
CO1: Medical applications-military applications-robotics applications- Advanced Real	Analyze (K4)

time Tracking-other applications- games, movies, simulations, therapy	
CO2: Identify problem statements and function as a member of an engineering design team.	Apply (K3)
CO3: Analyze the implications and issues pertaining to VR	Analyze (K4
CO4: Propose technical documents and give technical oral presentations related to design VR mini project results**.**	Create (K6)
CO5: Develop simple and portable VR applications using appropriate software.	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	2	-	-	1	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1

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

23BME034	**TELEHEALTH TECHNOLOGY** **(Department of Biomedical Engieering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		2	**0**	**2**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the fundamental concepts, benefits, and limitations of telemedicine and telehealth systems.
- To learn and apply various telecommunication technologies and multimedia techniques in telemedicine.
- To comprehend ethical, legal, and security aspects related to telemedical data and patientconfidentiality.
- To design and develop radiology and healthcare information systems using standards such as DICOM and PACS.
- To explore applications of telemedicine across multiple healthcare domains including teleradiology, telepathology, telecardiology, and telesurgery.
-

Unit I	FUNDAMENTALS OF TELEMEDICINE	9
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.		
Unit II	**TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE**	**9**
Audio, video, still images, text and data, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.		
Unit III	**ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE**	**9**
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues.		
Unit IV	**PICTURE ARCHIVING AND COMMUNICATION SYSTEM**	**9**
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.		
Unit V	**APPLICATIONS OF TELEMEDICINE**	**9**
Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery.		

LIST OF EXPERIMENTS	
1	Porting sensor data on mobile devices
2	IoT for healthcare monitoring
3	Porting medical data on cloud platform
4	Cloud computing applications in health informatics
5	Study of telemedicine tools
6	Design of an application for mobile devices
Lecture :30 PERIODS **Practical : 30 PERIODS** **Total periods:60 PERIODS**	

Text Books:
1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, “Handbook of Telemedicine”, IOS Press, Netherland, 3. 2002
2. Khandpur R S, “TELEMEDICINE – Technology and Applications”, PHI Learning Pvt Ltd., New Delhi, 2017.
3. Norris A C, “Essentials of Telemedicine and Telecare”, John Wiley, New York, 2002
References:
1. H K Huang, “PACS and Imaging Informatics: Basic Principles and Applications” Wiley, New Jersey, 2010.
2. Khandpur R S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003
3. Keith J Dreyer, Amit Mehta, James H Thrall, “Pacs: A Guide to the Digital Revolution”, Springer, New York, 2002.
4. Garrett Grolemund, Hands–On Programming with R, O'Reilly , 1 edition , 2014.
5. Michael Dawson, Python Programming for the Absolute Beginner, Course Technology , 3rd edition ,2010
6. Magesh Jayakumar, Arduino and Android Using Mit App Inventor, Createspace Independent Publishing Platform , 1.0 edition ,2016

Course Outcomes:	**Blooms Taxonomy**
CO1: To analyze the benefits and limitations of telemedicine.	Analyze (K4)
CO2: To apply multimedia technologies in telemedicine.	Apply (K3)
CO3: To explain protocols behind encryption techniques for secure transmission of data.	Understand (K2)
CO4: To develop radiology based information system.	Create (K6)
CO5: To apply telemedicine in various healthcare domains.	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	2	-	-	-	-	-	-	-	2	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-	2	-	-
CO3	3	2	1	1	2	-	-	-	-	-	-	-	2	-	-
CO4	3	2	1	1	2	-	-	1	-	-	-	-	2	-	-
CO5	3	2	1	1	2	-	-	1	-	-	-	-	2	-	-
AVG	3	2	1	1	2	-	-	0.6	-	-	-	-	2	-	-

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

23BME036	MEDICAL INFORMATICS (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Understand the basics, structure, and applications of medical informatics and hospital information systems.
- Learn how computers are used in clinical laboratories and medical imaging.
- Understand the components and uses of computerized patient records.
- Explore computer-assisted medical decision-making tools and expert systems.
- Learn recent trends like virtual reality, telemedicine, and computer-assisted surgery.

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

Automatedclinical laboratories-Automatedmethodsinhematology,cytologyandhistology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging-nuclear medicine, ultrasound imaging, raytomography, Radiationtherapyand planning, Nuclear MagneticResonance.

Unit III	COMPUTERISED PATIENT RECORD	9

Introduction - History taking by computer, Dialogue with the computer, 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, Expertsystem-General model of CMD, Computer– assisted decision support system-production rule system cognitivemodel,semanticnetworks,decisionsanalysisinclinicalmedicine-computersin the care of critically ill patients, Computer aids for the handicapped.

Unit V	RECENT TRENDS IN MEDICAL INFORMATICS	9
Virtualreality recent trends in medical informatics applicationsinmedicine, assistedsurgery,Surgicalsimulation, Virtual Telemedicine - Tele 9 endoscopy, Computer surgery,Computerassisted patienteducationandhealth- Medical educationandhealthcareinformation, computer assisted instruction in medicine.		
		Total periods:45

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. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.

Course Outcomes:	Blooms Taxonomy
CO1: 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.	Understand (K2)
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.	Apply (K3)
CO5: Discuss the application of virtual reality and telehealth technology in medical industry.	Understand (K2)

CO - PO & PSO Mapping

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

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

VERTICAL 7: ADVANCED HEALTHCARE DEVICES

23BME036	**BIO MEMS** **(Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- Understand various mechanical and thermal sensors and actuators and their principles of operation at the micro scale level.
- Understand various electrostatic and piezoelectric sensors and actuators at the micro scale level.
- Introduce microfluidic systems
- Know on the applications of MEMS in different field of medicine.

Unit I	**MEMS MATERIALS AND FABRICATION**	**9**

Semiconductor materials; photo lithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; submicron optical lithography; electron beam lithography; soft lithography and printing.

Unit II	**MECHANICAL AND THERMAL SENSORS AND ACTUATORS**	**9**

Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flowsensor.

Unit III	**ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATOR**	**9**

Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor

Unit IV	**MICROFLUIDIC SYSTEMS**	**9**

Laminar flow in circular conduits, fluid flow in micro conduits, in submicrometer and nanoscale. microfluidic components (filters, mixers, valves, and pumps)

Unit V	**APPLICATIONS OF BIOMEMS**	**9**

CAD for MEMS,DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor. Introduction to the MATLAB/Simulink/ CAD tool for modelling/simulations of bioelectronics systems.

LIST OF EXPERIMENTS	
1	Modeling and Simulation of MEMS sensors Using MATLAB (SIMULINK) such as Accelerometer, Current and Voltage Sensor.
2	Design of 3D CAD of BIOMEMS sensors.
3	Analysis of 3D CAD of BIOMEMS sensor.
Lecture :30 PERIODS Practical : 15 PERIODS Total periods:45 PERIODS	

Text Books:
1. TaiRan Hsu,MEMS and Microsystems Design and Manufacture, Tata McGrawHill Publishing Company, New Delhi, 2017.
2. WanjunWang and Stephen A.Soper, BioMEMS:Technologies and Applications, CRC Press, NewYork, 2007.
3. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2011.
4. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011.
5. P. Tabeling, S .Chen, Introduction to microfluidics, Oxford University Press, 2010.
6. Alok Pandya ,Vijai Singh, Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications - Part B, Academic Press, 2022
References:
1. Nadim Maluf & Kirt Williams, An Introduction to Microelectromechanical Systems Engineering, Artech House, 2nd Edition, 2004.
2. Stephen D. Senturia, Microsystem Design, Springer, 2004.
3. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, McGraw-Hill, 2nd Edition, 2008.
4. Marc Madou, Fundamentals of Microfabrication and Nanotechnology, CRC Press, 3rd Edition, 2011.
5. W. Menz, J. Mohr & O. Paul, Microsystem Technology, Wiley-VCH, 2014.
6. Gabriel Urban, BioMEMS, Springer-Verlag Berlin Heidelberg, 2006.
7. Albert Folch, Introduction to BioMEMS, CRC Press, 2012.

Course Outcomes:	Blooms Taxonomy
CO 1: Summarize various MEMS fabrication techniques.	Understand (K2)
CO2: Elucidate different types of mechanical and thermal sensors and actuators and their principles of operation at the micro Scale level.	Understand (K2)
CO3: Describe different types of various electrostatic and piezoelectric sensors and actuators and their principles of operation at the micro Scale level.	Understand (K2)

CO4: Explain microfluidic systems	Understand (K2)
CO5: Illustrate MEMS in different field of medicine.	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	2	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-
AVG	3	2	1	1	2	-	-	-	-	-	-	-	1	-	-

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

23BME037	CRITICAL CARE AND OPERATION THEATRE EQUIPMENT (Department of Biomedical Engineering)	Category: PEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To provide a clear understanding of various intensive care unit (ICU) equipment and their working principles.
- To study the design, operation, and safety of different operation theatre instruments and devices.
- To understand the functioning and application of dialyzers, ventilators, and other critical care machinery.
- To learn about centralized medical gas, air conditioning systems, and integrated OT support systems.
- To develop awareness of patient safety, electrical hazards, and preventive measures in ICU and OT environments.

Unit I	INTENSIVE CARE UNIT EQUIPMENT	9

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer

Unit II	CRITICAL CARE EQUIPMENT	9

Defibrillators, Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

Unit III	OPERATION THEATRE EQUIPMENT	9
Craniotomy, Electrosurgical Machines (ESU), electrosurgical analyzers, surgical aspirator,, Instruments for operation. Anesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy – Laparoscopy - Cryogenic Equipment - Anesthesia gas, Anesthesia gas monitor, - surgical microscope.		
Unit IV	**CENTRALISED SYSTEMS**	**9**
Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.		
Unit V	**PATIENT SAFETY**	**9**
Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.		
Total periods:45 PERIODS		
Text Books:		
1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015		
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012		
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003		
References:		
1. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.		
2. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.		
3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Apply the knowledge acquired, in designing new monitoring devices for ICU and assist the medical personnel's during emergency situations	Apply (K3)
CO2: Suggest suitable surgical instruments and operational devices.	Apply (K3)
CO3: Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods	Analyze (K4)

CO4: Assess the merits of the operation theatre equipment based on its applications	Evaluate (K5)
CO5: Design the devices for the particular application based on given specifications.	Create (K6)
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	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
CO5	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-
AVG	3	2	1	1	1	-	-	-	-	-	-	-	-	-	-

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

23BME038	**HUMAN ASSIST DEVICES (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To study the role and importance of machines that takes over the functions of the heart and lungs,
- To study various mechanical techniques that help a non-functioning heart.
- To learn the functioning of the unit which does the clearance of urea from the blood
- To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
- To study about recent techniques used in modern clinical applications

Unit I	**HEART LUNG MACHINE AND ARTIFICIAL HEART**	**9**

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

Unit II	**CARDIAC ASSIST DEVICES**	**9**

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.		
Unit III	**ARTIFICIAL KIDNEY**	**9**
Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.		
Unit IV	**RESPIRATORY AND HEARING AIDS**	**9**
Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.		
Unit V	**RECENT TRENDS**	**9**
Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.		
	Total periods:45 PERIODS	
Text Books:		
1. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 20		
2. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004		
3. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006		
References:		
1. Andreas.F. Von racum, “Hand book of bio material evaluation”, Mc-Millan publishers, 1980.		
2. Gray E Wnek, Gray L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering” Marcel Dekker Inc New York 2004.		
3. D.S. Sunder, “Rehabilitation Medicine”, 3rd Edition, Jaypee Medical Publication, 2010		

Course Outcomes:	**Blooms Taxonomy**
CO1: Explain the principles and construction of artificial heart	Understand (K2)
CO2: Understand various mechanical techniques that improve therapeutic technology	Understand (K2)
CO3: Explain the functioning of the membrane or filter that cleanses the blood.	Understand (K2)
CO4: Describe the tests to assess the hearing loss and development of wearable devices for the same.	Understand (K2)

CO5: Analyze and research on electrical stimulation and biofeedback techniques in rehabilitation and physiotherapy.	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**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO2	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO3	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO4	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO5	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
AVG	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BME039	**ADVANCEMENTS IN HEALTHCARE TECHNOLOGY (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**L**
		2	**0**	**2**	**3**

Prerequisites

- Nil

Course Objectives:

- Understand the requirements and implementation of digital health systems and their best practices.
- Learn the concepts and workflow of digital radiology and medical image management.
- Apply digital tools and methods to improve healthcare workflows in E-Health systems.
- Explore mobile healthcare technologies and wearable devices for patient monitoring.
- Evaluate standards for inter-operability, safety, and quality in developing digital healthcare systems.

Unit I	**DIGITAL HEALTH**	**9**

Digital Health: Requirements and best practices, Laws and regulations in Digital health, Ethical issues, barriers and strategies for innovation.

Unit II	**DIGITAL RADIOLOGY**	**9**

Digital radiology for digital hospital, picture archiving and communication, system integration, digital history of radiology, medical image archives, storage and networks.

Unit III	E-HEALTH	9
E-Health: Health care networking, medical reporting using speech recognition, physiological tests and functional diagnosis with digital methods, tele-consultation in medicine and radiology.		
Unit IV	**M-HEALTH CARE AND WEARABLE DEVICES**	**9**
Introduction to mobile healthcare devices-economy-average length of stay in hospital, outpatient care, health care costs, mobile phones, 4G, smart devices, wearable devices, Uptake of e-health and m-health technologies. Standards, system Design and case study.		
Unit V	**MODALITY AND STANDARDS FOR INTER-OPERABILITY**	**9**
Multimodality registration in daily clinical practice. Mobile healthcare. Selection and Implementation in e-Health project, design of medical equipment based on user needs. Security and privacy in digital health care. Case study.		
Total periods:45 PERIODS		
Text Books:		
1. Christoph Thuemmler, Chunxue Bai, “Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare”, Springer, 1st ed. 2017		
2. Wlater Hruby, “Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006		
3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, “Requirements Engineering For Digital Health”, Springer, 2015		
References:		
1. Rick Krohn (Editor), David Metcalf, Patricia Salber, “Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.		
2. Khandpur,R.S,”Handbook of Biomedical Instrumentation ”,Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003		
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Interpret the need for digital methods of handling medical records	Understand (K2)
CO2: Explain the digital radiology	Understand (K2)
CO3: Modify the tools and methods for work flow in E-Health	Apply (K3)
CO4: Identify the available technology for wearable healthcare devices	Analyze (K4)
CO5: Compare various standards for inter-operability of devices, quality and safety standards for developing healthcare systems	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	1	1	-	-	-	-	-	-	-	1	1	-
CO2	3	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO4	3	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO5	3	2	1	1	1	-	-	-	-	-	-	-	1	1	-
AVG	3	2	1	1	1	-	-	-	-	-	-	-	1	1	-

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

23BME040	**ROBOTICS IN MEDICINE (Department of Biomedical Engineering)**	**Category: PEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Get introduced to the fundamental of robotics and position analysis
- Learn about Parallel robots, different types of motions and force analysis
- Know the basics of trajectory planning, Motion control systems and actuators
- Have an insight into various sensors and vision systems
- Be acquainted to Fuzzy control and Applications of Robotics in Medicine

Unit I	**FUNDAMENTALS AND POSITION ANALYSIS**	**9**
Fundamentals – Classification, Advantages and disadvantages, Components, Degrees of freedom, Joints, Coordinates, Reference frames, Programming modes, Characteristics, Workspace, Languages, Collaborative robots, Position analysis – Robots as mechanisms, Conventions, Transformations, Forward and inverse kinematics, Denavit Hartenberg Representation, Degeneracy and Dextrerity, Screw based robots, Position analysis of Articulated robot Case studies		
Unit II	**PARALLEL ROBOTS, DIFFERENTIAL MOTIONS AND FORCE ANALYSIS**	**9**
Parallel robots – Physical characteristics, Forward and Inverse Kinematic approaches, Planar and Spatial parallel robots, Differential relationships, The Jacobian, Large scale motions, Frame vs Robot, Differential motions and change, Hand frame, Operator, Jacobian and Inverse for Screw based and Parallel Robots, Differential operator, Lagarangian mechanics, Moments of Inertia, Dynamic Equations of Multiple DOF Robots, Static force analysis, Transformation of forces and moments between coordinate framesCase studies		
Unit III	**TRAJECTORY PLANNING, MOTION CONTROL SYSTEMS AND ACTUATORS**	**9**
Path and Trajectory, Joint Space and Cartesian Space Descriptions and Trajectory Planning, Cartesian, Trajectory Recording, Basics, Block diagrams, Laplace Transform, Block diagram Algebra, Transfer Functions, Characteristic equation, Steady state error, Root locus, Proportional, Integral and Derivative controllers, Compensators, Bode, Loops, Multiple IO systems, Control - State space and Digital, Nonlinear systems, Characteristics of Hydraulic, Pneumatic, Electric motors, Other actuators, Speed reductionCase studies		
Unit IV	**SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS**	**9**
Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque, Microswitches, Visible and IR, Touch, Proximity, Range finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image processing, Segmentation, Region growing and splitting, Operations, Object recognition, Depth, Specialized lighting, Compression, Colour images, Heuristics,Case studies		
Unit V	**FUZZY CONTROL AND APPLICATIONS IN MEDICINE**	**9**
Fuzzy control - Crisp vs Fuzzy, Sets, Inference rules, Defuzzification, Simulation, Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery – Cardiac and abdominal procedures with teleoperated robots, Orthopedic surgery with cooperative robots Case studies		
Total periods:45 PERIODS		
Text Books:		

1. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, Pearson Education, 2020
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003
3. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.
4. J Craig, Introduction to Robotics, Pearson Education, 2005.
References:
1. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.
2. Klafter, Chmielewski and Negin, Robot Engineering, Prentice Hall Of India, 1989.
3. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.
4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.
5. Mikell P. Groover, Mitchell Weiss, Industrial robotics, technology, Programming and Applications, McGraw Hill International Editions, 1986.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering - An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

Course Outcomes:	**Blooms Taxonomy**
CO1: Describe the fundamental of robotics and position analysis	Understand (K2)
CO2: Outline the functioning of parallel robots, different types of motions and force analysis	Understand (K2)
CO3: Portray the basics of trajectory planning, Motion control systems and actuators.	Understand (K2)
CO4: Recognize and explain the use of various sensors and vision systems in robotics.	Understand (K2)
CO5: Employ Fuzzy control in robotics and apply it to Robotics in Medicine	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	-	-
CO2	3	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	1	1	-	-	-	-	-	-	-	1	-	-
AVG	3	2	1	1	1	-	-	-	-	-	-	-	1	-	-

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

23BME041	THERAPEUTIC EQUIPMENT (Department of Biomedical Engineering)	Category: PEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To learn the principles of cardiac assist devices.
- To understand the need and use of extracorporeal devices, and the use of lasers in medicine.
- To enable the students to gain knowledge on the working of therapeutic clinical equipment.
- Learn the basic working of dental equipment and dental X-ray.
- Know the basics of heat and light therapy equipment like diathermy and lasers.

Unit I	CARDIAC AND RESPIRATORY THERAPY EQUIPMENT	9

Cardiac Pacemaker: Internal and External Pacemaker– Programmable pacemakers. Cardiac Defibrillators: AC and DC Defibrillator- Internal and External Defibrillators - Protection Circuit, Defibrillator analyzers. Cardiac ablation catheter. Types of Ventilators – Pressure, Volume, and Time controlled. Basic principles of electromechanical, pneumatic and electronic ventilators, Patient Cycle Ventilators, Ventilator testing. Humidifiers, Nebulizers, Inhalators.

Unit II	BIOMECHANICAL THERAPEUTIC EQUIPMENT	9

Electrodiagnosis, Therapeutic radiation, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Functional Electrical Stimulation. peripheral nerve stimulator, ultrasonic stimulators, Stimulators for pain and relief - Inferential Therapy Unit, TENS. GAIT Assessment and Therapy. Continuous Passive Motion unit, Cervical / Lumber Traction Machine -Traction Table.

Unit III	BODY CARE EQUIPMENT	9

Skin Treatment: Ultrasonic spot remover, vacuum therapy unit, Skin tightening, Wrinkle Reduction, Facial and Rejuvenation. Laser hair therapy machine. Body Slimmer/Shaper – Deep Heat Therapy, Massager, Fitness – Treadmill, Bike.

Unit IV	DENTAL CARE EQUIPMENT	9

Dental Chair - Dental Hand pieces and Accessories: Evolution of rotary equipment, Low-speed handpiece, High- speed handpiece, Hand piece maintenance. Vacuum and Pneumatic techniques: Vacuum techniques, Oral evacuation systems, Vacuum pump, Pneumatic techniques, Dental compressor. Decontamination Unit and constant fumigation unit. Dental Radiography: Dental X-ray Machine.

Unit V	HEAT & PHOTON THERAPY EQUIPMENT	9

High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy. Therapeutic UV and IR Lamps. Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2laser, He-Ne laser, Nd-YAG and Ruby laser.

Total periods:45 PERIODS

Text Books:

1. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co., Ltd.
2003

2. John.G.Webster. "Medical Instrumentation, Application and Design". Fourth Edition.Wiley &s ons, Inc., NewYork. 2009

References:

1. Leslie Cromwell, Fred. J. Weibell & Erich. A.Pfeiffer. "Biomedical Instrumentation and Measurements". Second
Edition. Prentice Hall Inc.2000.

2. John Low & Ann Reed. "Electrotherapy Explained, Principles and Practice". Second Edition. Butterworth Heinemann Ltd. 2000.

3. Joseph. J. Carr, John Michael Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall and Technology, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO1: Suggest suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc	Apply (K3)
CO2: Comprehend the principles of bodycare equipment	Understand (K2)
CO3: Understand the operation of dental care equipment.	Understand (K2)
CO4: Analyze the different types of therapies for suitable applications.	Analyze (K4)
CO5: Appreciate the application of lasers in biomedical 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	1	-	-	-	-	-	-	-	-	1	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-
AVG	3	2	1	1	-	-	-	-	-	-	-	-	1	-	-

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

OPEN ELECTIVES

OPEN ELECTIVES - I

23ECO001	**SPACE SCIENCE**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Strong foundation in Physics, Mathematics, and Computer Science to understand celestial mechanics, spacecraft systems, and data analysis.
- Basic knowledge of Astronomy, problem-solving skills, and interest in research for studying space phenomena and advanced space technologies.

Course Objectives:

- To outline the space environment and their effects.
- To extend the origin of universe and development.
- To classify the galaxies and their evolution.
- To interpret the variable stars in the galaxies.
- To explain theory of formation of our solar system.

Unit I	**INTRODUCTION**	**9**

Introduction to space science and applications – historical development – Space EnvironmentVacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.

Unit II	**ORIGIN OF UNIVERSE**	**9**

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

Unit III

Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

Unit IV	STARS	10
Stellar spectra and structure – stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars) – Chandrasekhar limit.		
Unit V	**SOLAR SYSTEM**	**10**
Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – period of rotation about axis and period of revolution – distance of planets from sun – Bode's law – Kepler's Laws of planetary motion – Newton's deductions from Kepler's Laws – correction of Kepler's third law – determination of mass of earth – determination of mass of planets with respect to earth – Brief description of Asteroids – Satellites and Comets		
		Total Periods: 45 PERIODS

Text Books:

1.Hess W., "Introduction to Space Science", Gordon & Breach Science Pub; Revised Ed., 1968.

2.Krishnaswami K. S., "Astrophysics: A modern Perspective", New Age International, 2006

References:

1.Arnab Rai Choudhuri, "Astrophysics for Physicists", Cambridge University Press, New York, 2010.

2.Krishnaswami K. S., "Understanding cosmic Panorama", New Age International, 2008.

Course Outcomes:	Blooms Taxonomy
CO1: Obtain a broad, basic knowledge of the space sciences.	K2 (Understand)
CO2: Explain the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.	K2 (Understand)
CO3: Describe the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.	K2 (Understand)
CO4: Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories.	K3 (Apply)
CO5: Describe the presently accepted formation theories of the solar system based upon observational and physical constraints.	K2 (Understand)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	-	-	-	-	-	1	-	-	-	2	1	-
CO2	2	2	1	-	-	-	-	-	2	-	-	-	2	1	-
CO3	2	2	1	-	-	-	-	-	2	-	-	-	2	2	-
CO4	2	2	2	1	-	-	-	-	2	1	-	-	2	2	-
CO5	2	2	1	-	-	-	-	-	2	-	-	-	2	1	-
AVG	2	2	1	0.4	-	-	-	-	2	0.4	-	-	2	2	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO020	**INTRODUCTION TO INDUSTRIAL ENGINEERING**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Basic understanding of Mathematics, Physics, and logical reasoning to analyze processes and improve system efficiency.
- Fundamental computer skills and interest in operations, optimization, and problem-solving within industrial environments.

Course Objectives:

The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.

- Explain the concepts productivity and productivity measurement approaches.
- Explain the basic principles in facilities planning and plant location.
- Apply work study and ergonomic principles to design workplaces for the improvement of human performance.
- Impart knowledge to design and implement Statistical Process control in any industry.
- Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.

Unit I	**INTRODUCTION**	**9**

Concepts of Industrial Engineering – History and development of Industrial Engineering – Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

Unit II	PLANT LOCATION AND LAYOUT	9

Factors affecting Plant location – COURSE OBJECTIVES of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

Unit III	WORK SYSTEM DESIGN& ERGONOMICS	9

Need – COURSE OBJECTIVES – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

Unit IV	STATISTICAL QUALITY CONTROL	9

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve –Single sampling plan- Double sampling plan.

Unit V	PRODUCTION PLANNING AND CONTROL	9

Forecasting – Qualitative and Quantitative forecasting techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production – Dispatching– Progress control.

Total Periods: 45 PERIODS

Text Book:

1. O.P.Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications.

References:

1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited.
2. Martand Telsang,2006, Industrial Engineering and Production Management, S. Chand and Company.

Course Outcomes:	Blooms Taxonomy
CO 1: Ability To define the concepts of productivity and productivity measurement approaches.	K1 (Remember)
CO2: Ability to evaluate appropriate location models for various facility types and design various facility layouts.	K5 (Evaluate)
CO3: Ability To conduct a method study and time study to improve the efficiency of the system.	K3 (Apply)
CO4: Ability to Control the quality of processes using control charts in manufacturing/service industries.	K4 (Analyze)
CO5: Ability to define the Planning strategies and Material Requirement Plan.	K2 (Understand)

CO - PO & PSO Mapping

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

CO2	2	2	3	2	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	1	1	-	-	2	-	-	1	-	2	-	-
CO4	2	2	3	1	1	-	-	-	-	-	-	-	-	-	-
CO5	1	2	2	-	-	-	-	-	-	-	-	1	-	-	3
AVG	2	2	2.2	1.6	0.8	-	-	0.4	-	-	0.4	0.4	0.4	0.4	0.8
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BMO005	**FOOD, NUTRITION AND HEALTH**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Basic understanding of Biology and Chemistry to grasp how nutrients affect the human body.
- Interest in health, wellness, and scientific concepts related to diet, metabolism, and disease prevention.

Course Objectives:

- Build knowledge and an overview on general aspects of nutrition and health.
- Distinguish the nutritive value of various food items, BMI calculation differentiating super junk, and functional foods in the market.
- To Solve the real-world problems based on nutrition and health.

Unit I	**FOOD AND MICROBIOLOGY OF HEALTH:**	**9**

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies. Functional and "Super" Foods - role in optimal nutrition. Sugar, protein and fat substitutes. Food and behaviour- physiological disturbances in alcoholism, drug abuse and 207 smoking. Food Related Laws: Inspection – Microbial Indicators of product quality – Indicators of food safety – 229 Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria.

Unit II	**NUTRIENTS AND FOOD ADDITIVES:**	**9**

Macro nutrients- carbohydrates, proteins and lipids. Micronutrients-Minerals: Calcium, Magnesium, Iron, Zinc, Copper and Selenium; Vitamins. Nutritional Physiology: Digestion, absorption, and utilization of major and minor nutrients. Biotechnology of food additives- Bioflavors and colors, microbial polysaccharides, recombinant enzymes in food sector.

Unit III	NANO FOOD TECHNOLOGY:	9
Nano materials as food components, food packaging and nano materials, policies on usage of nanomaterials in foods. Food product development: steps involved in food product development, shelf-life assessment.		
Unit IV	**FOOD RELATED NUTRITIONAL DISORDERS AND ENERGY CALCULATION:**	**9**
Type I Disorders-Causes of life style and stress related diseases. Cardio-vascular diseases, hypertension, obesity. Type-II Disorders: Cancer, diabetics, ulcers, electrolyte and water imbalance. Health indices. Preventive and remedial measures. Energy balance and methods to calculate individual nutrient and energy needs. Planning a healthy diet.		
Unit V	**CONSUMERS ON GM FOODS AND CONTEMPORARY ISSUES:**	**9**
Global perspective of consumers on GM foods; Major concerns of transgenic, foods GM ingredients in food products. (labeling, bioavailability, safety aspects); regulatory agencies involved in GM foods, Case studies- GM foods.		
		Total Periods: 45 PERIODS

Text Books:

1. P.J. Fellows.2009. Food Processing Technology -Principles and Practice (Third Edition). A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.

2. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin. 2015. Food Biotechnology. CRC Press. Second edition.

References:

1.Understanding Nutrition. 2010. Ellie Whitney, Sharon Rady Rolfes, 11e. Thompson Wadsworth.

2.Nutritional Sciences- From Fundamentals to Food.2013. Michelle McGuire, Kathy A. Beerman, 2 nd e. Thompson Wadsworth.

3. Yasmine Motarjemi, Huub Lelieveld, Food Safety Management - A Practical Guide for the Food Industry (2014), 1st Edition, Academic Press, London, UK

Course Outcomes:	**Blooms Taxonomy**
CO1: To be able to understand the nutritional values of the various types of foods.	K2 (Understand)
CO2: To be able to Analyze the role of food in the metabolic activity of the healthy diet.	K4 (Analyze)
CO3: To be able to Infer the BMI calculation and stress related diseases.	K3 (Apply)
CO4: To be able to Elaborate the independent decision on the choice of food to prevent life style disorders and diseases.	K5 (Evaluate)
CO5: To be able to Assess about the food laws governance and modified and super foods.	K5 (Evaluate)

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

23CEO011	**ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Basic knowledge of Environmental Science, Geography, and societal systems to understand ecological and community impacts.
- Analytical skills, data interpretation ability, and interest in sustainability, policy, and project planning.

Course Objective:

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects
- To provide knowledge and skills for identifying and assessing environmental and social impacts of developmental projects.
- To familiarize students with EIA methods, legal frameworks, and environmental management planning.
- To enable preparation, evaluation, and implementation of EIA reports for sustainable development.
- To develop analytical and decision-making skills for sustainable project planning and mitigation of adverse impacts.

Unit I	INTRODUCTION	9
Impacts of Development on Environment – Rio Principles of Sustainable DevelopmentEnvironmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework–Stakeholders and their Role in EIA– Selection & Registration Criteria for EIA Consultants		
Unit II	**ENVIRONMENTAL ASSESSMENT**	**9**
Screening and Scoping in EIA – Drafting of Terms of Reference,Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise and energy, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction – Analysis of alternatives		
Unit III	**ENVIRONMENTAL MANAGEMENT PLAN**	**9**
Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Review of EIA Reports – Public HearingEnvironmental Clearance Post Project Monitoring		
Unit IV	**SOCIO ECONOMIC ASSESSMENT**	**9**
Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis		
Unit V	**CASE STUDIES**	**9**
EIA case studies pertaining to Infrastructure Projects – Real Estate Development - Roads and Bridges – Mass Rapid Transport Systems - Ports and Harbor – Airports - Dams and Irrigation projects - Power plants – CETPs- Waste Processing and Disposal facilities – Mining Projects.		
Total Periods: 45 PERIODS		
Text Books:		
1.Canter, R.L, “Environmental impact Assessment “, 2nd Edition, McGraw Hill Inc, New Delhi,1995.		
2.Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, “Environmental Impact Assessment for Developing Countries in Asia”, Volume 1 – Overview, Asian Development Bank,1997.		
3.Peter Morris, Riki Therivel “Methods of Environmental Impact Assessment”, Routledge Publishers,2009.		
References:		
1. Becker H. A., Frank Vanclay,“The International handbook of social impact assessment” conceptual and methodological advances, Edward Elgar Publishing, 2003.		
2. Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme, 2002.		

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

Course Outcomes:	**Blooms Taxonomy**
CO1: Carry out scoping and screening of developmental projects for environmental and social assessments.	K3 (Apply)
CO2: Explain different methodologies for environmental impact prediction and assessment.	K2 (Understand)
CO3: Plan environmental impact assessments and environmental management plans.	K3 (Apply)
CO4: Evaluate environmental impact assessment reports.	K5 (Evaluate)
CO5: Apply environmental and social impact assessment techniques to evaluate developmental projects.	K2 (Understand)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	-	-	-	-	2	-	-	-	3	2	-
CO2	2	2	1	1	-	-	-	-	2	-	-	-	2	2	-
CO3	3	3	2	2	-	-	-	-	2	1	-	-	3	3	-
CO4	3	3	2	2	-	-	-	-	2	1	-	-	3	3	-
AVG	3	3	2	2	-	-	-	-	2	0.6	-	-	2	2.2	-

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

23EEO011	**RENEWABLE ENERGY SYSTEM**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Strong basics in Physics and Mathematics to understand energy conversion, power systems, and sustainable technologies.
- Fundamental knowledge of Electrical/Mechanical concepts and interest in clean energy, environment, and modern energy solutions.

Course Objective:

- To Provide knowledge about various renewable energy technologies.
- To enable students to understand and design a PV system.
- To provide knowledge about wind energy system.
- To Provide knowledge about various possible hybrid energy systems

• To gain knowledge about application of various renewable energy technologies		
Unit I	**INTRODUCTION**	**9**
Primary energy sources, renewable vs. non-renewable primary energy sources, renewable energy resources in India, Current usage of renewable energy sources in India, future potential of renewable energy in power production and development of renewable energy technologies.		
Unit II	**SOLAR ENERGY**	**9**
Solar Radiation and its measurements, Solar Thermal Energy Conversion from plate Solar Collectors, Concentrating Collectors and its Types, Efficiency and performance of collectors,. Direct Solar Electricity Conversion from Photovoltaic, types of solar cells and its application of battery charger, domestic lighting, street lighting, and water pumping, power generation schemes. Recent Advances in PV Applications: Building Integrated PV, Grid Connected PV Systems,		
Unit III	**WIND ENERGY**	**9**
Wind energy principles, wind site and its resource assessment, wind assessment, Factors influencing wind, wind turbine components, wind energy conversion systems (WECS), Classification of WECS devices, wind electric generating and control systems, characteristics and applications		
Unit IV	**BIO-ENERGY**	**9**
Energy from biomass, Principle of biomass conversion technologies/process and their classification, Bio gas generation, types of biogas plants, selection of site for biogas plant, classification of biogas plants, Advantage and disadvantages of biogas generation, thermal gasification of biomass, biomass gasifies, Application of biomass and biogas plants and their economics.OTHER TYPES OF ENERGY		
Unit V	**OTHER TYPES OF ENERGY**	**9**
Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, minihydel power plants and their economics.		
		Total Periods: 45 PERIODS
Textbooks:		
1.Twidell, J. and Weir, T. *Renewable Energy Resources*, 3rd Edition, CRC Press (Taylor & Francis), 2015. – Comprehensive coverage of all renewable energy technologies with practical examples.		
2.Khan, B. H. *Non-Conventional Energy Resources*, Tata McGraw-Hill Education, 2006. – Popular textbook emphasizing Indian renewable energy potential and applications.		

References:

1. Twidell & Wier,‘Renewable Energy Resources’ CRC Press(Taylor & Francis).
2. Tiwari and Ghosal/ Narosa,‘Renewable energy resources’.
3. D.P.Kothari, K.C.Singhal,‘Renewable energy sources and emerging technologies’, P.H.I.
4. D.S.Chauhan, S.K. Srivastava, ‘Non – Conventional Energy Resources’, New Age Publishers, 2006.
5. B.H.Khan, ‘Non – Conventional Energy Resources’, Tata Mc Graw Hill, 2006

Course Outcomes:	Blooms Taxonomy
CO1: Attained knowledge about various renewable energy technologies.	K2 (Understand)
CO2: Ability to understand and design a PV system.	K3 (Apply)
CO3: Understand the concept of various wind energy system.	K2 (Understand)
CO4: Gained knowledge about various possible hybrid energy systems.	K2 (Understand)
CO5: Attained knowledge about various application of renewable energy technologies.	K2 (Understand)

CO - PO & PSO Mapping

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

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

23EEO12	INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Basic understanding of Physics, Mathematics, and Electrical fundamentals to learn measurement principles and control systems.
- Familiarity with sensors, circuits, and problem-solving skills to analyze industrial processes and automation concepts.

Course Objectives:

- To introduce common unit operations carried out in process industries.
- To impact knowledge about the important unit operations taking place in process industries.

- To prepare them to take up a case study on selected process industries like petrochemical industry, power plant industry and paper & pulp industry to make the students understand the different measurement and control techniques for important processes.
- Facilitate the students to apply knowledge to select appropriate measurement technique and control strategy for a given process.

Unit I	**COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -I**	**9**
Unit Operation, Measurement and Control:-Transport of solid, liquid and gases - Evaporators – Crystallizers-Dryers.		
Unit II	**COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II**	**9**
Unit Operation, Measurement and Control: - Distillation – Refrigeration processes – Chemical reactors.		
Unit III	**PROCESS MEASUREMENT AND CONTROL IN PETROCHEMICAL INDUSTRY**	**9**
Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionation Column – Catalytic Cracking unit – Catalytic reforming unitProcess flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines		
Unit IV	**PROCESS MEASUREMENT AND CONTROL IN THERMAL POWER PLANT INDUSTRY**	**9**
Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines		
Unit V	**PROCESS MEASUREMENT AND CONTROL IN PAPER & PULP INDUSTRY**	**9**
Process flow diagram of paper and pulp industry – Batch digestor – Continuous sulphatedigestor – Control problems on the paper machine.		
Total Periods: 45 PERIODS		

Text Books:

1. Balchen ,J.G., and Mumme, K.J., “ Process Control structures and applications”, Van Nostrand Reinhold Co.,
New York, 1988

2. Warren L. McCabe, Julian C. Smith and Peter Harriot, “Unit Operations of Chemical Engineering”, McGraw-
Hill International Edition, New York, Sixth Edition, 2001.

References:

1. Liptak B.G., “Instrument and Automation Engineers' Handbook: Process Measurement and Analysis”, Fifth
Edition, CRC Press, 2016.

2. James R.couper, Roy Penny, W., James R.Fair and Stanley M.Walas, “Chemical ProcessEquipment: Selection and Design”, Gulf Professional Publishing, 2010.

3. Austin G.T and Shreeves, A.G.T., “Chemical Process Industries”, McGraw–Hill International student, Singapore, 1985.
4. Luyben W.C., “Process Modeling, Simulation and Control for Chemical Engineers”, McGrawHill International edition, USA, 1989.
5. K. Krishnaswamy, Process Control, new age publishers , 2009.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand common unit operations in process industries. L2	K2 (Understand)
CO2: Identify the dynamics of important unit operations in petro chemical industry. L2	K2 (Understand)
CO3: develop understanding of important processes taking place selected case studies namely petrochemical industry, power plant industry and paper & pulp industry. L5	K5 (Evaluate)
CO4: Select appropriate measurement techniques for selective processes. L5	K5 (Evaluate)
CO5: Develop controller structure based on the process knowledge. L5.	K5 (Evaluate)
CO6: Analyze the operation and challenges in integrated industrial processes. L4	K4 (Analyze)
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	-	-	-	-	-
CO2	3	3	1	-	-	-	-	1	-	1	2	-	-	-	2
CO3	3	3	1	-	-	-	-	1	-	1	-	-	-	-	-
CO4	3	3	1	3	3	-	-	1	-	1	-	-	3	3	-
CO5	3	3	3	-	-	3	-	1	-	1	-	-	3	3	3
AVG	3	3	2	0.6	0.6	0.6	-	1	-	1	0.4	-	0.6	0.6	0.6

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

23MAO007	**GRAPH THEORY**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- Solid foundation in Discrete Mathematics and basic mathematical reasoning skills.
- Familiarity with sets, relations, algorithms, and problem-solving concepts for understanding graph structures and applications.

Course Objectives:

- To understand the graph models and basic concepts of graphs.
- To study the characterization and properties of trees and graph connectivity.
- To provide an exposure to the Eulerian and Hamiltonian graphs.
- To introduce Graph colouring and explain its significance.

- To provide an understanding of Optimization Graph Algorithms.

Unit I	**INTRODUCTION TO GRAPHS**	**9**
Graphs and Graph Models – Connected graphs – Common classes of graphs – Multi graphs and Digraphs – Degree of a vertex – Degree Sequence – Graphs and Matrices – Isomorphism of graphs.		
Unit II	**TREES AND CONNECTIVITY**	**9**
Bridges – Trees – Characterization and properties of trees – Cut vertices – Connectivity.		
Unit III	**TRAVERSABILITY**	**9**
Eulerian graphs – Characterization of Eulerian graphs – Hamiltonian graphs – Necessary condition for Hamiltonian graphs – Sufficient condition for Hamiltonian graphs.		
Unit IV	**PLANARITY AND COLOURING**	**9**
Planar Graphs – The Euler Identity – Non planar Graphs – Vertex Colouring – Lower and Upper bounds of chromatic number.		
Unit V	**OPTIMIZATION GRAPH ALGORITHMS**	**9**
Dijkstra's shortest path algorithm – Kruskal's and Prim's minimum spanning tree algorithms – Transport Network – The Max-Flow Min-Cut Theorem – The Labeling Procedure – Maximum flow problem.		
		Total Periods: 45 PERIODS

Text Books:

1. Chatrand and Ping Zhang, "Introduction to Graph Theory", Tata McGraw – Hill companies Inc., New York, 2006.
2. . Grimaldi, "Discrete and Combinatorial Mathematics, An applied introduction" Fifth edition, Pearson Education, Inc, Singapore, 2004.

References:

1. Balakrishnan R. and Ranganathan K., "A Text Book of Graph Theory", Springer – Verlag, New York, 2012.
2. Douglas B. West, "Introduction to Graph Theory", Pearson, Second Edition, New York, 2018
3. K. Krishnaswamy, Process Control, new age publishers , 2009.

Course Outcomes:	**Blooms Taxonomy**
CO1: Apply graph models for solving real world problem.	K3 (Apply)
CO2: Understand the importance the natural applications of trees and graph connectivity	K2 (Understand)
CO3: Understand the characterization study of Eulerian graphs and Hamiltonian graphs.	K2 (Understand)

CO4: Apply the graph colouring concepts in partitioning problems.	K3 (Apply)
CO5: Apply the standard optimization graph algorithms in solving application problems.	K3 (Apply)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	2	2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	2	2	2	-	-	-	-	-	2	-	-	-	-	-
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	3	2	-	2	-	-	-	-	3	-	-	-	-	-
AVG	0.6	2	2	0.4	0.6	-	-	-	-	0.6	-	-	-	-	-

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

<table>
<tr><td rowspan="3">23CSO007</td><td rowspan="3">DIGITAL MARKETING
DEPARETMENT OF BIOMEDICAL ENGINEERING</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- To provide foundational knowledge of the online marketplace, digital marketing strategies, website creation, and content development.
- To equip students with skills in Search Engine Optimization (SEO), Search Engine Marketing (SEM), keyword planning, and digital advertising techniques.
- To develop competency in email marketing automation, lead generation, and mobile marketing channels for effective customer targeting.
- To enable students to use social media platforms for brand building, engagement, customer relationship management, and influencer marketing.
- To familiarize students with digital transformation concepts, analytics tools, channel attribution, and emerging trends for strategic decision-making in digital marketing.

Unit I	**INTRODUCTION TO ONLINE MARKET**	**6**

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

Unit II	**SEARCH ENGINE OPTIMISATION**	**6**

Search Engine optimisation - Keyword Strategy- SEO Strategy - SEO success factors -On-Page Techniques - Off- Page Techniques. Search Engine Marketing- How Search Engine works- SEM components- PPC advertising - Display Advertisement		
Unit III	**E- MAIL MARKETING**	**6**
E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with Social Media and Mobile- Measuring and maximizing email campaign effectiveness. Mobile Marketing- Mobile Inventory/channels- Location based; Context based; Coupons and offers, Mobile Apps, Mobile Commerce, SMS Campaigns-Profiling and targeting		
Unit IV	**SOCIAL MEDIA MARKETING**	**6**
Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.		
Unit V	**DIGITAL TRANSFORMATION**	**6**
Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.		
Total :60 Periods		
Text Books:		
1. Fundamentals of Digital Marketing by Puneet Singh Bhatia;Publisher: Pearson Education;		
2. First edition (July 2017);ISBN-10: 933258737X;ISBN-13: 978-9332587373.		
3. Digital Marketing by Vandana Ahuja ;Publisher: Oxford University Press (April 2015). ISBN-10: 0199455449		
4. Marketing 4.0: Moving from Traditional to Digital by Philip Kotler;Publisher: Wiley; 1st edition (April 2017); ISBN10: 9788126566938;ISBN 13: 9788126566938;ASIN: 8126566930.		
5. Ryan, D. (2014). Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited..		
6. Barker, Barker, Bormann and Neher(2017), Social Media Marketing: A Strategic Approach, 2E South-Western ,Cengage Learning.		
7. Pulizzi,J Beginner's Guide to Digital Marketing , Mcgraw Hill Education.		
References:		
1. Chaffey, D., & Ellis-Chadwick, F. (2022). *Digital Marketing: Strategy, Implementation and Practice* (8th Edition). Pearson.		

2. Ologunebi, J. (2022). *The Importance of SEO and SEM in Improving Brand Visibility*. MPRA Paper.

3.Hartman, K. (2021). *Digital Marketing Analytics: In Theory and in Practice*. Routledge.

4. Solis, B. (2011). *Engage!: The Complete Guide for Brands and Businesses to Build, Cultivate, and Measure Success in the New Web*. Wiley.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand online market and digital marketing strategy.	Apply (K3)
CO2: Apply on-page, off-page SEO, PPC, and display ads.	Understand (K2)
CO3: Design and execute email campaigns and mobile marketing strategies.	Apply (K3)
CO4: Understand social media channels and influencer marketing.	Evaluate (K5)
CO5: Analyze campaigns, optimize strategies, and adapt to trend.	Understand (K2)

CO - PO & PSO Mapping

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

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

OPEN ELECTIVE II

23MGO008	**RESOURCE MANAGEMENT TECHNIQUES**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- A foundational understanding of management principles and organizational processes is required
- Basic analytical, mathematical, and problem-solving skills are essential for applying resource management t Techniques effectively.

Course Objectives:

- Learn to formulate linear programming problems and solve LPP using simple algorithm
- Learn to solve networking problems
- Learn to formulate and solve integer programming problems
- Learn to solve Non Linear programming problems
- Learn to understand and solve project management problems

Unit I	LINEAR PROGRAMMING	9
Principal components of decision problem – Modeling phases – LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.		
Unit II	**DUALITY AND NETWORKS**	**9**
Definition of dual problems – primal – Dual relationships – Dual simplex method –post optimality analysis – Transportation and assignment model – Shortest route problem.		
Unit III	**INTEGER PROGRAMMING**	**9**
Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.		
Unit IV	**CLASSICAL OPTIMISATION THEROY**	**9**
Unconstrained external problems, Newton – Ralphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.		
Unit V	**OBJECT SCHEDULOING**	**9**
Network diagram representation – Critical path method – Time charts and resource leveling – PERT.		
Total periods: 45 PERIODS		

Text Books:

1. H.A. Taha, “Operation Research”, Prentice Hall of India, 2002.

References:

1. Paneer selvam, ‘Operations Research’ Prentice Hall of India, 2002.
2. Anderson ‘Quantitative Methods for Business’, 8th Edition, Thomson Learning, 2002.
3. Winston ‘Operations Research for Business’, Thomson Learning, 2003.
4. Vohra, ’Quantitative Techniques in Management’, Tata Mc Graw Hill, 2002.
5. Anand sarma, ‘Operation Research’ Himalaya Publishing House, 2003.

Course Outcomes:	Blooms Taxonomy
CO 1: Understand to formulate linear programming problems and solve LPP using simple algorithm	K2 (Understand)
CO2: Understand to solve networking problems	K2 (Understand)
CO3: Understand to formulate and solve integer programming problems	K2 (Understand)
CO4: Understand to solve Non Linear programming problems	K2 (Understand)
CO5: Understand to understand and solve project management problems	K2(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	3
CO2	-	3	3	2	-	-	-	-	-	-	-	-	3	2	3
CO3	-	3	3	2	-	-	-	-	-	-	-	-	3	2	3
CO4	-	3	3	2	-	-	-	-	-	-	-	-	3	2	3

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

<table>
<tr><td rowspan="3">23MGO009</td><td rowspan="3">FINTECH REGULATION</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites:

- A basic understanding of financial systems, banking operations, and fundamental FinTech concepts is required.

Course Objectives:

- To learn about Laws and Regulation.
- To acquire the knowledge of Regulations of Fintech firm and their role in Market.
- To understand the legal frameworks, regulatory bodies, and compliance mechanisms governing the FinTech ecosystem.
- To analyze regulatory challenges and opportunities emerging from technological innovations in financial services.
- To evaluate regulatory and legal concerns related to crowdfunding, digital assets, mobile payments, cybersecurity, and anti-money laundering.

Unit I	**INTRODUCTION**	**9**

The Role of the Regulators, Equal Treatment and Competition, Need for a regulatory assessment of Fintech, India Regulations, The Risks to Consider, Regtech and SupTech, The rise of TechFins, Regulatory sandboxes, compliance and whistleblowing.

Unit II	**INNOVATION AND REGULATION**	**9**

The technology, market and the law, Regulation and Innovation in Banking and Finance, Regulations of Fintech Firms and their role in Market-Based Chains, Current Regulatory Approach, Fintech Innovations in Banking, Asset Management, Insurance, Pensions and Healthcare Schemes, Patentability of FinTech inventions.

Unit III	**CROWDFUNDING AND DIGITAL ASSETS**	**9**

Types of crowdfunding, The Jobs Act, Regulation crowdfunding, Regulation A+, Regulation D crowdfunding, Intrastate offerings, Digital Assets – Three uses of Digital Assets, A world of Altcoins, Stablecoins, Digital Asset Forks, Initial Coin Offerings, Regulatory Framework for Digital and Crypto Assets, Central Bank Digital Currencies.

Unit IV	**MARKETPLACE LENDING AND MOBILE PAYMENTS**	**9**

Online Lending Business Models, Payday Loans, Consumer Protection Laws, Debt Collection, Equal Credit Opportunity Act, Contract Formation and the E-Sign Act, Military Lending Act, Securities Laws Considerations, Mobile Devices, Payment Cards and the Law, Truth in Lending Act and Regulation Z, Card Act, Electronic Fund Transfer Act and Regulation E, Fair Credit Reporting Act, Federal Bank Secrecy Act, State Money Transmitter Laws.		
Unit V	**ANTI-MONEY LAUNDERING AND CYBERSECURITY**	**9**
Reporting requirements under the Bank Secrecy Act, Patriot Act, Panalties for violating the BSA, Virtual currencies and the Bank Secrecy Act, Cybersecurity Frameworks, Cybersecurity Act of 2015, Contractual and Self Regulatory obligations		
Total periods: 45 PERIODS		
References:		
1. JelenaMadir, FinTech – Law and Regulation, Edward Elgar Publishing Limited, 2019.		
2. Valerio Lemma, Fintech Regulation : Exploring New Challenges of the Capital Markets Union, Palgrave Macmillan, 2020.		
3. Chris Brummer, Fintech Law in a Nutshell, West Academic Publishing, 2020.		
4. Bernardo Nicoletti, The Future of Fintech, Integrating Finance and Technology in Financial Services, Springer Nature, 2017.		
5. Kevin C. Taylor, FinTech Law : A Guide to Technology Law in the Financial Services Industry, BNA Books, 2014.		
6. Lee Reiners, FinTech Law and Policy, 2018.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand the role of regulators and key regulatory frameworks governing FinTech.	K2 (Understand)
CO2: Analyze how innovation interacts with regulation in banking, finance, and emerging FinTech sectors.**K2 (Understand)**	K4 (Analyze)
CO3: Evaluate crowdfunding models and regulatory approaches to digital and crypto assets.	K5 (Evaluate)
CO4: Explain legal, compliance, and consumer-protection requirements in marketplace lending and mobile payments.	K2 (Understand)
CO5: Understand AML laws, BSA requirements, and cybersecurity frameworks applicable to FinTech.	K2 (Understand)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	-	-	2	-	1	2	-	-
CO2	2	3	3	2	1	-	-	-	-	2	-	1	2	1	-
CO3	1	2	3	3	2	-	1	-	-	3	-	1	3	1	-
CO4	1	2	2	2	1	1	-	-	1	3	-	1	2	-	-
CO5	2	3	2	2	3	1	1	-	-	2	-	1	2	-	-
AVG	2.2	2.6	2.2	1.6	1.2	0.4	0.4	-	0.2	2.2	-	1	2	0.4	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BTO007	**HOLISTIC NUTRITION**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- A basic understanding of human biology and general nutrition is required to comprehend body functions and dietary impacts.

Course Objectives:

- To introduce the fundamental principles of nutrition, nutrients, metabolism, and their impact on health.
- To explain Ayurvedic mind–body principles and their application in personalized dietary practices.
- To understand how environmental factors and food safety influence nutrition and disease prevention.
- To compare various dietary systems and evaluate their therapeutic benefits and limitations.
- To explore the role of nutrition in preventive healthcare and examine current research on nutraceuticals.

Unit I	**NUTRITION AND HEALTH**	**9**

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

Unit II	**AYURVEDA – MIND/BODY HEALING**	**9**

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

Unit III	**NUTRITION AND ENVIRONMENT**	**9**

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

Unit IV	COMPARATIVE DIETS	9

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative diet approaches, including: modern diets (intermittent fasting, macrobiotics), food combining (colour therapy/rainbow diet), high protein diets (Ketogenic, Paleo), Vegetarian approaches (plant based/vegetarian/vegan variations, fruitarian, raw food), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

Unit V	PREVENTIVE HEALTH CARE	9

Proper nutrition protection against, reverse and/or retard many ailments including: osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

Total periods: 45 PERIODS

Text Books:

1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000.
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition.Vol. XI. Academic Press.

References:

1. Modern Nutrition in Health & Disease by Young & Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350.
3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published byNational Institute of Nutrition, Indian Council of Medical Research, 1989.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Discuss the role of essential nutrients in physical, mental and emotional wellness.	K2 (Understand)
CO2: Discuss the role of deficiencies in essential nutrients in the disease process.	K2 (Understand)
CO3: Explain how the standard American diet relates to the disease process.	K2 (Understand)
CO4: Identify five contemporary eating “styles” and lists the pros and cons of each.	K3 (Apply)
CO5: Discuss the concept of whole foods nutrition and its relationship to wellness.	K2 (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	1	-	-	-	-	-	2	-	1	2	1	-

CO2	2	2	2	1	-	-	-	-	-	2	-	1	2	1	-
CO3	2	2	1	1	-	-	-	-	-	2	-	1	2	1	-
CO4	2	3	2	1	-	-	-	-	-	2	-	1	3	1	-
CO5	2	2	2	1	-	-	-	-	-	2	-	1	2	1	-
AVG	2	2.6	0.8	1	-	-	-	-	-	2	-	1	2.2	1	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CSO008	**ICT IN AGRICULTURE**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- A basic understanding of agriculture fundamentals and farming practices is required to grasp system applications.

Course Objectives:

- To introduce the students to areas of agricultural systems in which IT and computers play a major role.
- To also expose the students to IT applications in precision farming, environmental control systems, agricultural systems management and weather prediction models.
- To understand the applications of IT and computer technologies in modern agricultural systems, including precision farming.
- To analyze and apply IT-based solutions for environmental control, crop production management, and greenhouse automation.
- To explore the role of IT in weather prediction models, decision support systems, and e-governance in agriculture.

Unit I	**PRECISION FARMING**	**9**

Precision agriculture and agricultural management – Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.

Unit II	**ENVIRONMENT CONTROL SYSTEMS**	**9**

Artificial light systems, management of crop growth in greenhouses, simulation of CO2 consumption in greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture.

Unit III	AGRICULTURAL SYSTEMS MANAGEMENT	9
Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems.		
Unit IV	**WEATHER PREDICTION MODELS**	**9**
Importance of climate variability and seasonal forecasting, Understanding and predicting world's climate system, Global climatic models and their potential for seasonal climate forecasting, General systems approach to applying seasonal climate forecasts.		
Unit V	**E-GOVERNANCE IN AGRICULTURAL SYSTEMS**	**9**
Expert systems, decision support systems, Agricultural and biological databases, e-commerce, e business systems & applications, Technology enhanced learning systems and solutions, e-learning, Rural development and information society.		
		Total periods: 45 PERIODS

Text Books:

1. National Research Council, "Precision Agriculture in the 21st Century", National Academies Press, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation", 1989.

References:

1. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, New York, 2004.
2. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.

Course Outcomes:	Blooms Taxonomy
CO 1: The students shall be able to understand the applications of IT in remote sensing applications such as Drones etc.	K2 (Understand)
CO2: The students will be able to get a clear understanding of how a greenhouse can be automated and its advantages.	K2 (Understand)
CO3: The students will be able to apply IT principles and concepts for management of field operations.	K3 (Apply)
CO4: The students will get an understanding about weather models, their inputs and applications.	K2 (Understand)
CO5: The students will get an understanding of how IT can be used for e-governance in agriculture.	K2 (Understand)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	3	2	3	1	3	3	1	3	3	3	1	1	1
CO2	3	3	3	3	3	1	3	3	1	3	3	3	1	1	1
CO3	2	3	3	2	3	2	3	2	2	3	3	3	2	2	2
CO4	3	3	3	1	3	2	3	3	1	3	3	3	2	2	2
CO5	2	3	3	2	3	2	3	3	1	3	3	3	2	2	2
AVG	2.4	3	3	1.8	3	1.4	3	2.6	1.2	3	3	3	1.6	1.6	1.6
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23EEO013	**INTRODUCTION TO CONTROL ENGINEERING**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- A basic understanding of mathematics—especially calculus, differential equations, and linear algebra—is required for analyzing control systems.

Course Objectives:

- To introduce the control system components and transfer function model with their graphical representation.
- To understand the analysis of system in time domain along with steady state error.
- To introduce frequency response analysis of systems.
- To accord basic knowledge in design of compensators.
- To introduce the state space models.

Unit I	**MATHEMATICAL MODELLING**	**9**

Introduction – transfer function – simple electrical, mechanical, ,pneumatic , hydraulic and thermal systems– analogies.

Unit II	**FEEDBACK CONTROL SYSTEMS**	**9**

Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

Unit III	**TIME DOMAIN ANALYSIS**	**9**

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

Unit IV	STABILITY ANALYSIS	9
Necessary and sufficient conditions, Routh-Hurwitz criteria of stability,Rootlocus and Bodetechniques,Concept and construction,frequency response.		
Unit V	**STATE SPACE TECHNIQUE**	**9**
State vectors–state space models-Digital Controllers–design aspects.		
Total periods: 45 PERIODS		

Text Books:

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers,2017.
2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014.

References:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.
2. Richard C. Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education,2009.
3. John J.D., Azzo Constantine, H. and HoupisSttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor& Francis Reprint 2009.
4. RamesC.Panda and T. Thyagarajan, "An Introduction to Process Modelling Identification and Control of Engineers", Narosa Publishing House, 2017.
5. M. Gopal, "Control System: Principle and design", McGraw Hill Education, 2012.
6. NPTEL Video Lecture Notes on "Control Engineering "by Prof. S. D. Agashe, IIT Bombay.

Course Outcomes:	**Blooms Taxonomy**
CO 1: To represent and develop systems in different forms using the knowledge gained (L5).	K5 (Evaluate)
CO2: To analyses the system in time and frequency domain (L4).	K4 (Analyze)
CO3: Ability to Derive Transfer function Model of Electrical and Mechanical Systems. K1 (Remember)	K2 (Understand)
CO4: Ability to Obtain the transfer Function by the Reduction of Block diagram & Signal flow graph (L3)	K3 (Apply)
CO5: To analyses the stability of physical systems(L4).	K4 (Analyze)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	-	-	-	1	-	1	-	1	-	-	-
CO2	3	3	3	2	-	-	-	1	-	1	-	1	-	-	-
CO3	2	1	2	1	-	-	-	1	-	1	-	1	-	-	-
CO4	3	3	3	3	-	-	-	1	-	1	-	1	-	-	-
CO5	3	3	3	2	-	-	-	1	-	1	-	1	-	-	-
AVG	2.4	2.2	2.4	2.1	-	-	-	1	-	1	-	1	-	-	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BMO006	PHARMACEUTICAL NANOTECHNOLOGY	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites:

- A basic understanding of pharmaceutical sciences, including dosage forms, biopharmaceutics, and drug delivery principles, is required.

Course Objectives:

- The goal of this course is to provide an insight into the fundamentals of nanotechnology in biomedical and Pharmaceutical research. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales.
- To understand the fundamentals of nanostructures, their preparation, properties, and characterization.
- To apply nanotechnology in biomedical and pharmaceutical fields, including drug delivery and disease diagnosis.
- To explore the use of nanomaterials in cosmetics, reconstructive surgery, and cancer therapy.
- To analyze nanotoxicology, ethical considerations, and risk management in the development of nanoproducts.

Unit I	NANOSTRUCTURES	9

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization- nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

Unit II	NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY	9

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis - in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery – Nanocarriers: sustained, controlled, targeted drug delivery systems

Unit III	NANOTECHNOLOGY IN CANCER THERAPY	9
Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment – mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.		
Unit IV	**NANOTECHNOLOGY IN COSMETICS**	**9**
Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.		
Unit V	**NANOTOXICITY**	**9**
NanoToxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.		
Total periods: 45 PERIODS		

Text Books:
1. Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004
2. Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004
3. Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013
4. Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead "Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics", American Chemical Society, 2006.
References:
1. Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007
2. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004
3. Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

Course Outcomes:	Blooms Taxonomy
CO1: Identify the process for the preparation and characterization of the different nanostructured materials.	K1 (Remember)
CO2: Apply the nanotechnology in biomedical discipline with related to drug delivery and disease diagnosis	K3 (Apply)
CO3: Develop the process, experiments and apply in identifying in a societal and global context.	K6 (Create)
CO4: Design and develop the process with suitable equipment for the preparation of nanomaterials in developing cosmetic products.	K6 (Create)

CO5: Understand the ethical principles to confirm the safety of the nano products with respect to risk assessment and its management.	K2 (Understand)
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	-	-
CO2	2	3	2	-	-	2	-	-	-	-	-	-	2	2	-
CO3	2	2	3	2	2	2	-	-	-	-	-	-	3	2	2
CO4	2	2	2	3	2	3	-	-	-	-	-	-	3	2	2
CO5	2	2	2	-	2	2	-	-	-	-	-	-	3	3	2
AVG	2.1	2.1	2.1	1	1.2	2.1	-	-	-	-	-	-	2.2	1.4	1.2

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

23ECO010	ROBOTIC PROCESS AUTOMATION (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		2	0	2	3

Prerequisites

- Nil

Course Objectives:

- To understand the basic concepts of Robotic Process Automation.
- To expose to the key RPA design and development strategies and methodologies.
- To learn the fundamental RPA logic and structure.
- To explore the Exception Handling, Debugging and Logging operations in RPA.
- To learn to deploy and Maintain the software bot.

Unit I	**INTRODUCTION TO ROBOTIC PROCESS AUTOMATION**	**9**

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

Unit II	**AUTOMATION PROCESS ACTIVITIES**	**9**

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events

Unit III	APP INTEGRATION, RECORDING AND SCRAPING	9
App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.		
Unit IV	**EXCEPTION HANDLING AND CODE MANAGEMENT**	**9**
Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.		
Unit V	**DEPLOYMENT AND MAINTENANCE**	**9**
Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA		

LIST OF EXPERIMENTS

1	Create a Sequence to obtain user inputs display them using a message box;
2	Create a Flowchart to navigate to a desired page based on a condition;
3	Create a State Machine workflow to compare user input with a random number.
4	Build a process in the RPA platform using UI Automation Activities.
5	Create an automation process using key System Activities, Variables and Arguments
6	Also implement Automation using System Trigger
7	Automate login to (web)Email account
8	Recording mouse and keyboard actions.
9	Scraping data from website and writing to CSV
10	Implement Error Handling in RPA platform
11	Web Scraping
12	Email Query Processing

Lecture : 30 PERIODS **Practical : 30 PERIODS** **Total periods: 60 PERIODS**

Text Books:

1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, 2018.

2. Tom Taulli , "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems", Apress publications, 2020.

References:

1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018

2. Richard Murdoch, Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018
3. A Gerardus Blokdyk, “Robotic Process Automation Rpa A Complete Guide “, 2020

Course Outcomes:	**Blooms Taxonomy**
CO1: Identify the importance of democratic, secular and scientific values in harmonious functioning of social life	Understand (K2)
CO2: Practice democratic and scientific values in personal and professional life	Apply (K3)
CO3: Find rational solutions to social problems	Apply (K3)
CO4: Behave in an ethical manner in society	Analyze (K4)
CO5: Practice critical thinking and the pursuit of truth	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	1	3	-	-	-	1	3	3	2	2	2	1
CO2	1	1	3	3	3	-	-	-	1	2	3	1	3	2	1
CO3	2	3	3	3	3	-	-	-	2	3	1	1	3	2	3
CO4	1	2	2	2	2	-	-	-	1	2	1	3	3	3	2
CO5	3	3	3	3	3	-	-	-	3	1	1	1	3	3	1
AVG	2	2.2	2.2	2.4	2.4	-	-	-	1.6	2.2	1.8	1.6	2.8	2.4	1.6

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

OPEN ELECTIVE -III

<table>
<tr><td rowspan="3">23HSO001</td><td rowspan="3">ENGLISH FOR COMPETITIVE EXAMINATIONS
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.
- To improve students' confidence to express their ideas and opinions in formal contexts
- To create awareness of accuracy and precision in communication

Unit I	**VOCABULARY AND VERBAL ABILITY**	**9**

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

Unit II	**GRAMMAR AND SENTENCE SKILLS**	**9**

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject-verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

Unit III	**READING COMPREHENSION**	**9**

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

Unit IV	**WRITING SKILLS**	**9**

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters,
memos, emails – Statements of Purpose – Structure, Content and Style.

Unit V	**LISTENING AND SPEAKING SKILLS**	**9**

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication – Dysfluency -Sentence stress –

Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

Total periods:45 PERIODS

Text Books:

1. R.P.Bhatnagar - General English for Competitive Examinations. Macmillan India Limited, 2009.

References:

1. Educational Testing Service - The Official Guide to the GRE Revised General Test, Tata McGraw Hill, 2010.

2. The Official Guide to the TOEFL Test, Tata McGraw Hill, 2010.

3. R Rajagopalan- General English for Competitive Examinations, McGraw Hill Education (India) Private Limited, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO 1: expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required	Apply (K3)
CO2: identify errors with precision and write with clarity and coherence	Analyze (K4)
CO3: understand the importance of task fulfilment and the usage of task-appropriate vocabulary	Understand (K2)
CO4: communicate effectively in group discussions, presentations and interviews	Apply (K3)
CO5:write topic based essays with precision and accuracy	Create (K6)

CO - PO & PSO Mapping

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

1-low, 2-medium, 3-high, ‘-“- no correlation

<table>
<tr><td rowspan="3">23MG0001</td><td rowspan="3">NGOS AND SUSTAINABLE DEVELOPMENT
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- Understand environmental concerns, pollution types, and waste treatment.
- Explain the role and challenges of NGOs in environmental and community development.
- Analyze sustainability issues, energy resources, and sustainability indicators.
- Understand global and civil society initiatives for environmental sustainability.
- Understand environmental legal frameworks and the role of NGOs in implementation.

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 LEGAL FRAMEWORKS	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. Deeksha Dave & S.S. Katewa — *Textbook of Environmental Studies*, 3rd Edition. Cambridge India, 2024.
2. Ajith Sankar R. N — *Environmental Management*. Oxford University Press India, 2015.
3. Peter Rogers, Kazi F. Jalal & John A. Boyd — *An Introduction to Sustainable Development*. Earthscan, 2007.

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**
CO 1: Have a thorough grounding on the issues and challenges being faced in attaining sustainable development	Understand (K2)
CO2: have a knowledge on the role of NGOs towards sustainable development	Understand (K2)
CO3: present strategies for NGOs in attaining sustainable development	Apply (K3)
CO4: recognize the importance of providing energy, food security and health equity to all members of the society without damaging the environment	Analyze (K4)
CO5: understand the environmental legislations	Understand (K2)

CO - PO & PSO Mapping

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

CO4	3	-	-	-	-	2	-	-	-	-	-	-	3	-	2
CO5	-	-	2	-	-	-	2	-	-	-	-	-	-	2	-
AVG	1.2	0.4	0.4	0.2	0.2	1	0.2	-	-	-	-	-	1.2	1.6	1.4
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MGO002	**DEMOCRACY AND GOOD GOVERNANCE (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Understand the principles of democracy and good governance in India.
- Learn the functioning of key political and governance institutions.
- Know the role of major regulatory bodies.
- Study lobbying groups and their influence on policy.
- Understand India's development models, liberalisation, and the role of civil society and media.

Unit I	**Democracy and Good Governance**	**9**
Structure and Process of Governance: Indian Model of Democracy, Parliament, Party Politics and Electoral Behaviour, Federalism, the Supreme Court and Judicial Activism, Units of Local Governanc		
Unit II	**Regulatory Institutions in India**	**9**
Regulatory Institutions – SEBI, TRAI, Competition Commission of India.		
Unit III	**Lobbying Institutions in India**	**9**
Lobbying Institutions: Chambers of Commerce and Industries, Trade Unions, Farmers Associations, etc.		
Unit IV	**Contemporary Political Economy of Development in India**	**9**
Contemporary Political Economy of Development in India: Policy Debates over Models of Development in India, Recent trends of Liberalisation of Indian Economy in different sectors, E-governance		
Unit V	**Civil Society, Media and Popular Culture**	**9**
Dynamics of Civil Society: New Social Movements, Role of NGO's, Understanding the political significance of Media and Popular Culture.		
		Total 45: Periods

Text Books:
1. Atul Kohli (ed.) – *The Success of India’s Democracy*, Cambridge University Press, 2001.
2.Stuart Corbridge & John Harris – *Reinventing India: Liberalisation, Hindu Nationalism and Popular Democracy*, Oxford University Press, 2000.
3.Jean Dreze & Amartya Sen – *India: Economic Development and Social Opportunity*, Clarendon Press, 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.
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. Jagdish Bhagwati: India in Transition: Freeing The Economy, 1993
6. Smitu Kothari: Social Movements and the Redefinition of Democracy, Boulder, Westview, 1993.
7. Himat Singh: Green Revolution Reconsidered: The Rural World of Punjab, OUP, 2001.

Course Outcomes:	**Blooms Taxonomy**
CO1: Students will understand how Indian democracy and governance operate.	Apply/Analyze (K3,K4)
CO2: They will explain the roles of Parliament, judiciary, federalism, and local bodies.	Understand (K1)
CO3: They will understand the functions of regulatory institutions.	Remember (K2)
CO4: They will identify the impact of lobbying and civil society on policy-making.	Apply/understand (K1,K3)
CO5: They will analyse development trends, liberalisation, e-governance, and media influence.	Apply/Analyze (K3,K4)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	3	2	1	2	2	1	1	1	3	2	-
CO2	3	2	2	2	2	2	1	2	1	1	3	1	3	2	-
CO3	2	2	3	1	2	2	1	2	1	2	2	1	3	3	-
CO4	2	3	2	2	3	2	2	2	3	2	2	1	2	3	-
CO5	1	3	2	2	2	3	2	2	3	3	3	1	2	3	-
AVG	2.2	2.4	2	1.6	2.4	2.1	1.4	2	2	1.8	2.1	1	2.6	2.6	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23EEO001	**RENEWABLE ENERGY TECHNOLOGIES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

Unit I	**ENERGY SCENARIO**	**9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status-Potential of various renewable energy sources-Global energy status-Per capita energy consumption - Future energy plans

Unit II	**SOLAR ENERGY**	**9**

Solar radiation – Measurements of solar radiation and sunshine – Solar spectrum - Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photo voltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

Unit III	**WIND ENERGY**	**9**

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues - Applications.

Unit IV	**BIO-ENERGY**	**9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

Unit V	OCEAN AND GEOTHERMAL ENERGY	9

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact.

Total periods: 45 PERIODS

Text Books:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707

References:

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

Course Outcomes:	**Blooms Taxonomy**
CO 1: Discuss the Indian and global energy scenario.	Understand (K2)
CO2: Describe the various solar energy technologies and its applications.	Understand/Remember (K2/K1)
CO3: Explain the various wind energy technologies.	Understand (K2)
CO4: Explore the various bio-energy technologies.	Apply / Understand(K3/K2)
CO5: Discuss the ocean and geothermal technologies.	Understand (K2)

CO - PO & PSO Mapping

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

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

<table>
<tr><td rowspan="3">23MEO001</td><td rowspan="3">APPLIED DESIGN THINKING
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>0</td><td>2</td><td>3</td></tr>
<tr><td colspan="6">Prerequisites
• Nil</td></tr>
<tr><td colspan="6">Course Objectives:
• Introduce tools & techniques of design thinking for innovative product
• development Illustrate customer-centric product innovation using on simple
• use cases Demonstrate development of Minimum usable Prototypes
• Outline principles of solution concepts & their evaluation
• Describe system thinking principles as applied to complex systems</td></tr>
<tr><td>Unit I</td><td colspan="4">DESIGN THINKING PRINCIPLES</td><td>9</td></tr>
<tr><td colspan="6">Exploring Human-centered Design - Understanding the Innovation process, discovering areas of opportunity, Interviewing & empathy-building techniques, Mitigate validation risk with FIR [Forge Innovation rubric] - Case studies</td></tr>
<tr><td>Unit II</td><td colspan="4">ENDUSER-CENTRIC INNOVATION</td><td>9</td></tr>
<tr><td colspan="6">Importance of customer-centric innovation - Problem Validation and Customer Discovery - Understanding problem significance and problem incidence - Customer Validation. Target user, User persona & user stories. Activity: Customer development process - Customer interviews and f ield visit</td></tr>
<tr><td>Unit III</td><td colspan="4">APPLIED DESIGN THINKING TOOLS</td><td>9</td></tr>
<tr><td colspan="6">Concept of Minimum Usable Prototype [MUP] - MUP challenge brief - Designing & Crafting the value proposition - Designing and Testing Value Proposition; Design a compelling value proposition; Process, tools and techniques of Value Proposition Design</td></tr>
<tr><td>Unit IV</td><td colspan="4">CONCEPT GENERATION</td><td>9</td></tr>
<tr><td colspan="6">Solution Exploration, Concepts Generation and MUP design- Conceptualize the solution concept; explore, iterate and learn; build the right prototype; Assess capability, usability and feasibility. Systematic concept generation; evaluation of technology alternatives and the solution concepts</td></tr>
<tr><td>Unit V</td><td colspan="4">SYSTEM THINKING</td><td>9</td></tr>
<tr><td colspan="6">System Thinking, Understanding Systems, Examples and Understandings, Complex Systems</td></tr>
<tr><td colspan="6" align="right">Total periods:45 PERIODS</td></tr>
</table>

Text Books:

1. Steve Blank, (2013), The four steps to epiphany: Successful strategies for products that win, Wiley
2. Alexander Osterwalder, Yves Pigneur, Gregory Bernarda, Alan Smith, Trish Papadakos, (2014), Value
3. Proposition Design: How to Create Products and Services Customers Want, Wiley
4. Tim Brown,(2012) “Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation”, Harper Business.

References:

1. https://www.ideou.com/pages/design-thinking#process
2. https://blog.forgefor ward.in/product-innovation-rubric-adf5ebdfd356
3. https://blog.forgefor ward.in/evaluating-product-innovations-e8178e58b86e
4. https://blog.forgefor ward.in/user-guide-for-product-innovation-rubric-857181b253dd

Course Outcomes:	**Blooms Taxonomy**
CO1: Explain human-centered design principles and empathy-based innovation techniques.	Understand (K2)
CO2: Identify customer problems using validation methods, personas, and discovery tools.	Understand (K2)
CO3: Develop and test value propositions using MUP and design-thinking tools.	Apply (K3)
CO4: Generate, refine, and evaluate solution concepts and prototypes**.**	Analyze(K4)
CO5: Apply system-thinking principles to understand and analyze complex systems.	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	1	1	–	–	–	–	2	1	1	–	–	–
CO2	1	2	2	2	1	1	–	–	1	2	1	1	–	–	–
CO3	2	2	3	2	3	1	–	–	2	3	2	2	2	1	–
CO4	2	3	3	3	3	1	–	–	2	3	2	3	2	2	–
CO5	2	2	2	3	2	1	1	–	1	2	1	3	1	2	–
AVG	1.8	2	2.4	2.2	2	0.8	0.2	-	1.2	2.4	1.4	2	1	1	-

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

23MEO002	REVERSE ENGINEERING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

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 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", Kluver Academic Publishers, 1996		

Course Outcomes:	**Blooms Taxonomy**
CO1: Apply the fundamental concepts and principles of reverse engineering in product design and development.	Understand (K1)
CO2: Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development	Apply (K3)
CO3: Apply the fundamental concepts and principles of reverse engineering in product design and development.	Remember (K2)
CO4: Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development	Understand (K1)
CO5: Analyze the various legal aspect	Analyze (K4)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	3	1	-	-	-	1	-	1	3	2	-
CO2	3	3	2	3	2	1	2	-	-	-	-	1	3	-	-
CO3	3	2	2	3	3	-	-	-	-	-	-	1	3	2	-
CO4	2	3	2	3	3	-	-	-	-	2	-	2	2	3	-
CO5	2	3	1	-	-	3	-	3	-	2	-	2	-	-	-
AVG	2.6	2.6	2	2.2	2.2	1	0.2	0.6	-	1	-	1.4	2.2	1.4	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO003	SUSTAINABLE MANUFACTURING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To familiarize with trends in sustainable operations.
- To provide the student with the knowledge of strategy to achieve sustainability.
- 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 SUSTAINABILITY**	**9**
Concepts of competitive strategy and manufacturing strategies and development of a strategic improvement programme - Manufacturing strategy in business success strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.		
Unit V	**TRENDS IN SUSTAINABLE OPERATIONS**	**9**
Principles of sustainable operations - Life cycle assessment manufacturing and service activities - influence of product design on operations - Process analysis – Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being.		
		Total periods:45 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, Ęmper, 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 (K2)
CO2: Describe the importance of sustainable practices.	Understand (K2)
CO3: Identify drivers and barriers for the given conditions.	Apply (K3)
CO4: Formulate strategy in sustainable manufacturing.	Analyze (K4)
CO5: Plan for sustainable operation of industry with environmental, cost consciousness.	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	-	-	-	2	2	-	1	1	2	2	2	1
CO2	3	-	-	-	-	-	2	-	-	1	1	2	1	2	2
CO3	3	-	-	-	-	-	2	3	-	1	1	2	1	2	2
CO4	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
CO5	3	-	3	-	-	-	2	2	-	1	1	2	2	2	1
AVG	3	-	1.6	-	-	-	2	1.8	-	1	1	2	1.6	2	1.4
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23EEO002	**ELECTRIC AND HYBRID VEHICLES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the design considerations, performance parameters, and structural requirements of electric vehicles.
- To study various energy sources such as batteries, fuel cells, ultracapacitors, and battery management systems.
- To learn the working principles and characteristics of different electric vehicle motors and drives.
- To understand power converters, switching devices, and motor control strategies used in electric vehicles.
- To explore the components, configurations, control strategies, and economics of hybrid and electric vehicles.

Unit I	**DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES**	**9**

Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.

Unit II	**ENERGY SOURCES**	**9**

Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion-Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System.		
Unit III	**MOTORS AND DRIVES**	**9**
Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics		
Unit IV	**POWER CONVERTERS AND CONTROLLERS**	**9**
Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes		
Unit V	**HYBRID AND ELECTRIC VEHICLES**	**9**
Main components and working principles of a hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.		
		Total periods:45

Text Books:

1. Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
2. Mehrdad Ehsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRCPress,2005.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2. Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005
3. Ron HodKinson, “Light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005.

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the operation and architecture of electric and hybrid vehicles	Understand (K2)
CO2: Identify various energy source options like battery and fuel cell	Understand (K2)
CO3: Select suitable electric motor for applications in hybrid and electric vehicles.	Analyze (K4)
CO4: Explain the role of power electronics in hybrid and electric vehicles	Understand (K2)
CO5: Analyze the energy and design requirement for hybrid and electric vehicles**.**	Analyze (K4)

CO - PO & PSO Mapping

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

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

23ECO002	**SPACE ENGINEERING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

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

Course Outcomes:	**Blooms Taxonomy**
CO1: Apply the fundamental concepts and principles of reverse engineering in product design and development.	Apply(K3)
CO2: Apply the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.	Apply(K3)
CO3: Apply the concept and principles of material identification and process verification in reverse engineering of product design and development.	Apply(K3)
CO4: Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering of product design and development.	Apply(K3)
CO5: Analyze the various legal aspect	Analyze(K4)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	2	-	-	-	-	1	-	2	3	2	2
CO2	3	2	3	3	2	-	-	-	-	1	-	2	3	2	2
CO3	3	2	2	3	3	-	-	-	-	1	-	2	3	3	2
CO4	3	2	3	2	3	-	-	-	-	2	-	3	2	3	3
CO5	2	3	2	-	-	-	2	3	-	2	-	1	1	1	3
AVG	2.8	2.2	2.6	2	2	-	0.2	0.3	-	1.4	-	2	2.4	2.2	2.4

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

23MGO004	INDUSTRIAL MANAGEMENT (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

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. O.P. Khanna, Industrial Engineering and Manageme**nt**, Dhanpat Rai Publications, New Delhi, 2010.

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 (K2)
CO2: Identify the group conflicts and its causes.	Analyze (K4)
CO3: Perform swot analysis	Apply (K3)
CO4: Analyze the learning curves	Analyze (K4)
CO5: Understand the placement and performance appraisal	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	-	-	-	-	2	1	-	-	2	1	-
CO2	-	3	2	3	-	-	-	-	-	2	-	-	-	2	-
CO3	2	3	2	3	-	-	-	-	-	-	1	2	3	2	3
CO4	2	2	3	3	-	-	-	-	-	-	-	3	3	3	-
CO5	2	2	-	-	-	-	-	-	-	2	-	-	-	2	-
AVG	1.6	2.2	1.4	1.8	-	-	-	-	0.4	1	0.2	1	1.6	2	0.6

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

<table>
<tr><td rowspan="3">23MGO003</td><td rowspan="3">QUALITY ENGINEERING
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">Prerequisites
• Nil</td></tr>
<tr><td colspan="6">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 thespecialcontrolproceduresforserviceandprocessorientedindustries.
• Analyzing and understanding the process capability study.
• Developing the acceptance sampling procedures for incoming raw material.</td></tr>
<tr><td>Unit I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">Quality Dimensions–Quality definitions–Inspection-Quality control–Quality Assurance–Quality planning-Quality costs–Economics of quality– Quality loss function</td></tr>
<tr><td>Unit II</td><td colspan="4">CONTROLCHARTS</td><td>9</td></tr>
<tr><td colspan="6">Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u- Construction and application.</td></tr>
<tr><td>Unit III</td><td colspan="4">SPECIAL CONTROL PROCEDURES</td><td>9</td></tr>
<tr><td colspan="6">Warning and modified control limits, control chart for individual measurements, multi-vari chart, Xchart with a linear trend, chart for moving averages and ranges, cumulative-sum and exponentially weighted moving average control charts.</td></tr>
<tr><td>Unit IV</td><td colspan="4">STATISTICALPROCESSCONTROL</td><td>9</td></tr>
<tr><td colspan="6">Process stability, process capability analysis using a Histogram or probability plots and control chart.Gauge capability studies,setting specification limits.</td></tr>
<tr><td>Unit V</td><td colspan="4">ACCEPTANCESAMPLING</td><td>9</td></tr>
<tr><td colspan="6">The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables,MIL-STD-105DandMIL-STD-414E&IS2500 standards.</td></tr>
<tr><td colspan="6" align="right">Total periods:45</td></tr>
<tr><td colspan="6">Text Books:</td></tr>
<tr><td colspan="6">1. Montgomery, D. C., “Introduction to Statistical Quality Control”, 6th Edition, John Wiley & Sons, New York, 2009.</td></tr>
</table>

2. Grant, E. L. and Leavenworth, R. S., **"Statistical Quality Control"**, 7th Edition, McGraw-Hill International Editions, New York, 1996.

References:

1. Juran, J. M. and Gryna, F. M., **"Juran's Quality Planning and Analysis for Enterprise Quality"**, McGraw-Hill Publishing Co., New York, 1993.

Course Outcomes:	**Blooms Taxonomy**
CO1: Control the quality of processes using control charts for variables in manufacturing industries.	Apply (K3)
CO2: Control the occurrence of defective product and the defects in manufacturing companies.	Apply (K3)
CO3: Control the occurrence of defects in services.	Apply (K3)
CO4: Analyzing and understanding the process capability study.	Analyze (K4)
CO5: Developing the acceptance sampling procedures for incoming raw material.	Analyze (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	2	-	-	1	-	-	-	-	3	2	-
CO2	3	2	-	-	2	-	-	1	-	-	-	-	3	2	-
CO3	3	2	-	-	2	-	-	1	-	-	-	-	2	2	-
CO4	2	3	2	-	1	-	-	2	-	-	-	-	2	3	-
CO5	3	2	-	-	3	-	-	2	-	-	-	-	3	2	1
AVG	2.8	2.4	0.4	-	2	-	-	1.4	-	-	-	-	2.6	2.2	0.2

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

23CHO001	**FIRE SAFETY ENGINEERING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To enable the students to acquire knowledge of Fire and Safety Studies
- To learn about the effect of fire on materials used for construction, the method of test for non-combustibility & fire resistance
- To learn about fire area, fire stopped areas and different types of fire-resistant doors
- To learn about the method of fire protection of structural members and their repair due to fire damage.
- To develop safety professionals for both technical and management through systematic and

quality-based study programmes		
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 (K2)
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.	Apply (K3)
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.	Apply (K3)
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(K3)
CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.	Analyze(K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	-	1	2	-	-	1	-	2	3	2	1
CO2	3	3	3	2	2	1	2	-	-	1	-	2	3	3	2
CO3	2	2	3	2	1	1	3	1	-	1	-	2	2	3	2
CO4	3	2	3	2	2	2	2	1	-	1	-	2	3	3	2
CO5	2	3	2	1	-	2	1	3	2	3	2	2	1	2	3
AVG	2.6	2.4	2.4	1.8	1	1.4	2	1	0.4	1.4	0.4	2	1.8	2.6	2

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

<table>
<tr><td rowspan="3">23CEO001</td><td rowspan="3">INTRODUCTION TO NON-DESTRUCTIVE TESTING
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- Understanding the basic importance of NDT in quality assurance.
- Imbibing the basic principles of various NDT techniques, its applications, limitations, codes and standards.
- Equipping themselves to locate a flaw in various materials, products.
- Applying apply the testing methods for inspecting materials in accordance with industry specifications and standards.
- Acquiring the knowledge on the selection of the suitable NDT technique for a given application

Unit I	**INTRODUCTION TO NDT & VISUAL TESTING**	**9**

Concepts of Non-destructive testing-relative merits and limitations-NDT Versus mechanical testing, Fundamentals of Visual Testing – vision, lighting, material attributes, environmental factors, visual perception, direct and indirect methods – mirrors, magnifiers, boroscopes and fibroscopes – light sources and special lighting.

Unit II	**LIQUID PENETRANT & MAGNETIC PARTICLE TESTING**	**9**

Liquid Penetrant Inspection: principle, applications, advantages and limitations, dyes, developers and cleaners, Methods & Interpretation. Magnetic Particle Inspection: Principles, applications, magnetization methods, magnetic particles, Testing Procedure, demagnetization, advantages and limitations, – Interpretation and evaluation of test indications.

Unit III	**EDDY CURRENT TESTING & THERMOGRAPHY**	**9**

Eddy Current Testing: Generation of eddy currents– properties– eddy current sensing elements, probes, Instrumentation, Types of arrangement, applications, advantages, limitations – Factors affecting sensing elements and coil impedance, calibration, Interpretation/Evaluation. Thermography- Principle, Contact & Non-Contact inspection methods, Active & Passive methods, Liquid Crystal – Concept, example, advantages & limitations. Electromagnetic spectrum, infrared thermography- approaches, IR detectors, Instrumentation and methods, applications.

Unit IV	ULTRASONIC TESTING & AET	9
Ultrasonic Testing: Types of ultrasonic waves, characteristics, attenuation, couplants, probes, EMAT. Inspection methods-pulse echo, transmission and phased array techniques, types of scanning and displays, angle beam inspection of welds, time of flight diffraction (TOFD) technique, Thickness determination by ultrasonic method, Study of A, B and C scan presentations, calibration. Acoustic Emission Technique – Introduction, Types of AE signal, AE wave propagation, Source location, Kaiser effect, AE transducers, Principle, AE parameters, AE instrumentation, Advantages & Limitations, Interpretation of Results, Applications.		
Unit V	**RADIOGRAPHY TESTING**	**9**
Sources-X-rays and Gamma rays and their characteristics-absorption, scattering. Filters and screens, Imaging modalities-film radiography and digital radiography (Computed, Direct, Real Time, CT scan). Problems in shadow formation, exposure factors, inverse square law, exposure charts, Penetrameters, safety in radiography.		
Total periods: 45		

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.	Understanding (K2)
CO2: Have a basic knowledge of surface NDE techniques which enables to carry out various inspection in accordance with the established procedures.	Understanding/ Applying (K2, K3)

CO3: Calibrate the instrument and inspect for in-service damage in the components by means of Eddy current testing as well as Thermography testing.	Applying (K3)
CO4: Differentiate various techniques of UT and AET and select appropriate NDT methods for better evaluation.	Analyzing (K4)
CO5: Interpret the results of Radiography testing and also have the ability to analyse the influence of various parameters on the testing.	Analyzing (K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	-	-	2	2	-	-	-	2	1	2	-
CO2	3	1	2	2	-	-	2	2	-	-	-	2	2	2	1
CO3	3	2	1	2	-	-	2	2	-	-	-	2	2	2	-
CO4	3	1	2	2	-	-	2	2	-	-	-	2	2	2	2
CO5	3	2	2	2	-	-	2	2	-	-	-	2	2	2	1
AVG	2.8	1.8	1.8	2.2	-	-	2	2	-	-	-	2	1.8	2	0.8

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

23MEO004	MECHATRONICS (Common to BME,BT,CIVIL,CHEMICAL,ECE, EEE,MECH)	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

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. Histand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

Course Outcomes:	Blooms Taxonomy
CO1: Select sensors to develop mechatronics systems.	Apply (K3)
CO2: Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.	Understand (K2)
CO3: Design appropriate interfacing circuits to connect I/O devices with microprocessor.	Understand (K2)

CO4: Apply PLC as a controller in mechatronics system.	Create (K6)
CO5: Design and develop the apt mechatronics system for an application.	Apply (K3)
CO - PO & PSO Mapping	

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

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

23MEO005	**FOUNDATION OF ROBOTICS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To study the kinematics, drive systems and programming of robots.
- To study the basics of robot laws and transmission systems.
- To familiarize students with the concepts and techniques of robot manipulator, its kinematics.
- To familiarize students with the various Programming and Machine Vision application in robots.
- To build confidence among students to evaluate, choose and incorporate robots in engineering systems.

Unit I	**FUNDAMENTALS OF ROBOT**	**9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions – Need for Robots – Different Applications.

Unit II	**ROBOT KINEMATICS**	**9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations and problems. Homogeneous transformation matrices, translation and rotation matrices.

Unit III	ROBOT DRIVE SYSTEMS AND END EFFECTORS	9
Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper		
Unit IV	**SENSORS IN ROBOTICS**	**9**
Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, safety considerations in robotic cell, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.		
Unit V	**PROGRAMMING AND APPLICATIONS OF ROBOT**	**9**
Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.		
Total periods: 45		

Text Books:

1.Ganesh.S.Hedge,"A textbook of Industrial Robotics", Lakshmi Publications, 2006

2. Mikell.P.Groover , "Industrial Robotics – Technology, Programming and applications" McGraw Hill 2ND edition
2012.

References:

1. Fu K.S. Gonalz R.C. and ice C.S.G."Robotics Control, Sensing, Vision and Intelligence", McGraw Hill book co.
2007.

2. YoramKoren, "Robotics for Engineers", McGraw Hill Book, Co., 2002.

3. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill 2005.

4.John. J.Craig, "Introduction to Robotics: Mechanics and Control" 2nd Edition, 2002.

5. Jazar, "Theory of Applied Robotics: Kinematics, Dynamics and Control", Springer India reprint, 2010.

Course Outcomes:	Blooms Taxonomy
CO1: Understand the effect of fire on materials used for construction	Understand (K2)

CO2: Understand the method of test for non-combustibility and fire resistance; and will be able to select different structural elements and their dimensions for a particular fire resistance rating of a building.	Apply (K3)
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.	Apply (K3)
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(K3)
CO5: Describe the safety techniques and improve the analytical and intelligence to take the right decision at right time.	Analyze(K4)

CO - PO & PSO Mapping

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

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

23MEO006	**FUNDAMENTALS OF AERONAUTICAL ENGINEERING** **(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

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**	**9**

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**	**9**
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**
types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains-Hooke's law- stress-strain diagrams- elastic constants-Factor of Safety.		
Unit V	**BASICS OF PROPULSION**	**9**
Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust production-Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.		
Total periods:45		

Text Books:	
1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015	
2. 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 Kataraia & sons, 2015	
2. KERMODE , "FLIGHT WITHOUT FORMULAE", -, Pitman; 4th Revised edition 1989	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Illustrate the history of aircraft & developments over the years	Understand (K2)
CO2: Ability to identify the types & classifications of components and control systems	Apply (K3)
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere	Understand (K2)

CO4: Identify the types of fuselage and constructions**.**	Analyze (K4)
CO5: Distinguish the types of Engines and explain the principles of Rocket	Create (K6)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	-	1	-	-	1	-	-	-	-	2	1	-
CO2	3	2	-	-	2	-	-	2	-	-	-	-	3	2	-
CO3	2	2	-	-	2	-	-	1	-	-	-	-	2	2	-
CO4	2	3	2	-	1	-	-	2	-	-	-	-	2	3	-
CO5	3	2	-	-	3	-	-	2	-	-	-	-	3	2	1
AVG	2.4	2	0.4	-	1.8	-	-	1.6	-	-	-	-	2.4	2	0.2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO002	**REMOTE SENSING CONCEPTS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Provide fundamental knowledge about remote sensing principles, electromagnetic radiation, and radiation laws.
- Enable students to understand how electromagnetic radiation interacts with the atmosphere and Earth's surface materials.
- Introduce orbital mechanics, satellite orbits, and various remote sensing platforms.
- Familiarize students with different types of remote sensors, sensing techniques, and characteristics of Indian Earth observation systems.
- Train students in data products, image interpretation, and basic digital image processing techniques related to remote sensing.

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 :45 Periods

Text Books:

1.Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, *Remote Sensing and Image Interpretation*, John Wiley & Sons, New York, 2015.

2.George Joseph, C. Jeganathan, *Fundamentals of Remote Sensing*, 3rd Edition, Universities Press, 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**
CO 1: Understand the fundamental concepts and physical laws governing remote sensing.	(K2) – Understand
CO2: Explain the interactions between electromagnetic radiation, atmosphere, and Earth materials.	(K2)– Understand
CO3: Demonstrate knowledge of satellite orbits, orbital mechanics, and classification of remote sensing platforms**.**	(K3) – Apply
CO4: Understand the principles, types, and characteristics of various remote sensors**.**	(K3) – Apply
CO5: Apply knowledge of image products, interpretation techniques, and basic digital image processing.	(K3) – Apply

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	3	3	3	3
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
CO3	3	-	-	-	-	-	-	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
AVG	3	1.2	1.2	1.2	1.2	-	-	-	-	-	-	2.4	3	3	3

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

23CEO003	**URBAN AGRICULTURE (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Understand the benefits of urban agriculture, including economic, environmental, social, educational, and health aspects.
- Explain the principles, structures, and components of vertical farming, green walls, roof gardens, and indoor planting systems.
- Apply knowledge of soilless cultivation techniques such as hydroponics, aeroponics, and aquaponics, including merits, limitations, and challenges.
- Analyze modern urban gardening concepts, including vertical pipe cultivation, micro-irrigation systems, rooftop greenhouses, polyhouses, and shade net crop production.

- Evaluate waste management practices in urban agriculture, including recycling organic and garden waste, solid waste handling, and minimizing residues from pesticides and fungicides.

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		
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	Apply (K3)
CO2: Explain different methods of crop production on roof tops	Understand (K2)
CO3: Explain nutrient and pest management for crop production on roof tops	Apply (K3)
CO4: Illustrate crop water requirement and irrigation water management on roof tops	Analyze (K4)
CO5: Explain the concept of waste management on roof tops	Analyze (K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	2	-	-	-	-	3	2	-
CO2	3	2	-	-	2	-	-	1	-	-	-	-	2	2	-
CO3	3	2	-	-	2	-	-	2	-	-	-	-	3	2	-
CO4	2	3	2	-	2	-	-	2	-	-	-	-	2	3	-
CO5	3	2	-	-	3	-	-	2	-	-	-	-	3	2	1
AVG	2.8	2.2	0.4	-	2.2	-	-	1.8	-	-	-	-	2.6	2.2	0.2

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

23CEO004	DRINKING WATER SUPPLY AND TREATMENT (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To understand the sources of water and their quality for public water supply.
- To learn how water is conveyed from the source using pipes, pumps, and intake structures.
- To understand basic water treatment processes used to make water safe for drinking.
- To learn advanced water treatment methods like softening, RO, ion exchange, and defluoridation.
- To understand water distribution systems in cities and buildings, including pipes, reservoirs, and plumbing.

Unit I	SOURCES OF WATER	9

Public water supply system – Planning, Objectives, Design period, Population forecasting; Water demand – Sources of water and their characteristics, Surface and Groundwater – Impounding Reservoir – Development and selection of source – Source Water quality – Characterization – Significance – Drinking Water quality standards.

Unit II	CONVEYANCE FROM THE SOURCE	9
Water supply – intake structures – Functions; Pipes and conduits for water – Pipe materials – Hydraulics of flow in pipes – Transmission main design – Laying, jointing and testing of pipes – appurtenances – Types and capacity of pumps – Selection of pumps and pipe materials.		
Unit III	**WATER TREATMENT**	**9**
Objectives – Unit operations and processes – Principles, functions, and design of water treatment plant units, aerators of flash mixers, Coagulation and flocculation –- sand filters - Disinfection -– Construction, Operation and Maintenance aspects.		
Unit IV	**ADVANCED WATER TREATMENT**	**9**
Water softening – Desalination- R.O. Plant – demineralization – Adsorption - Ion exchange– Membrane Systems - Iron and Manganese removal - Defluoridation - Construction and Operation and Maintenance aspects		
Unit V	**WATER DISTRIBUTION AND SUPPLY**	**9**
Requirements of water distribution – Components – Selection of pipe material – Service reservoirs - Functions – Network design – Economics - Computer applications – Appurtenances – Leak detection - Principles of design of water supply in buildings – House service connection – Fixtures and fittings, systems of plumbing and types of plumbing.		
	Total periods: 45	

Text Books:

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008.
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, “ Water supply Engineering” Lakshmi publication private limited, New Delhi, 2016.
3. Rangwala "Water Supply and Sanitary Engineering", February 2022
4. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

References:

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" , Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., “Elememts of public Health Engineering”, S.Chand and Company Ltd,

Course Outcomes:	**Blooms Taxonomy**
CO1: An understanding of water quality criteria and standards, and their relation to public Health	Understand (K2)
CO2: The ability to design the water conveyance system	Apply (K3)
CO3: The knowledge in various unit operations and processes in water treatment	Understand (K2)
CO4: An ability to understand the various systems for advanced water treatment	Understand (K2)
CO5: An insight into the structure of drinking water distribution system	Understand (K2)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	1	-	2	2	2	-	1	-	2	3	2	1
CO2	3	2	3	2	2	-	-	-	-	1	1	2	3	3	2
CO3	3	2	1	2	2	-	-	-	-	1	-	2	3	2	2
CO4	2	2	2	2	3	-	-	-	-	1	-	2	2	3	2
CO5	2	1	-	1	-	2	2	-	1	2	-	2	2	2	3
AVG	2.6	1.8	1.2	1.6	1.4	0.8	0.8	0.4	0.2	1.2	0.2	2	2..6	2.4	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23EEO003	**ELECTRIC VEHICLE TECHNOLOGY (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

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. Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition, 2020.

References:

1. Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition, Power Electronics and Motor Drives, CRC Press, 2011
2. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
3.Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition, 10th Impression 2021.
4. Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
5. Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
6. 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 (K2)
CO2: Acquired the concepts of power devices and power converters	Understand (K2)
CO3: Able to understand the control for DC and AC drive systems.	Apply (K3)
CO4: Learned the electric vehicle architecture and power train components.	Understand (K2)
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	2	2	-	-	3	-	-	3	-	-	-	3	3	3
CO3	3	-	-	3	-	2	2	-	-	-	-	-	3	3	3
CO4	3	2	2	-	3	-	-	-	-	-	-	-	3	3	3
CO5	3	-	2	-	-	-	-	-	-	-	2	-	3	3	3
AVG	3	1.2	1.2	0.6	0.6	1	0.4	-	0.6	-	0.4	-	3	3	3

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

23EEO004	INTRODUCTION TO PLC PROGRAMMING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

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

Text Books:	
1. Frank Petruzzula, 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. MadhuchanndMitra and SamerjitSengupta, Programmable Logic Controllers Industrial Automation an Introduction, Penram International Publishing Pvt. Ltd.	
2. J. R. Hackworth and F. D. Hackworth, Programmable Logic Controllers Principles andApplications, Pearson publication	
Course Outcomes:	**Blooms Taxonomy**
CO1: Know the basic requirement of a PLC input/output devices and architecture.	Remembering (K1)
CO2: Ability to apply Basics Instruction Sets used for ladder Logic and Function Block Programming.	Understanding (K2)
CO3: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function BIock	Applying (K3)
CO4: Able to develop a PLC logic for a specific application on real world problem.	Evaluating (K5)
CO5: Ability to Understand the Concepts of Communication used for PLC/SCADA.	Remembering (K1)
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	-	-	-	-	-
CO2	3	3	2	-	-	-	-	1	-	1	2	-	-	-	2
CO3	3	3	3	3	1	-	-	1	-	1	-	-	3	3	-
CO4	3	3	-	3	3	-	-	1	-	1	-	-	3	3	-
CO5	3	3	3	2	1	-	-	1	-	1	-	-	3	3	3
AVG	3	2.8	1.8	1.6	1	-	-	1	-	1	0.4	-	1.8	1.8	1

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

23CHO002	NANO TECHNOLOGY (Department of Biomedical Engineering)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To understand the fundamental properties of nanomaterials including structural, physical, chemical, and surface characteristics.
- To acquire knowledge of various synthesis techniques for nanomaterials using top-down and bottom-up approaches.
- To describe the shape, size, structure, and interface effects in nanocomposites and their applications.
- To understand and apply different characterization techniques for analyzing nanomaterials.
- To explore and evaluate the applications of nanomaterials in fields such as electronics, energy, medicine, and environmental remediation.

Unit I	INTRODUCTION	9

General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

Unit II	SYNTHESIS OF NANOMATERIALS	9

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

Unit III	NANO COMPOSITES	9

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

Unit IV	NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES	9

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

Unit V	APPLICATIONS OF NANO MATERIALS	9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

Total periods:45 PERIODS	
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	
Course Outcomes:	**Blooms Taxonomy**
CO 1: understand the basic properties such as structural, physical, chemical properties of nanomaterials and their applications.	Understand (K2)
CO2: able to acquire knowledge about the different types of nano material synthesis	Understand (K2)
CO3: describes about the shape, size,structure of composite nano materials and their interference	Apply (K3)
CO4: understand the different characterization techniques for nanomaterials	Analyze (K4)
CO5: develop a deeper knowledge in the application of nanomaterials in different fields.	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	2	3	3	-	-	-	1	1	3	1	3	2	1
CO2	2	3	1	3	3	-	-	-	1	1	2	3	3	3	2
CO3	2	2	2	3	3	1	1	-	1	1	2	3	3	3	2
CO4	2	2	1	3	3	1	1	1	1	-	3	1	3	3	3
CO5	2	2	1	3	3	1	1	1	1	-	3	2	3	3	3
AVG	2.2	2.2	1.4	3	3	0.6	0.6	0.4	1	0.6	2.6	2	3	2.8	2.2

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

<table>
<tr><td rowspan="3">23MEO007</td><td rowspan="3">FUNCTIONAL MATERIALS
(Department of Biomedical Engineering)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- NIL

Course Objectives:

- Understand the basics, types, and functional importance of advanced materials.
- Learn the principles and applications of molecular self-assembly.
- Study key bio-inspired materials and their engineering relevance.
- Understand smart materials and their technological applications.
- Learn the fundamentals of polymer electronics and modern display technologies

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 composities.

Unit V	MATERIALS FOR POLYMER ELECTRONICS	9

Polymers for Electronics, Organic Light Emitting Diodes, Working Principle of OLEDs, Illustrated Examples, Organic Field-Effect Transistors Operating Principle, Design Considerations, Polymer FETs vs Inorganic FETs, Liquid Crystal Displays, Engineering Aspects of Flat Panel Displays, Intelligent Polymers for Data Storage, Polymer-based Data Storage-Principle, Magnetic Vs. Polymer-based Data Storage.

Total periods:45

Text Books:

1. Vijayamohanan K. Pillai and MeeraParthasarathy, “Functional Materials: A chemist’s perpective”, Universities

Press Hyderabad (2012).
References:
1. Stephen Manne "Biomimetic Materials Chemistry" Wiley-VCH Newyork, 1966.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Describe the fundamentals, classification, and functional behavior of advanced materials.	Understand (K2)
CO2: Explain molecular self-assembly mechanisms and outline their technological applications.	Understand (K2)
CO3: Identify and relate bio-inspired materials to their natural analogues and engineering uses.	Understand (K2)
CO4: Discuss the principles, properties, and applications of smart and intelligent materials.	Apply (K3)
CO5: Analyze materials used in polymer electronics and compare major electronic display technologies.	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	2	-	-	-	-	-	-	-	1	-	1
CO2	3	2	1	1	2	-	-	-	-	-	-	-	1	-	1
CO3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
CO5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVG	3	2	1	1	2	-	-	0.6	-	-	-	-	1	-	1

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

23BMO001	**BIOMEDICAL INSTRUMENTATION (Department Of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the origin of various biological signals and electrode configurations specific tobio-potential measurements.
- To understand the characteristics of Bio signals.
- To understand the design of bioamplifiers
- To explain the different techniques used for measurement of non-electrical bio- parameters.
- To explain the biochemical measurement techniques as applicable for diagnosis andtreatment.

Unit I	ELECTRODE CONFIGURATIONS	9

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode– skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

Unit II	BIOSIGNAL CHARACTERISTICS	9

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12lead system. EEG - EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode.

Unit III	BIOAMPLIFIERS	9

Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference

Unit IV	MEASUREMENT OF BIO SIGNALS	9

Temperature, respiration rate and pulse rate measurements. Blood Pressure - indirect methods: auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements

Unit V	BIOCHEMICAL MEASUREMENTS	9

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter,flame photometer, spectrophotometer, blood cell counter, auto analyzer.

Total periods: 45 PERIODS

Text Books:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prenticehall of India, New Delhi, 2015.

2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, WileyIndia Pvt Ltd, New Delhi, 2015.

3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, NewDelhi, 2003.

References:	
1. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", second edition, Academic Press,2005.	
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology",Pearson Education, 2004.	
Course Outcomes:	**Blooms Taxonomy**
CO1: Illustrate the origin of various biological signals and their characteristic**s.**	Understanding
CO2: Gain knowledge on characteristics of bio signals.	Remembering / Understanding
CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals	Understanding / Applying
CO4: Explain the different measurement techniques for non-electrical bio-parameters.	Understanding / Applying
CO5: Explain the biochemical measurement techniques as applicable for diagnosis and further treatment**.**	Understanding / Applying / Analyzing
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	2	-
CO2	3	2	-	1	2	-	-	-	-	-	-	1	2	3	-
CO3	3	2	2	1	3	-	-	-	-	-	-	1	3	3	-
CO4	2	3	2	3	2	-	-	-	-	-	-	1	3	3	-
CO5	2	2	2	2	1	-	-	-	-	-	-	2	2	3	-
AVG	2.6	2.2	1.2	1.4	1.8	-	-	-	-	-	-	1.2	2.6	2.8	-

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

CO2: Gain knowledge on characteristics of bio signals.	Remembering / Understanding
CO3: Gain knowledge on various amplifiers involved in monitoring and transmission of biosignals	Understanding / Applying
CO4: Explain the different measurement techniques for non-electrical bio-parameters.	Understanding / Applying
CO5: Explain the biochemical measurement techniques as applicable for diagnosis and furthertreatment**.**	Understanding / Applying / Analyzing

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	2	-
CO2	3	2	-	1	2	-	-	-	-	-	-	1	2	3	-
CO3	3	2	2	1	3	-	-	-	-	-	-	1	3	3	-
CO4	2	3	2	3	2	-	-	-	-	-	-	1	3	3	-
CO5	2	2	2	2	1	-	-	-	-	-	-	2	2	3	-
AVG	2.6	2.2	1.2	1.4	1.8	-	-	-	-	-	-	1.2	2.6	2.8	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BTO001	**TRADITIONAL INDIAN FOODS** **(Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Understand the cultural, religious, and historical significance of food.
- Compare traditional and modern food processing methods.
- Explore regional and traditional Indian food patterns.
- Examine commercial production and marketing of traditional foods.
- Evaluate the health, nutritional, and environmental aspects of traditional foods.

Unit I	**HISTORICAL AND CULTURAL PERSPECTIVES**	**9**

Food production and accessibility - subsistence foraging, horticulture, agriculture and pastoralization, origin of agriculture, earliest crops grown. Food as source of physical sustenance, food as religious and cultural symbols; importance of food in understanding human culture - variability, diversity, from basic ingredients to food preparation; impact of customs and traditions on food habits, heterogeneity within cultures (social groups) and specific social contexts - festive occasions, specific religious festivals, mourning etc. Kosher, Halal foods; foods for religious and other fasts.

Unit II	**TRADITIONAL METHODS OF FOOD PROCESSING**	**9**

Traditional methods of milling grains – rice, wheat and corn – equipments and processes as compared to modern methods. Equipments and processes for edible oil extraction, paneer, butter and ghee manufacture – comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons.

Traditional methods of food preservation – sundrying, osmotic drying, brining, pickling and smoking.

Unit III	**TRADITIONAL FOOD PATTERNS**	**9**

Typical breakfast, meal and snack foods of different regions of India.Regional foods that have gone Pan Indian / Global. Popular regional foods; Traditional fermented foods,pickles and preserves, beverages, snacks, desserts and sweets, street foods; IPR issues in traditional foods

Unit IV	**COMMERCIAL PRODUCTION OF TRADITIONAL FOODS**	**9**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods – types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods – ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters.

Unit V	**HEALTH ASPECTS OF TRADIONAL FOODS**	**9**

Comparison of traditional foods with typical fast foods / junk foods – cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total periods:45

Text Books:

1. Sen, Colleen Taylor “Food Culture in India” Greenwood Press, 2005.
2. Davidar, Ruth N. “Indian Food Science: A Health and Nutrition Guide to Traditional Recipes: East West Books, 2001.

References:

1. Mohammed Al-Khusaibi, Nasser Al-Habsi & Mohammad Shafiur Rahman, *Traditional Foods: History, Preparation, Processing and Safety*, Springer, 2019
2. Mohammad Shafiur Rahman, *Handbook of Food Preservation*, 3rd Edition, Taylor & Francis, 2016.
3. Swarnendu Roy, Prakasan Nisha & Rakhi Chakraborty (eds.), *Traditional Foods: The Reinvented Superfoods*, Springer, 2024.
4. Isaac Shearn et al., *Perspectives: An Open Introduction to Cultural Anthropology*, 2nd Ed., American Anthropological Association Press, (chapter on “Subsistence”)

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain the evolution of food systems and the cultural, religious, and social significance of food.	Understand (K2)
CO2: Compare traditional and modern methods of food processing, preservation, and nutrient retention**.**	Understand (K2)
CO3: Identify and classify regional foods, fermented products, and traditional beverages, and explain their cultural importance**.**	Analyze (K4)

CO4: Examine commercial production, packaging, and marketing strategies for traditional foods and their economic impact.												Apply (K3)		
CO5: Assess the nutritional, health, and environmental benefits of traditional foods compared to fast foods.												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	2	–	–	–	–	–	–	–	1	–	1
CO2	3	2	2	2	2	–	–	–	–	–	–	–	1	1	1
CO3	3	2	2	1	2	–	–	1	–	–	–	–	1	1	1
CO4	3	2	2	2	3	–	–	1	–	–	–	–	1	2	2
CO5	3	2	2	2	2	2	–	1	2	–	–	–	1	1	2
AVG	3	2	1.8	1.4	2.2	0.4	-	0.6	0.4	-	-	-	1	1	1.4
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23BTO002	**INTRODUCTION TO FOOD PROCESSING (Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To introduce the students to the fundamentals of food processing and its importance for producers, manufacturers, and consumers.
- To familiarize students with different sources of food, their classification, and the significance of processing raw materials.
- To explain various methods of food handling, storage, and preservation to maintain quality and safety.
- To provide knowledge of large-scale food processing techniques, including milling, pasteurization, canning, drying, and fermentation.
- To sensitize students about food hygiene, safety measures, and waste management in food processing operations.

Unit I	**PROCESSING OF FOOD AND ITS IMPORTANCE**	**9**

Source of food - plant, animal and microbial origin; different foods and groups of foods as raw materials for processing – cereals, pulses, grains, vegetables and fruits, milk and animal foods, sea weeds, algae, oil seeds & fats, sugars, tea, coffee, cocoa, spices and condiments, additives; need and significance of processing these foods.

Unit II	METHODS OF FOOD HANDLING AND STORAGE	9
Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods.		
Unit III	**LARGE-SCALE FOOD PROCESSING**	**9**
Milling of grains and pulses; edible oil extraction; Pasteurisation of milk and yoghurt; canning and bottling of foods; drying – Traditional and modern methods of drying, Dehydration of fruits, vegetables, milk, animal products etc; preservation by use of acid, sugar and salt; Pickling and curing with microorganisms, use of salt, and microbial fermentation; frying, baking, extrusion cooking, snack foods.		
Unit IV	**FOOD WASTES IN VARIOUS PROCESSES**	**9**
Waste disposal-solid and liquid waste; rodent and insect control; use of pesticides; ETP; selecting and installing necessary equipment.		
Unit V	**FOOD HYGIENE**	**9**
Food related hazards – Biological hazards – physical hazards – microbiological considerations in foods. Food adulteration – definition, common food adulterants, contamination with toxic metals, pesticides and insecticides; Safety in food procurement, storage handling and preparation; Relationship of microbes to sanitation, Public health hazards due to contaminated water and food; Personnel hygiene; Training& Education for safe methods of handling and processing food; sterilization and disinfection of manufacturing plant; use of sanitizers, detergents, heat, chemicals, Cleaning of equipment and premises.		
		Total periods:45 PERIODS

Text Books:

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.

References:

1. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
2. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

Course Outcomes:	**Blooms Taxonomy**
CO1: Identify and explain the different methods applied to processing foods.	Understand (K2)
CO2: Understand the significance of food processing and its impact on food quality, safety, and nutrition.	Understand (K2)
CO3: Apply knowledge of storage and preservation techniques to maintain the quality of raw and processed foods.	Apply (K3)

CO4: Analyze large-scale food processing methods and their effects on different types of foods.	Analyze (K4)
CO5: Evaluate food hygiene practices, safety measures, and waste management strategies in food processing operations.	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	2	1	1	-	-	-	1	1	-	1	2	1	1
CO2	3	2	2	1	2	-	-	-	1	1	-	1	2	1	1
CO3	3	3	2	2	2	1	-	-	2	2	1	1	3	2	1
CO4	3	3	3	2	3	1	-	-	2	2	1	1	3	2	2
CO5	3	3	2	2	3	1	2	-	2	2	-	1	3	2	2
AVG	3	2.6	2.2	1.6	2.2	0.6	0.4	-	1.6	1.6	0.4	1	2.6	1.6	1.4

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

23BTO003	IPR FOR PHARMA INDUSTRY (Department of Biomedical Engineering)	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To provide fundamental knowledge of different forms of Intellectual Property Rights at national and international levels.
- To explain the significance of patents, copyrights, industrial designs, plant varieties, and geographical indications in the pharmaceutical industry.
- To familiarize students with the procedures for obtaining and enforcing patents and other IPRs.
- To analyze the practical aspects of licensing, infringement, and enforcement of IPR in pharma.
- To understand the role of international treaties and organizations in regulating and protecting Intellectual Property Rights globally.

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**
CO1: Understand and differentiate the categories of intellectual property rights**.**	Understand (K2)
CO2: Describe about patents and procedure for obtaining patents.	Understand (K2)
CO3: Distinguish plant variety, traditional knowledge and geographical indications under IPR.	Analyze (K4)
CO4: Provide the information about the different enforcements and practical aspects involved in protection of IPR.	Apply (K3)
CO5: Understand the interrelationships between different Intellectual Property Rights on International Society	Analyze (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	2	2	-	-	-	-	-	-	-	2	2	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	2	2	-
CO3	3	3	2	2	-	-	-	-	1	-	-	-	2	2	-
CO4	2	2	3	3	2	2	-	-	-	-	-	-	2	2	-
CO5	3	-	3	-	2	1	-	-	-	-	-	-	2	2	-
AVG	2.8	2.2	2.4	1.8	1.2	0.6	-	-	0.2	-	-	-	2	2	-

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

23CHO005	**BASICS OF TEXTILE FINISHING (Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Understand the principles, types, and mechanisms of resin finishing, including anti-crease and durable press treatments.
- Explain flame proof, flame retardant, waterproof, water-repellent, and antimicrobial finishes and their applications.
- Analyze soil release, anti-pilling, antistatic, and UV protection finishes and their mechanisms.
- Examine mechanical finishing methods such as calendaring, compacting, sanforising, peach finishing, and heat setting.
- Explore advanced finishing techniques including stiffening, softening, microencapsulation, nano

finishes, plasma treatment, and bio-finishing.		
Unit I	**RESIN FINISHING**	**9**
Importance of finishing and its classification. Resin finishing: Mechanism of creasing, Types of Resins .Anti crease, wash and wear, durable press resin finishing. Study about eco friendly method of anti crease finishing.		
Unit II	**FLAME PROOF & WATERPROOF**	**9**
Concept of Flame proof & flame retardancy. Flame retardant finishes for cotton, Concept of waterproof and water repellent Finishes, Durable & Semi durable and Temporary finishes, Concept of Antimicrobial finish.		
Unit III	**SOIL RELEASE AND ANTISTATIC FINISHES**	**9**
Soil Release Finishing: Mechanism of soil retention & soil release. Anti pilling Finishing: chemical and mechanical methods to produce anti pilling. Concept of UV Protection finishes- Concept of antistatic finishes.		
Unit IV	**MECHANICAL FINISHES**	**9**
Mechanical finishing of textile materials - calendaring, compacting, Sanforising, Peach finishing. Object of Heat setting. Various methods of heat setting and mechanism of heat setting.		
Unit V	**STIFFENING AND SOFTENING**	**9**
Concept of stiffening and softening of textile materials. Mechanism in the weight reduction of PET .Concept of Micro encapsulation techniques in finishing process, Nano finish, Plasma Treatment and Bio finishing.		
		Total periods:45
Text Books:		
1. V.A.Shennai, "Technology of Finishing", Vol X, Sevak Publications, Mumbai		
2. Perkins, W.S., “Textile colouration and finishing”, Carolina Academic Press., U.K, ISBN: 0890898855.2004.		
References:		
1. Microencapsulation in finishing, Review of progress of Colouration, SDC, 2001 62		
2. Chakraborty, J.N, Fundamentals and Practices in colouration of Textiles, Woodhead Publishing India, 2009, ISBN-13:978-81-908001-4-3		
3. W. D. Schindler and P. J. Hauser "Chemical finishing of textiles", Woodhead Publishing Cambridge England,2004.		

Course Outcomes:	Blooms Taxonomy
CO 1: Basics of Resin Finishing Process.	Understand (K2)
CO2: Concept of Flame proof & flame retardancy, waterproof and water repellent, Antimicrobial finishes**.**	Understand (K2)
CO3: Concept of Soil Release, Anti Pilling, UV Protection and Antistatic finishes.	Analyze (K4)
CO4: Concept of Mechanical finishing.	Apply (K3)
CO5: Basics of Micro encapsulation techniques, Nano finish, Plasma Treatment.	Analyze (K4)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	–	–	–	–	–	–	–	1	–	–
CO2	3	2	1	1	2	–	–	–	–	–	–	–	1	–	–
CO3	3	2	2	2	2	–	–	1	–	–	–	–	1	1	–
CO4	3	2	2	3	2	–	–	1	–	–	–	–	1	–	–
CO5	3	2	2	2	2	–	–	1	–	–	–	–	1	1	–
AVG	3	2	1.6	1.8	2	-	-	0.6	-	-	-	-	1	0.4	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHO004	INDUSTRIAL ENGINEERING FOR GARMENT INDUSTRY (Department of Biomedical Engineering)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To understand the fundamental concepts of industrial engineering and its role in productivity improvement in the garment industry.
- To learn the principles and techniques of method study for analyzing and optimizing work processes.
- To understand motion study and motion analysis for efficient workflow design in apparel production.
- To apply work measurement techniques, including time study and standard allowed minutes (SAM), to garment manufacturing.
- To understand ergonomics and its application to designing safe, efficient, and comfortable workstations in the garment industry.

Unit I	INTRODUCTION	9
Scope of industrial engineering in apparel Industry, role of industrial engineers. Productivity: Definition - Productivity, Productivity measures .Reduction of work content due to the product and process, Reduction of ineffective time due to the management, due to the worker. Causes for low productivity in apparel industry and measures for improvement.		
Unit II	**WORK STUDY**	**9**
Definition, Purpose, Basic procedure and techniques of work-study. Work environment – Lighting, Ventilation, Climatic condition on productivity. Temperature control, humidity control, noise control measures. Safety and ergonomics on work station and work environment Material Handling – Objectives, Classification and characteristics of material handling equipments, Specialized material handling equipments.		
Unit III	**METHOD STUDY**	**9**
Definition, Objectives, Procedure, Process charts and symbols. Various charts – Charts indicating process sequence: Outline process chart, flow process chart (man type, material type and equipment type); Charts using time scale – multiple activity chart. Diagrams indicating movement – flow diagram, string diagram, cycle graph, chrono cycle graph, travel chart MOTION STUDY: Principle of motion economy, Two handed process chart, micro motion analysis – therbligs, SIMO chart.		
Unit IV	**WORK MEASUREMENT**	**9**
Definition, purpose, procedure, equipments, techniques. Time study - Definition, basics of time study- equipments. Time study forms, Stop watch procedure. Predetermined motion time standards (PMTS). Time Study rating, calculation of standard time, Performance rating – relaxation and other allowances. Calculation of SAM for different garments, GSD.		
Unit V	**WORK STUDY APPLICATION**	**9**
Application of work study techniques in cutting, stitching and packing in garment industry. Workaids in sewing, Pitch diagram, Line balancing, Capacity planning, scientific method of training.		
Total periods:45 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**
CO 1: Understand the fundamental concepts of industrial engineering and productivity improvement in garment industry.	Understand (K2)
CO2: Method study	Apply (K3)
CO3: Motion analysis	Analyze (K4)
CO4: Work measurement and SAM	Apply (K3)
CO5: Ergonomics and its application to garment 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	3	3	2	1	1	2	2	1	1	1	1	1	-
CO2	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO3	1	2	3	3	2	1	1	2	2	1	2	2	1	1	-
CO4	1	2	3	3	2	1	1	2	2	1	3	2	1	1	-
CO5	1	2	3	3	2	1	2	2	2	1	3	2	1	1	-
AVG	1.2	2	3	3	2	1	1.2	2	2	1	2.2	1.8	1	1	-

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

23CHO003	**BASICS OF TEXTILE MANUFACTURE** **(Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To enable the students to understand the fundamental concepts of natural and man-made fibres, their classification, properties, and methods of cultivation/production.
- To provide knowledge on the production processes, characteristics, and structural features of regenerated and synthetic fibres.
- To familiarize the students with the basic principles of spinning, yarn formation, machine sequence, and yarn numbering systems.
- To familiarize the students with the basic principles of spinning, yarn formation, machine sequence, and yarn numbering systems.
- To introduce the principles of knitting and nonwoven fabric formation, including their classifications, structures, and production techniques**.**

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 - calculation		
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.

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.Gohl E. P. G., “Textile Science”, CBS Publishers and distributors, 1987, ISBN 0582685958

Course Outcomes:	**Blooms Taxonomy**
CO 1: Classification of fibres and production of natural fibres	Understand(K2)
CO2: Regenerated and synthetic fibres	Understand(K2)
CO3: Yarn spinning	Apply(K3)
CO4: Weaving	Understand(K2)
CO5: Knitting and nonwoven	Understand(K2)

CO - PO & PSO Mapping

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

CO5	3	-	2	-	-	-	-	-	-	-	2	-	3	3	3
AVG	3	1.2	1.2	0.6	0.6	1	0.4	-	0.6	-	0.4	-	3	3	3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CHO006	**INTRODUCTION TO PETROLEUM REFINING AND PETROCHEMICALS (Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the origin, formation, classification, and evaluation of crude oil and its products.
- To learn the primary and secondary refining processes, including distillation, cracking, and coking.
- To gain knowledge about reforming, hydrotreating, and treatment techniques for improving petroleum product quality.
- To introduce the basics of petrochemical production from petroleum feedstocks, including ethylene, propylene, and aromatics.
- To develop an understanding of the societal and industrial impact of petrochemicals and the optimization of process parameters for efficient production.

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 Terephathalate(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**
CO1: Understand the classification, composition and testing methods of crude petroleum and its products. Learn the mechanism of refining process.	Understand (K2)
CO2: Understand the insights of primary treatment processes to produce the precursors.	Understand (K2)
CO3: Study the secondary treatment processes cracking, vis-breaking and coking to produce more petroleum products.	Apply (K3)
CO4: Appreciate the need of treatment techniques for the removal of sulphur and other impurities from petroleum products.	Analyze (K4)
CO5: Understand the societal impact of petrochemicals and learn their manufacturing processes.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	2	-	-	-	1	1	-	1	3	2	1
CO2	3	3	2	1	3	-	-	-	1	1	-	1	3	3	2
CO3	3	3	3	2	3	1	-	-	2	2	1	1	3	3	2
CO4	3	3	3	2	3	1	-	-	2	2	1	1	3	3	3
CO5	3	3	2	2	3	1	2	-	2	2	-	1	3	3	3
AVG	3	2.8	2.4	1.6	2.8	0.6	0.4	-	1.4	1.4	0.4	1	3	2.8	2.2

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

<table>
<tr><td rowspan="3">23EEO005</td><td rowspan="3">ENERGY CONSERVATION AND MANAGEMENT
(Department of Biomedical Engineering)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

Course Objectives:

- Understand the fundamentals of energy, global and national consumption patterns, and the environmental impact of energy use.
- Explain the principles of electrical systems, including transformers, motors, capacitors, power factor, and energy-efficient lighting.
- Learn the basics of thermal systems such as boilers, furnaces, thermic fluid heaters, and steam systems, along with efficiency and energy conservation measures.
- Analyze energy conservation opportunities in major utilities, including pumps, fans, blowers, compressed air, and HVAC systems.
- Understand energy economics, including cost analysis, payback period, life cycle costing, and the role of ESCOs in energy management.

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		

Text Books:

1. Energy Manager Training Manual (4 Volumes) at www.energymanagertraining.com. a website administered by
Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004. available

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: Remember the knowledge for Basic combustion and furnace design and selection of thermal and mechanical energy equipment	Apply (K3)
CO2: Study the Importance of Stoichiometry relations, Theoretical air required for complete combustion**.**	Understand (K2)
CO3: Skills on combustion thermodynamics and kinetics.	Analyze (K4)
CO4: Apply calculation and design tube still heaters.	Apply (K3)
CO5: Studied different heat treatment furnace.	Understand (K2)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	–	–	–	–	–	–	–	1	–	–
CO2	3	2	1	1	2	–	–	–	–	–	–	–	1	–	–
CO3	3	2	2	2	2	–	–	1	–	–	–	–	1	1	–
CO4	3	2	2	3	2	–	–	1	–	–	–	–	1	1	–
CO5	3	2	2	2	2	–	–	1	–	–	–	–	1	1	–
AVG	3	2	1.6	1.6	2	-	-	0.6	-	-	-	-	1	0.6	-

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

23CHO007	BASICS OF PLASTICS PROCESSING (Department of Biomedical Engineering)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Understand the fundamentals of plastics processing, such as the relationships between material structural properties and required processing parameters, and so on
- To gain practical knowledge on the polymer selection and its processing
- Understanding the major plastic material processing techniques (Extrusion, Injection molding, Compression and Transfer molding, Blow molding, Thermoforming and casting)
- To understand suitable additives for plastics compounding
- To Propose troubleshooting mechanisms for defects found in plastics products manufactured by various processing techniques

Unit I	INTRODUCTION TO PLASTICS PROCESSING	9

Introduction to plastic processing – Principles of plastic processing: processing of plastics vs. metals and ceramics. Factors influencing the efficiency of plastics processing: molecular weight, viscosity and rheology. Difference in approach for thermoplastic and thermoset processing. Additives for plastics compounding and processing: antioxidants, light stabilizers, UV stabilizers, lubricants, impact modifiers, flame retardants, antistatic agents, stabilizers and plasticizers. Compounding: plastic compounding techniques, plasticization, pelletization.

Unit II	EXTRUSION	9

Extrusion – Principles of extrusion. Features of extruder: barrel, screw, types of screws, drive mechanism, specifications, heating & cooling systems, types of extruders. Flow mechanism: process variables, die entry effects and exit instabilities. Die swell, Defects: melt fracture, shark skin, bambooing. Factors determining efficiency of an extruder. Extrusion of films: blown and cast films. Tube/pipe extrusion. Extrusion coating: wire & cable. Twin screw extruder and its applications. Applications of extrusion and new developments.

Unit III	INJECTION MOLDING	9

Injection molding – Principles and processing outline, machinery, accessories and functions, specifications, process variables, mould cycle. Types of clamping: hydraulic and toggle mechanisms. Start-up and shut down procedures- Cylinder nozzles- Press capacity projected area -Shot weight Basic theoretical concepts and their relationship to processing - Interaction of moulding process aspect effects in quoted variables. Basic mould types. Reciprocating vs. plunger type injection moulding. Thermoplastic vs. thermosetting injection moulding. Injection moulding vs. other plastic processing techniques. State-of-the art injection moulding techniques - Introduction to trouble shooting

Unit IV	COMPRESSION AND TRANSFER MOLDING	9

Compression moulding – Basic principles of compression and transfer moulding-Meaning of terms Bulk factor and flow properties, moulding materials, process variables and process cycle, Inter relation between flow properties- Curing time-Mould temperature and Pressure requirements. Preforms and preheating-Techniques of preheating. Machines used-Types of compression mould- positive, semi-positive and flash. Common moulding faults and their correction- Finishing of mouldings. Transfer moulding: working principle, equipment, Press capacity-Integral moulds and auxiliary ram moulds, moulding cycle, moulding tolerances, pot transfer, plunger transfer and screw transfer moulding techniques, advantages over compression moulding		
Unit V	**BLOW MOLDING, THERMOFORMING AND CASTING**	**9**
Blow moulding: principles and terminologies. Injection blow moulding. Extrusion blow moulding. Design guidelines for optimum product performance and appearance. Thermoforming: principle, vacuum forming, pressure forming mechanical forming. Casting: working principle, types and applications.		
Total periods:45 PERIODS		
Text Books:		
1. S. S. Schwart, S. H. Goodman, Plastics Materials and Processes, Van Nostrad Reinhold Company Inc. (1982).		
2. F. Hensen (Ed.), Plastic Extrusion Technology, Hanser Gardner (1997).		
3. W. S. Allen and P. N. Baker, Hand Book of Plastic Technology, Volume-1, Plastic Processing Operations [Injection, Compression, Transfer, Blow Molding], CBS Publishers and Distributors (2004).		
4. M. Chanda, S. K. Roy, Plastic Technology handbook, 4th Edn., CRC Press (2007).		
References:		
1. I. I. Rubin, Injection Molding Theory & Practice, Society of Plastic Engineers, Wiley (1973).		
2. D.V. Rosato, M. G. Rosato, Injection Molding Hand Book, Springer (2012).		
3. M. L. Berins (Ed.), SPI Plastic Engineering Hand Book of Society of Plastic Industry Inc., Springer (2012).		
4. B. Strong, Plastics: Material & Processing, A, Pearson Prentice hall (2005).		
5. D.V Rosato, Blow Molding Hand Book, Carl HanserVerlag GmbH & Co (2003).		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Ability to find out the correlation between various processing techniques with product properties.	Apply (K3)
CO2: Understand the major plastics processing techniques used in moulding (injection, blow, compression, and transfer), extrusion, thermoforming, and casting.	Analyze (K4)
CO3: Acquire knowledge on additives for plastic compounding and methods employed for the same	Understand (K2)

CO4: : Familiarize with the machinery and ancillary equipment associated with various plastic processing techniques.	Understand (K2)
CO5: Select an appropriate processing technique for the production of a plastic product	Analyze (K4)

CO - PO & PSO Mapping

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

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

23ECO003	**SIGNALS AND SYSTEMS** **(Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- Understand the classification and properties of continuous-time (CT) and discrete-time (DT) signals and systems.
- Analyze continuous-time signals using Fourier series, Fourier transforms, and Laplace transforms.
- Examine linear time-invariant (LTI) continuous-time systems using impulse response, convolution, and transform techniques.
- Analyze discrete-time signals using sampling, discrete-time Fourier transform (DTFT), and Z-transform methods.
- Understand and analyze discrete-time LTI systems, including recursive and non-recursive systems, using convolution sums, DFT, and Z-transform.
-

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

Text Books:

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.(UnitsI - V)
2. Simon Haykin, Barry Van Veen, “Signals and Systems”, 2nd Edition, Wiley, 2002

References:

1. B. P. Lathi, “Principles of Linear Systems and Signals”, 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**
CO1: determine if a given system is linear/causal/stable	Analyze (K4)
CO2: determine the frequency components present in a deterministic signal	Analyze (K4)
CO3: characterize continuous LTI systems in the time domain and frequency domain	Apply (K3)
CO4: characterize discrete LTI systems in the time domain and frequency domain	Apply (K3)
CO5: compute the output of an LTI system in the time and frequency domains	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	3	2	–	–	–	–	–	–	–	–	1	–	–

CO2	3	2	3	2	–	–	–	–	–	–	–	–	1	–	–
CO3	3	2	2	3	–	–	–	–	–	–	–	–	1	1	–
CO4	3	2	2	3	–	–	–	–	–	–	–	–	1	1	–
CO5	3	2	2	3	–	–	–	–	–	–	–	–	1	1	–
AVG	3	2	2	2.6	-	-	-	-	-	-	-	-	1	0.6	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23ECO004	**FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS (Department of Biomedical Engineering)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- **Introduce the concept of diodes, Bipolar Junction Transistors and FET.**
- **Study the various model parameters of Transistors**
- **Learn the concept of special semiconductor devices, Power & Display devices**
- **Impart the knowledge of various configurations, characteristics, applications.**
- **To have knowledge of display and power devices.**

Unit I	**SEMICONDUCTOR DIODE**	**9**
PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.		
Unit II	**BIPOLAR JUNCTION TRANSISTORS**	**9**
NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon- model, Multi Emitter Transistor.		
Unit III	**FIELD EFFECT TRANSISTORS**	**9**
MOSFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance-Threshold voltage -Channel length modulation, small signal Characteristics, D- MOSFET, E-MOSFET-Characteristics – Comparison of MOSFET with BJT.		
Unit IV	**SPECIAL SEMICONDUCTOR DEVICES**	**9**
Metal-Semiconductor Junction - MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Point Contact Diode, p-i-n Diode, Avalanche Photodiode, Schottky barrier diode- Zener diode- Varactor diode – Tunnel diode- Gallium Arsenide device, LASER diode, LDR.		
Unit V	**POWER DEVICES AND DISPLAY DEVICE**	**9**
UJT, Thyristor - SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Opto Coupler, Solar cell, CCD.		

Total periods:45 PERIODS
Text Books:
1. Millman and Halkias, "Electronic Devices and Circuits", 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, "Electronic Devices and Circuits", Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, "Electronic Devices and circuits", 4th Edition, McGraw Hill, 2016.
References:
1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, "Solid State Electronic Devices", 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, "A Textbook of Electronic Devices and Circuits", 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Analyze the characteristics of semiconductor diodes.	Analyze (K4)
CO2: Analyze and solve problems of Transistor circuits using model parameters.	Apply (K3)
CO3: Identify and characterize diodes and various types of transistors.	Understand (K2)
CO4: Analyze the characteristics of special semiconductor devices.	Analyze (K4)
CO5: Analyze the characteristics of Power and Display devices.	Analyze (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
AVG	3	3	1.8	-	-	-	-	-	-	-	-	-	1	-	-

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

23MAO001	**OPERATIONS RESEARCH**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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.L.td, New Delhi , 2014.

5. F.S.Hillier and G.J. Lieberman, " Introduction to Operations Research " , Tata McGraw Hill, Eighth Edition , New Delhi, 2005.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.	Understand(K2)
CO2: Analyze the concept of developing, formulating, modeling and solving transportation and assignment problems.	Understand(K2)
CO3: Solve the integer programming problems using various methods	Analyze(K4)
CO4: Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.	Apply(K3)
CO5: Determine the optimum solution for non linear programming problems.	Understand(K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	2	-	-	2	-	-	-
CO2	3	3	3	2	-	-	-	-	2	-	-	2	-	-	-
CO3	3	3	-	-	-	-	-	-	2	-	-	2	-	-	-
CO4	3	3	-	-	-	-	-	-	2	-	-	2	-	-	-
CO5	3	3	2	2	-	-	-	-	2	-	-	2	-	-	-
AVG	3	3	1	0.8	-	-	-	-	2	-	-	2	-	-	-

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

<table>
<tr><td rowspan="3">23MAO002</td><td rowspan="3">ALGEBRA AND NUMBER THEORY
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category:</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

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.
- To familiarize learners with Diophantine equations and congruences.
- To understand and apply classical number theory theorems

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

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**
CO1: Explain the fundamental concepts of advanced algebra and their role in modern mathematics and applied contexts.	Understand (K2)
CO2: Demonstrate accurate and efficient use of advanced algebraic techniques.	Understand (K2)
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	Apply (K3)
CO4: Solve simple Diophantine equations and congruence problems using modular arithmetic concepts.	Analyze (K4)
CO5: Apply basic number theory theorems like Fermat's, Wilson's, and Euler's and work with phi, tau, and sigma functions.	Apply (K3)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	-	-	-	2	1	-	1	2	2	-	-	-
CO2	3	3	1	1	3	1	2	1	1	1	2	2	-	-	-
CO3	3	3	2	1	3	1	3	1	1	1	3	3	-	-	-
CO4	3	3	2	2	3	2	2	1	1	1	2	2	-	-	-
CO5	2	2	1	-	3	1	2	1	1	1	2	2	-	-	-
AVG	2.8	2.4	1.6	0.8	2.4	1	2.2	1	0.8	1	2.2	2.2	-	-	-

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

23MAO003	LINEAR ALGEBRA (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- Nil

Course Objectives:

- To test the consistency and solve system of linear equations.
- To find the basis and dimension of vector space.
- To obtain the matrix of linear transformation and its eigenvalues and eigenvectors.
- To find orthonormal basis of inner product space and find least square approximation.
- To find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.

Unit I	MATRICES AND SYSTEM OF LINEAR EQUATIONS	9

Matrices - Row echelon form - Rank - System of linear equations - Consistency - Gauss elimination method - Gauss Jordan method.

Unit II	VECTOR SPACES	9

Vector spaces over Real and Complex fields - Subspace – Linear space - Linear independence and dependence - Basis and dimension.

Unit III	LINEAR TRANSFORMATION	9

Linear transformation - Rank space and null space - Rank and nullity - Dimension theorem– Matrix representation of linear transformation - Eigenvalues and eigenvectors of linear transformation – Diagonalization.

Unit IV	INNER PRODUCT SPACES	9

Inner product and norms - Properties - Orthogonal, Orthonormal vectors - Gram Schmidt orthonormalization process
- Least square approximation.

Unit V	EIGEN VALUE PROBLEMS AND MATRIX DECOMPOSITION	9

Eigen value Problems : Power method, Jacobi rotation method - Singular value decomposition – QR decomposition.

Total periods: 45

Text Books:

1. 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**
CO1: Test the consistency and solve system of linear equations.	Apply (K3)
CO2: Find the basis and dimension of vector space.	Understand (K2)
CO3: Obtain the matrix of linear transformation and its eigenvalues and eigenvectors.	Analyze (K4)
CO4: Find orthonormal basis of inner product space and find least square approximation.	Analyze (K4)
CO5: Find eigenvalues of a matrix using numerical techniques and perform matrix decomposition.	Apply (K3)

CO - PO & PSO Mapping

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

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

23CEO002	**LEAN CONCEPTS, TOOLS AND PRACTICES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To introduce the fundamentals of construction project management
- To understand the principles of lean management
- To learn the core concepts of lean thinking
- To gain knowledge of lean tools and techniques
- To explore lean 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 respect 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. Linda K. Nozick and Rachel Davidson, "Lean Construction: Core Concepts and Techniques", McGraw-Hill Education, 1st Edition, New York, 2015.

2. Lincoln H. Forbes and Syed M. Ahmed, "Modern Construction: Lean Project Delivery and Integrated Practices", CRC Press, 2nd Edition, Boca Raton, 2020.

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**
CO1: Explains the contemporary management techniques and the issues in present scenario.	Understand (K2)
CO2: Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.	Apply (K3)
CO3: Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.	Understand (K2)
CO4: Apply lean techniques to achieve sustainability in construction projects.	Apply (K3)
CO5: Apply lean construction techniques in design and modeling.	Apply (K3)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	-	1	-	-	-	-	1	2	-	1	-	-	-
CO2	2	2	2	1	-	-	-	-	1	2	-	1	-	-	-
CO3	2	2	3	2	-	-	-	-	2	2	-	2	-	-	-
CO4	1	1	2	2	1	-	2	-	1	1	-	2	-	-	-
CO5	2	2	3	2	2	-	-	-	2	2	-	2	-	-	-
AVG	1.8	1.6	2	1.6	0.6	-	0.4	-	1.4	1.8	-	1.6	-	-	-

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

OPEN ELECTIVE IV

23HSO002	**PROJECT REPORT WRITING (Common to BME,BT,C IVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

The Course will enable Learners to,

- 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	**Fundamentals of Grammar and Writing Skills**	**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	**Fundamentals of Project and Technical Report Writing**	**9**

Project Report – Definition, Structure, Types of Reports, Purpose – Intended Audience – Plagiarism – Report Writing in STEM fields – Experiment – Statistical Analysis.

Unit III	**Structuring the Project Report – Essential Components**	**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	**Advanced Components of Project Report Writing**	**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	**Proofreading and Presentation of Project Reports**	**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

Text Books:

1. Virendra K. Pamecha - Guide to Project Reports, Project Appraisals and Project Finance (2012)

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.	Apply (K3)

CO2: Use statistical tools with confidence**.**	Apply
CO3: Explain the purpose and intension of the proposed project coherently and with clarity.	Understand (K2)
CO4: Create writing texts to suit achieve the intended purpose**.**	Create (K6)
CO5: Master the art of writing winning proposals and projects**.**	Evaluate (K5)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	1	1	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	-	-	-
AVG	2.4	2.2	2.4	2.2	2	2.6	2.8	2.2	2.6	3	2.6	3	-	-	-

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

23MAO004	**ADVANCED NUMERICAL METHODS**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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.
- To understand and apply numerical techniques for solving systems of algebraic equations and eigenvalue problems.
- To impart knowledge on interpolation methods and least square approximation for analyzing discrete and continuous data.
- To familiarize students with numerical methods for solving ordinary differential equations and boundary value problems.
- To introduce finite difference methods for solving elliptic, parabolic, and hyperbolic partial differential equations.

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 (up to 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	**INITE 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”, 9th 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. Sastry, S.S., “Introductory Methods of Numerical Analysis”, 5th Edition, PHI Learning, 2015.

Course Outcomes:	**Blooms Taxonomy**
CO 1: demonstrate the understandings of common numerical methods for nonlinear equations, system of linear equations and eigenvalue problems;	Remember & Understand
CO2: understand the interpolation theory;	Understand & Apply
CO3: understand the concepts of numerical methods for ordinary differential equations;	Apply & Analyze
CO4: demonstrate the understandings of common numerical methods for elliptic equations;	Analyze & Evaluate
CO5: understand the concepts of numerical methods for time dependent partial differential equations	Apply, Analyze & Evaluate

CO - PO & PSO Mapping

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

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

23MAO005	**RANDOM PROCESSES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To introduce the basic concepts of probability, one and two dimensional random variables with applications to engineering which can describe real life phenomenon.
- To understand the basic concepts of random processes which are widely used in communication networks.
- To acquaint with specialized random processes which are apt for modelling the real time scenario.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

Unit I	**RANDOM VARIABLES**	**9**
Discrete and continuous random variables – Moments – Moment generating functions – Joint Distribution-Covariance and Correlation – Transformation of a random variable.		
Unit II	**RANDOM PROCESSES**	**9**
Classification – Characterization – Cross correlation and Cross covariance functions - Stationary Random Processes – Markov process - Markov chain.		
Unit III	**SPECIAL RANDOM PROCESSES**	**9**
Bernoulli Process – Gaussian Process - Poisson process – Random telegraph process.		
Unit IV	**CORRELATION AND SPECTRAL DENSITIES**	**9**
Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.		
Unit V	**LINEAR SYSTEMS WITH RANDOM INPUTS**	**9**
Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output**.**		
	Total periods:45	
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 & Apply K2/K3
CO2: Apply the concept random processes in engineering disciplines.	Apply K3
CO3: Understand and apply the concept of correlation and spectral densities.	Understand & Apply K2/K3
CO4: Get an exposure of various distribution functions and help in acquiring skills in handling situations involving more than one variable.	Understand K2
CO5: Analyze the response of random inputs to linear time invariant systems.	Analyze K4

CO - PO & PSO Mapping

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

- NIL

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
CO1: Enable the students to apply the concept of random processes in engineering disciplines.	Understand (K2)
CO2: Students acquire skills in analyzing various queueing models	Apply (K3)
CO3: Students can understand and characterize phenomenon which evolve with respect to time in a probabilistic manner	Apply (K3)
CO4: Students can analyze reliability of the systems for various probability distributions.	Analyze (K4)
CO5: Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach	Apply (K3) / Analyze (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	-	-	-	-	2	-	-	2	-	-	-
CO2	3	3	2	-	-	-	-	-	2	-	-	2	-	-	-
CO3	3	3	-	2	-	-	-	-	2	-	-	2	-	-	-
CO4	3	3	2	-	-	-	-	-	2	-	-	2	-	-	-
CO5	3	3	3	2	-	-	-	-	2	-	-	2	-	-	-
AVG	3	3	1.4	0.8	-	-	-	-	2	-	-	2	-	-	-

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

23MGO004	PRODUCTION AND OPERATIONS MANAGEMENT FOR ENTREPRENEURS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To introduce the basic concepts and functions of Production and Operations Management for entrepreneurs.
- To understand production systems, automation, and capacity/facility planning methods.
- To learn production and operations planning techniques for effective process management.
- To study process selection, work study, plant layout, and related optimisation tools.
- To understand production and operations control, including inventory, quality, and supply chain management.

Unit I	INTRODUCTION TO PRODUCTION AND OPERATIONS MANGEMENT 9	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	**CONTROLING 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. Amitabh Raturi, Production and Inventory Management, , 2008.		
2. Chary S.N, Production and Operations Management, TMH Publications, 2010.		
3. . Terry Hill ,Operation Management. Pal Grave McMillan (Case Study).2005.		
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 (K2)
CO2: To learn about the Production & Operation Systems.	Understand (K2)
CO3: 3 To acquaint on the Production & Operations Planning Techniques followed by entrepreneurs in Industries.	Apply (K3)
CO4: To known about the Production & Operations Management Processes in organisations.	Analyze (K4)
CO5: To comprehend the techniques of controlling , Production and Operations in industries.	Apply (K3)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	-	-	-	1	1	1	-	2	3	2	-
CO2	3	2	3	2	1	-	-	-	1	1	-	2	3	2	1
CO3	3	3	3	1	1	-	-	2	2	-	-	3	3	3	2
CO4	3	3	2	2	1	1	-	-	2	2	-	3	3	3	2
CO5	3	3	3	3	2	1	-	-	3	3	2	3	3	3	2
AVG	3	2.6	2.6	1.8	1	0.4	-	0.6	1.8	1.4	0.4	2.6	3	2.6	1.4
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MGO005	**MULTIVARIATE DATA ANALYSIS**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Understand and apply fundamental and advanced multivariate analysis techniques for informed decision-making.
- Perform accurate data analysis using advanced multivariate methods and interpret results effectively.
- Analyze real-world problems using appropriate multivariate techniques and draw meaningful conclusions.
- Prepare clear, structured, and insightful analytical reports for real-world case studies.
- Use multivariate data analytics to support and improve business decision-making

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

Text Books:

1. Joseph F Hair, Rolph E Anderson, Ronald L. Tatham & William C. Black, Multivariate Data Analysis, Pearson Education, New Delhi, 2005.

References:

1. Barbara G. Tabachnick, Linda S.Fidell, Using Multivariate Statistics, 6th Edition, Pearson, 2012. Statistics, 6th Edition, Pearson, 2012.

2. Richard A Johnson and Dean W.Wichern, Applied Multivariate Statistical Analysis, Prentice Hall, New Delhi,2005.

3. David R Anderson, Dennis J Seveency, and Thomas A Williams, Statistics for Business and Economics, Thompson, Singapore, 2002

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(K2)
CO2: Use advanced techniques to conduct thorough and insightful analysis, and interpret the results correctly with detailed and useful information.	Apply(K3)
CO3: Show substantial understanding of the real problems; conduct deep analysis using correct methods; and draw reasonable conclusions with sufficient explanation and elaboration.	Apply(K3)
CO4: Write an insightful and well-organized report for a real-world case study, including thoughtful and convincing details.	Apply(K3)
CO5: : Make better business decisions by using advanced techniques in data analytics.	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	2	1	-	1	-	2	1	1	2	2	1
CO2	3	3	2	3	2	-	-	1	-	2	1	1	3	2	2
CO3	3	3	2	3	3	-	-	1	1	2	2	1	3	3	2
CO4	3	3	2	3	3	-	1	1	1	2	2	2	3	3	3
CO5	3	3	2	2	3	-	1	1	1	2	3	2	3	3	3
AVG	3	2.8	1.8	2.4	2.6	0.2	0.4	1	0.6	2	1.8	1.4	2.8	2.6	2.2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO009	**ADDITIVE MANUFACTURING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To introduce the development, capabilities, applications, of Additive Manufacturing (AM), and its business opportunities.
- To be acquainted with vat polymerization and material extrusion processes
- To be familiar with powder bed fusion and binder jetting processes
- To gain knowledge on applications of direct energy deposition, and material jetting processes.
- To impart knowledge on sheet lamination and direct write technologies.

Unit I	**INTRODUCTION**	**9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain - ASTM/ISO 52900 Classification - Benefits - AM Unique Capabilities - AM File formats: STL, AMF Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare. Business Opportunities in AM.

Unit II	**VAT POLYMERIZATION AND MATERIAL EXTRUSION**	**9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications.

Material Extrusion: Fused Deposition Modeling (FDM) - Process-Materials -Applications and Limitations.

Unit III	POWDER BED FUSION AND BINDER JETTING	9
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.		
Unit IV	**MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION**	**9**
Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery Materials -Benefits - Applications.		
Unit V	**SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY**	**9**
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.		
Total periods:45 PERIODS		
Text Books:		
1.Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0		
2.Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1 56990-582-1.		
References:		
1.Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN :9783446425521.		
2.Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.		
3.Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.		
4.Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States ,2006, ISBN: 978-1-4614-9842-1.		

5.Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Recognize the development of AM technology and how AM technology propagated into various businesses and developing opportunities**.**	Understand
CO2: Acquire knowledge on process vat polymerization and material extrusion processes and its applications.	Understand
CO3: Elaborate the process and applications of powder bed fusion and binder jetting**.**	Analyze
CO4: Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes**.**	Evaluate
CO5: Acquire knowledge on sheet lamination and direct write technology.	Understand
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	1	1	-	-	-	-	2	-	1	3	1	-
CO2	3	2	2	-	1	-	-	-	-	1	-	-	3	1	-
CO3	3	2	2	1	1	-	-	-	-	1	-	-	2	2	2
CO4	3	3	2	2	2	-	-	-	-	2	-	1	2	3	3
CO5	3	2	1	1	1	-	-	-	-	1	-	-	2	3	2
AVG	3	2	1.6	1	1.2	-	-	-	-	1.4	-	0.4	1.2	2	1.4

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

23MEO010	**NEW PRODUCT DEVELOPMENT**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To introduce the fundamental concepts of the new product development.
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development.
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

Unit I	FUNDAMENTALS OF NPD	9
Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.		
Unit II	**MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS**	**9**
Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.		
Unit III	**ESSENTIALS OF NPD**	**9**
RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programming. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.		
Unit IV	**CRITERIONS OF NPD**	**9**
New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD.		
Unit V	**REPORTING & FORWARD-THINKING OF NPD**	**9**
Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)		

Total periods: 45 PERIODS

Text Books:

1. Product Development – Sten Jonsson.
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger.

References:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark.
2. Change by Design.
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker.
4. Winning at New Products – Robert Brands 3rd Edition.
5. Product Design & Value Engineering – Dr. M.A. Bulsara &Dr. H.R. Thakkar.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Discuss fundamental concepts and customer specific requirements of the New Product development.	Understand (K2)
CO2: Discuss the Material specification standards, analysis and fabrication, manufacturing process.	Understand (K2)
CO3: Develop Feasibility Studies & reporting of New Product development.	Apply (K3)
CO4: Analyzing the New product qualification and Market Survey on similar products of new product development.	Analyze (K4)
CO5: Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model.	Apply (K3)

CO - PO & PSO Mapping

Particular	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO1 1**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2
CO2	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2
CO3	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2
CO4	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2
CO5	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2
AVG	1	1	3	1	-	-	-	1	1	-	-	1	1	3	2

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

23MEO011	INDUSTRIAL DESIGN & RAPID PROTOTYPING TECHNIQUES	Category: OEC			
		L	T	P	C
		2	0	2	3

Prerequisites

- NIL

Course Objectives:

The course aims to

- Outline Fundamental concepts in UI & UX
- Introduce the principles of Design and Building an mobile app
- Illustrate the use of CAD in product design
- Outline the choice and use of prototyping tools
- Understanding design of electronic circuits and fabrication of electronic devices

Unit I	**UI/UX**	**9**

Fundamental concepts in UI & UX - Tools - Fundamentals of design principles - Psychology and Human Factors for User Interface Design - Layout and composition for Web, Mobile and Devices - Typography - Information architecture - Color theory - Design process flow, wireframes, best practices in the industry - User engagement ethics
- Design alternatives

Unit II	**APP DEVELOPMENT**	**9**

SDLC - Introduction to App Development - Types of Apps - web Development - understanding Stack - Frontend - backend - Working with Databases - Introduction to API - Introduction to Cloud services - Cloud environment Setup- Reading and writing data to cloud - Embedding ML models to Apps - Deploying application

Unit III	**INDUSTRIAL DESIGN**	**9**

Introduction to Industrial Design - Points, lines, and planes - Sketching and concept generation - Sketch to CAD - Introduction to CAD tools - Types of 3D modeling - Basic 3D Modeling Tools - Part creation – Assembly - Product design and rendering basics - Dimensioning & Tolerancing

Unit IV	**MECHANICAL RAPID PROTOTYPING**	**9**

Need for prototyping - Domains in prototyping - Difference between actual manufacturing and prototyping - Rapid prototyping methods - Tools used in different domains - Mechanical Prototyping; 3D Printing and classification - Laser Cutting and engraving - RD Works - Additive manufacturing

Unit V	**ELECTRONIC RAPID PROTOTYPING**	**9**

Basics of electronic circuit design - lumped circuits - Electronic Prototyping - Working with simulation tool - simple PCB design with EDA

Total periods: 45 PERIODS

Text Books:

1. Peter Fiell, Charlotte Fiell, Industrial Design A-Z, TASCHEN America Llc(2003)
2. Samar Malik, Autodesk Fusion 360 - The Master Guide.
3. Steve Krug, Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability, Pearson,3rd edition(2014)

References:

1. https://www.adobe.com/products/xd/learn/get-star ted.html
2. https://developer.android.com/guide
3. https://help.autodesk.com/view/fusion360/ENU/courses/
4. https://help.prusa3d.com/en/category/prusaslicer_204

Course Outcomes:	**Blooms Taxonomy**
CO 1: Create quick UI/UX prototypes for customer needs	Create(K6)
CO2: Develop web application to test product traction / product feature	Create(K6)
CO3: Develop 3D models for prototyping various product ideas	Create(K6)
CO4: Built prototypes using Tools and Techniques in a quick iterative methodology	Create(K6)
CO5: Design, simulate, prototype, and test simple electronic circuits and PCBs using fundamental circuit principles and EDA tools.	Analyze(K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	-	3	-	3	-	-	-	-	2	-	-	2	-	1
CO2	2	-	3	-	3	-	-	-	-	-	2	-	-	2	2
CO3	-	-	3	-	3	-	-	-	-	-	2	-	3	-	2
CO4	2	-	3	2	3	-	-	-	-	-	2	-	3	-	3
CO5	3	2	3	2	3	-	-	-	-	-	-	-	3	-	2
AVG	1.4	0.4	3	0.8	3	-	-	-	-	0.4	1.2	-	2.2	0.4	2

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

23MEO012	MICRO AND PRECISION ENGINEERING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

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

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 Manufacturing‖, New Age International, New Delhi, 2005.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Select suitable precision machine tools and operate	Apply – K3
CO2: Apply the macro and micro components for fabrication of micro systems..	Apply – K3
CO3: Apply suitable machining process	Apply – K3
CO4: Able to work with miniature models of existing machine tools/robots and other	Apply – K3
CO5: Apply metrology for micro system	Apply – K3
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	3	-	-	-	2	1	1	2	3	3	3
CO2	3	2	2	1	3	-	-	-	2	1	1	2	3	3	3
CO3	3	2	2	2	3	-	-	-	2	1	1	2	3	3	3
CO4	3	2	2	1	3	-	-	-	3	1	1	2	3	3	3
CO5	3	2	2	2	3	-	-	-	2	1	1	2	3	3	3
AVG	3	2	2	1.4	3	-	-	-	2.2	1	1	2	3	3	3

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

23MEO013	**COST MANAGEMENT OF ENGINEERING PROJECTS**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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 contracts		
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 problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing		
Unit IV	**COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL**	**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 PERIODS		
Text Books:		
1. Charles T. Horngren, Srikant M. Datar & Madhav V. Rajan – Cost Accounting: A Managerial Emphasis, Pearson Education.		
2. Prasanna Chandra – Projects: Planning, Analysis, Selection, Financing, Implementation & Review, Tata McGraw Hill.		
3. R. Paneerselvam – Operations Research, PHI Learning.		
References:		
1. M.Y. Khan & P.K. Jain – Management Accounting, Tata McGraw Hil		
2. Kanishka Bedi – Production and Operations Management, Oxford University Press.		
3. D.R. Carmichael & Paul A. Hoxley – Project Management for Engineering and Construction, McGraw Hill.		
4. Ashok Sharma – Project Management and Cost Estimating, New Age International Publishers.		

Course Outcomes:	Blooms Taxonomy
CO 1: Understand the costing concepts and their role in decision making.	Understand (K2)
CO2: Understand the project management concepts and their various aspects in selection.	Understand (K2)
CO3: Interpret costing concepts with project execution	Apply (K3)
CO4: Gain knowledge of costing techniques in service sector and various budgetary control techniques.	Apply (K3)
CO5: : Become familiar with quantitative techniques in cost management.	Analyze (K4)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	-	1	1	-	3	3	3	-
CO2	3	2	2	2	1	-	-	-	2	2	-	3	3	3	1
CO3	3	3	2	2	2	1	-	-	2	2	-	3	3	3	1
CO4	3	3	3	3	2	1	-	-	2	3	-	3	3	3	2
CO5	3	3	3	3	2	1	-	-	3	3	2	3	3	3	2
AVG	3	2.6	2.4	2.2	1.4	0.6	-	-	2	2.2	0.4	3	3	3	1.2

1 - Low, 2 - Medium, 3 - High , '-' No correlation3

23EEO011	**BATTERIES AND MANAGEMENT SYSTEM**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand Li-ion chemistries, characteristics, safety limits, and balancing methods.
- To learn battery pack design, sizing, peak-power behavior, and smart-charging concepts.
- To study equivalent circuit, electrochemical, and AI-based battery modelling methods and tools.
- To understand SOC estimation principles and algorithms using electrical and intelligent methods.
- To learn BMS structure, components, communication interfaces, and model-based design practices.

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. NCR18650B 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 frameworks.		
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 PERIODS		
Text Books:		
1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles'', Wiley, 2015.		
2. Davide Andrea ,"Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.		
References:		
1. Developing Battery Management Systems with Simulink and Model-Based Design-whitepaper		
2. Panasonic NCR18650B- DataSheet		
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 (K2)
CO2: Design a Battery Pack and make related calculations.	Apply / Analyze (K3 / K4)
CO3: Demonstrate a BatteryModel or Simulation.	Analyze / Create (K4 / K6)

CO4: Estimate State-of-Charges in a Battery Pack.	Analyze / Evaluate (K4 / K5)
CO5: Approach different BMS architectures during real world usage.	Apply / Analyze (K3 / K4)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	1	1	1	-	-	-	-	-	-	2	3	1	1
CO2	2	2	3	2	3	-	-	-	2	-	2	-	3	2	2
CO3	2	2	2	3	3	-	-	-	2	-	2	-	3	2	3
CO4	2	2	2	3	2	-	-	-	-	-	-	2	3	2	2
CO5	2	2	3	2	3	2	2	2	2	2	2	2	3	1	3
AVG	2	2	2.2	2.2	2.6	0.4	0.4	0.4	1.2	0.4	1.2	1.2	3	1.6	2.2

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

23EEO006	**SENSORS AND ACTUATORS**	**Category: BSC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- The objective of this course is to make the students to list common types of sensor and actuators used in automotive vehicles.
- To understand the principles, classification, characteristics, and calibration of sensors and transducers used in measurement systems.
- To study the construction, working, and applications of variable resistance, inductance, and special sensors used in automotive and industrial systems.
- To gain knowledge of the operating principles, construction, and performance of automotive actuators and electrical machines.
- To develop the ability to design and analyze automatic temperature control actuators and controller systems for vehicle applications.

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.	Remember
CO2: Design measuring equipment's for the measurement of pressure force, temperature and flow.	Apply
CO3: Generate new ideas in designing the sensors and actuators for automotive application	Create
CO4: Understand the operation of the sensors, actuators and electronic control**.**	Understand
CO5: Design temperature control actuators for vehicles.	Create
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO1 1	PO1 2	PSO1	PSO2	PSO3
CO1	3	1	1	-	1	-	-	-	-	1	-	-	2	2	1
CO2	3	3	3	1	2	-	-	-	-	1	-	1	3	3	2
CO3	2	3	3	2	2	-	-	-	1	1	-	2	3	3	3
CO4	2	2	2	1	2	-	-	-	-	1	-	1	2	2	2
CO5	2	3	-	-	1	-	-	-	1	-	1	2	3	3	3
AVG	2.4	2.4	1.8	0.8	1.6	-	-	-	0.4	0.8	0.2	1.2	2.6	2.6	2.2

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

23ECO005	SPACE VEHICLES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

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 CONTRO**	**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

Text Books:

1. Sutton, G.P. & Biblarz, O., *Rocket Propulsion Elements*, Wiley.

2. Humble, R., Henry, G., & Larson, W., *Space Propulsion Analysis and Design*, McGraw-Hill.

3. Fortescue, P., Stark, J., & Swinerd, G., *Spacecraft Systems Engineering*, Wiley.

4. Anderson, J.D., *Introduction to Flight*, McGraw-Hill – (For aerodynamic aspects including nose cone design)
References:
1. Sutton, G.P., *History of Liquid Propellant Rocket Engines*, AIAA.
2. Larson, W. & Wertz, J., *Space Mission Analysis and Design*, Microcosm Press.
3. Choueiri, E., *Fundamentals of Electric Propulsion*, Princeton University Press.
4. Milligan, D., *Modern Missile Guidance*, McGraw-Hill.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Explain exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.	Understand (l2)
CO2: Apply knowledge in selecting the appropriate rocket propulsion systems.	Understand (l2)
CO3: Interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.	Apply (l3)
CO4: Analyze aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.	Analyze (l4)
CO5: Adapt from aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.	Analyze (l4)

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	3	1	-
CO2	3	2	-	-	-	-	1	-	-	-	-	2	2	1	-
CO3	3	3	2	-	2	-	-	-	-	-	-	1	3	2	2
CO4	3	3	2	2	3	-	-	-	-	-	-	1	3	3	3
CO5	3	3	2	2	2	-	-	-	-	-	-	1	2	3	2
AVG	3	2.6	1.2	0.8	1.4	-	0.6	-	-	-	-	1.2	2.6	2	1.4

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

23MGO006	**MANAGEMENT SCIENCE**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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 Theory X and Theory Y- Hertzberg Two Factor Theory of Motivation Leadership Styles, 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) StatisticalQualityControl:controlchartsforVariablesandAttributes (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 Product Life Cycle.

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 Card as Contemporary Business Strategies.

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 Card as Contemporary Business Strategies.		
	Total periods: 45 PERIODS	

Text Books:
1. Kanishka Bedi, Production and Operations Management, OxfordUniversityPress,2007.
2. Stoner, Freeman, Gilbert, Management,6th Ed, Pearson Education, NewDelhi,2004.
3. Thomas N.Duening & John M. Ivancevich Management Principles and Guidelines, Biztantra,2007.
4. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India,2012.
References:
1. KotlerPhilip and KellerKevinLane: Marketing Management, Pearson, 2012.
2. Koontz and Weihrich: Essentials of Management, McGrawHill, 2012.
3. Lawrence R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGrawHill,2012.
4. Samuel C.Certo: Modern Management,2012.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Plan an organizational structure for a given context in the organisation to carryout production operations through Work-study**.**	Apply (k3)
CO2: Survey the markets, customers and competition better and price the given products appropriatey.	Analyze (K4)
CO3: Ensure quality for a given product or service.	Apply (K3)
CO4: Plan, schedule and control projects through PERT and CPM.	Apply (K3)
CO5: Evaluate strategy for a business or service organisation.	Evaluate (K5)
CO - PO & PSO Mapping	

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

CO3	3	-	-	3	2	2	-	3	2	2	-	-	-	-	2
CO4	3	-	-	3	2	2	-	3	2	3	-	-	-	-	3
CO5	3	-	-	2	3	3	-	2	3	3	-	-	2	1	-
AVG	3	-	-	2.6	2.6	2.6	-	2.6	2.6	2.4	-	-	0.8	1.2	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO014	**PRODUCTION PLANNING AND CONTROL**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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 PPC**	**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	

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. Upendra Kachru, “ Production and Operations Management – Text and cases” 1st Edition, Excel books 2007
3. Samson Eilon, “Elements of Production Planning and Control”, Universal Book Corpn.1984
4. . Norman Gaither, G. Frazier, “Operations Management” 9th Edition, Thomson learning IE, 2007
5. Melynk, Denzler, “ Operations management – A value driven approach” Irwin Mcgraw hill.

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**,**	Apply
CO3: The students can able to prepare production scheduling	Analyze
CO4: The students can able to prepare Inventory Control.	Apply / Create
CO5: They can plan manufacturing requirements manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).	Evaluate

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	-	3	-	-	-	-	-	-	-	3	-	-
CO2	3	2	-	-	3	-	-	-	-	-	-	-	-	2	-
CO3	-	2	-	-	3	-	-	-	-	-	-	-	-	2	-
CO4	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	-	1	-
AVG	1.8	2.4	0.8	-	1.8	-	-	-	-	-	-	-	0.6	1	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MGO007	OPERATIONS MANAGEMENT	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- Recognize and appreciate the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages.
- Describe the concept and contribution of various constituents of Production and Operations Management (both manufacturing and service).
- Relate the interdependence of the operations function with the other key functional areas of a firm.
- Teach analytical skills and problem-solving tools to the analysis of the operations problems.
- Apply scheduling and Lean Concepts for improving System Performance.

Unit I	**INTRODUCTION TO OPERATIONS MANAGEMENT**	**9**

Operations Management – Nature, Importance, historical development, transformation processes, differences between services and goods, a system perspective, functions, challenges, current priorities, recent trends; Operations Strategy - Strategic fit , framework; Supply Chain Management

Unit II	**FORECASTING, CAPACITY AND FACILITY DESIGN**	**9**

Demand Forecasting - Need, Types, COURSE OBJECTIVES and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning - Long range, Types, Developing capacity alternatives. Overview of sales and operations planning. Overview of MRP, MRP II and ERP. Facility Location – Theories, Steps in Selection, Location Models.

Facility Layout – Principles, Types, Planning tools and techniques.

Unit III	**DESIGN OF PRODUCT, PROCESS AND WORK SYSTEMS**	**9**

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Work Study – COURSE OBJECTIVES, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.		
Unit IV	**MATERIALS MANAGEMENT**	**9**
Materials Management – COURSE OBJECTIVES, Planning, Budgeting and Control. Purchasing – COURSE OBJECTIVES, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – COURSE OBJECTIVES, Costs and control techniques. Overview of JIT.		
Unit V	**SCHEDULING AND PROJECT MANAGEMENT**	**9**
Project Management – Scheduling Techniques, PERT, CPM; Scheduling - work centers – nature, importance; Priority rules and techniques, shopfloor control; Flow shop scheduling – Johnson's Algorithm – Gantt charts; personnel scheduling in services.		
	Total periods: 45 PERIODS	
Text Books:		
1. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, Tata McGraw Hill, 12th Edition, 2010.		
2. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.		
References:		
1. William J Stevenson, Operations Management, Tata McGraw Hill, 9th Edition, 2009.		
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.		
3. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.		
4. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.		
5. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.		
6. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.		
7. 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 (K2)

CO2: The students will obtain sufficient knowledge and skills to forecast demand for Production and Service Systems.	Apply / Analyze (K3 / K4)
CO3: The students will able to Formulate and Assess Aggregate Planning strategies and 300 Material Requirement Plan.	Analyze / Evaluate (K4 / K5)
CO4: The students will be able to develop analytical skills to calculate capacity requirements and developing capacity alternatives.	Apply / Analyze (K3 / K4)
CO5: The students will be able to apply scheduling and Lean Concepts for improving System Performance.	Analyze / Evaluate (K4 / K5)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO2	-	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO3	-	2	3	3	-	-	-	-	-	-	-	-	2	3	-
CO4	-	3	3	3	-	-	-	-	-	-	-	-	2	3	-
CO5	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
AVG	0.6	1.6	2.4	1.6	-	-	-	-	-	-	-	0.4	0.8	1.8	0.6

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

23BMO003	**INDUSTRIAL HYGIENE**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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 Limit .		
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. Butterworth Heinemann 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	Apply (K3)
CO2: Specify designs that avoid occupation related injuries	Analyze (K4)
CO3: Define and apply the principles of work design, motion economy, and work environment design.	Apply (K3)
CO4: Identify the basic human sensory, cognitive, and physical capabilities and limitations with respect to human-machine system performance.	Understand (K2)
CO5: Acknowledge the impact of workplace design and environment on productivity	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	2	-	2	-	-	-	-	-	2	-	-	-	-
CO2	-	-	2	-	-	-	1	-	-	-	1	-	-	-	-
CO3	-	-	-	-	2	-	-	-	-	-	2	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	-	3	-	-	-	-
CO5	2	-	2	-	-	-	1	1	2	-	2	-	-	-	-
AVG	0.8	-	1.2	-	0.8	-	0.4	0.2	0.8	-	2	-	-	-	-

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

23CHO008	**CHEMICAL PROCESS SAFETY (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Teach the principles of safety applicable to the design, and operation of chemical process plants.
- Ensure that potential hazards are identified and mitigation measures are in place to prevent unwanted release of energy.
- Learn about the hazardous chemicals into locations that could expose employees and others to serious harm.
- Focuses on preventing incidents and accidents during large scale manufacturing of chemicals and pharmaceuticals.
- Ensure that the general design of the plant is capable of complying with the dose limits in force and with the radioactive releases.

Unit I	**SAFETY IN THE STORAGE AND HANDLING OF CHEMICALS AND GASES**	**9**

Types of storage-general considerations for storage layouts- atmospheric venting, pressure and temperature relief - relief valve sizing calculations - storage and handling of hazardous chemicals and industrial gases, safe disposal methods, reaction with other chemicals, hazards during transportation - pipe line transport - safety in chemical laboratories

Unit II	**CHEMICAL REACTION HAZARDS**	**9**

Hazardous inorganic and organic reactions and processes, Reactivity as a process hazard, Detonations, Deflagrations, and Runaways, Assessment and Testing strategies, Self - heating hazards of solids, Explosive potential of chemicals, Structural groups and instability of chemicals, Thermochemical screening

Unit III	**SAFETY IN THE DESIGN OF CHEMICAL PROCESS PLANTS**	**9**

Design principles -Process design development -types of designs, feasibility survey, preliminary design, Flow diagrams, piping and instrumentation diagram, batch versus continuous operation, factors in equipment scale up and design, equipment specifications - reliability and safety in designing - inherent safety - engineered safety - safety during startup and shutdown - non destructive testing methods - pressure and leak testing - emergency safety devices
- scrubbers and flares- new concepts in safety design and operation- Pressure vessel testing standards- Inspection techniques for boilers and reaction vessels

Unit IV	**SAFETY IN THE OPERATION OF CHEMICAL PROCESS PLANTS**	**9**

Properties of chemicals - Material Safety Data Sheets - the various properties and formats used - methods available for property determination. Operational activities and hazards -standards operating procedures - safe operation of pumps, compressors, heaters, column, reactors, pressure vessels, storage vessels, piping systems - effects of pressure, temperature, Flow rate and humidity on operations - corrosion and control measures- condition monitoring - control
valves - safety valves - pressure reducing valves, drains, bypass valves, inert gases. Chemical splashes, eye irrigation and automatic showers.

Unit V	SAFETY AND ANALYSIS	9

Safety vs reliability- quantification of basic events, system safety quantification, Human error analysis, Accident investigation and analysis, OSHAS 18001 and OSHMS.

Total periods:45

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**
CO 1: Differentiate between inherent safety and engineered safety and recognize the importance of safety in the design of chemical process plants.	Apply K3
CO2: Develop thorough knowledge about safety in the operation of chemical plants.	Apply K3
CO3: Apply the principles of safety in the storage and handling of gases	Apply K3
CO4: Identify the conditions that lead to reaction hazards and adopt measures to prevent them**.**	Apply K3
CO5: Develop thorough knowledge about	Apply K3

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	1	-	-	1	-	-	-	2	-	-
CO2	-	-	-	2	-	-	-	-	1	-	-	-	-	2	-
CO3	-	3	-	1	-	-	-	2	-	-	1	-	-	-	-
CO4	-	2	-	-	-	1	-	-	1	-	-	-	-	-	2
CO5	-	2	3	-	-	-	-	1	-	-	1	-	-	-	-
AVG	0.4	2	0.6	0.6	-	0.4	-	0.6	0.6	-	0.4	-	0.4	0.4	0.4

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

- NIL

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, special 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 specific 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 - He-Ne, 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, 2 nd 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**
CO 1: Understand various types of dielectric materials, their properties in various conditions.	Understand (K2)
CO2: Evaluate magnetic materials and their behavior.	Understand (K2)
CO3: Evaluate semiconductor materials and technologies.	Apply (K3)
CO4: Select suitable materials for electrical engineering applications.	Analyze (K4)
CO5: Identify right material for optical and optoelectronic applications	Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	2	2	2	1
CO2	3	2	2	2	-	-	-	-	-	-	-	2	2	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	2	2	2	1
CO4	3	2	1	2	-	-	-	-	-	-	-	2	2	2	1
CO5	3	2	2	2	-	-	-	-	-	-	-	2	2	2	1
AVG	3	2	1.6	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

- NIL

Course Objectives:

The main learning objective of this course is to prepare the students for:

- 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 306 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. 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 (K2)
CO2: Recognise the effects of dimensionality of materials on the properties	Analyze (K4)
CO3: Process different nanomaterials and use them in engineering applications	Apply (K3)
CO4: Use appropriate techniques for characterising nanomaterials	Analyze (K4)
CO5: Identify and use different nanomaterials for applications in different engineering fields.	Apply (K3)

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	2	2	2	-
CO2	3	1	2	2	-	-	-	-	-	-	-	2	2	2	1
CO3	3	2	1	2	-	-	-	-	-	-	-	2	2	2	-
CO4	3	1	-	2	-	-	-	-	-	-	-	2	2	2	2
CO5	3	2	2	2	-	-	-	-	-	-	-	2	2	2	1
AVG	3	1.6	1.4	2	-	-	-	-	-	-	-	2	2	2	0.8

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

23CEO011	HYDRAULICS AND PNEUMATICS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

1. To knowledge on fluid power principles and working of hydraulic pumps
2. To obtain the knowledge in hydraulic actuators and control components
3. To understand the basics in hydraulic circuits and systems
4. To obtain the knowledge in pneumatic and electro pneumatic systems
5. To apply the concepts to solve the trouble shooting

Unit I	FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS	9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

Unit II	HYDRAULIC ACTUATORS AND CONTROL COMPONENTS	9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

Unit III	HYDRAULIC CIRCUITS AND SYSTEMS	9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit IV	PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS	9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits

Unit V	TROUBLE SHOOTING AND APPLICATIONS	9
Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.		
	Total periods:45 periods	

Text Books:

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997.

References:

1. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls". Chand & Co, 2006.
2. Majumdar, S.R., "Oil Hydraulics Systems – Principles and Maintenance", Tata McG Raw Hill, 2001.
3. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGRaw Hill, 2007.
4. Dudley, A. Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987
5. Srinivasan. R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008
6. Joshi.P, Pneumatic Control", Wiley India, 2008.
7. Jagadeesha T, "Pneumatics Concepts, Design and Applications ", Universities Press, 2015.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Analyze the methods in fluid power principles and working of hydraulic pumps	Analyze (L4)
CO2: Recognize the concepts in hydraulic actuators and control components	Remember (L1)
CO3: Obtain the knowledge in basics of hydraulic circuits and systems	Understand (L2)
CO4: Know about the basics concept in pneumatic and electro pneumatic systems	Remember (L1)
CO5: Apply the concepts to solve the trouble shooting hydraulic and pneumatics	Apply (L3)

CO - PO & PSO 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	1
CO2	3	2	1	-	2	2	-	-	-	-	-	1	2	2	1
CO3	3	2	1	-	2	2	-	-	-	-	-	1	2	2	1
CO4	3	2	1	-	2	2	-	-	-	-	-	1	2	2	1
CO5	3	2	1	-	2	2	-	-	-	-	-	1	2	2	1
AVG	3	2	1	-	2	2	-	-	-	-	-	1	2	2	1

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

<table>
<tr><td rowspan="3">23EEO008</td><td rowspan="3">SENSORS
(Common to
BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- Nil

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. Histand, “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 densor response.	Understand (K2)
CO2: Analyze and select suitable sensor for displacement, proximity and range measurement.	Analyze (K4)
CO3: Analyze and select suitable sensor for force, magnetic field, speed, position and direction measurement.	Analyze (K4)
CO4: Analyze and Select suitable sensor for light detection, pressure and temperature measurement and also familiar with other miniaturized smart sensors.	Analyze (K4)
CO5: Select and design suitable signal conditioning circuit with proper compensation and linearizing element based on sensor output signal	Apply (K3)

CO - PO & PSO Mapping															
Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	-	-	-	-	-	-	-	1	2	3	2	1
CO2	3	3	2	1	1	1	-	-	-	-	1	2	3	2	1
CO3	3	3	2	1	1	1	-	-	-	-	1	2	3	2	1
CO4	3	3	2	1	1	1	-	-	-	-	1	2	3	2	1
CO5	3	3	2	1	1	1	-	-	-	-	1	2	3	2	1
AVG	3	3	2	0.8	0.8	0.8	-	-	-	-	1	2	3	2	1
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23ECO006	**CONCEPTS IN MOBILE ROBOTS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	0	0	3

Prerequisites

- NIL

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 Roots – 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	

Text Books:

1.Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge,
2004.

References:

1.Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth- Heinemann, 2018

2.MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing,
2015.

3.Peter Corke, “Robotics, Vision and Control”, Springer, 2017.

4.Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.

5.Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.

6.Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN:
978-1107031159.

Course Outcomes:	Blooms Taxonomy
CO1: Understand the fundamental concepts, types, and locomotion mechanisms of mobile robots.	Understand-K2
CO2: Apply kinematic principles for analyzing motion, navigation, and control of mobile robotic systems.	Apply-K3

CO3: Analyze and differentiate various perception and sensing techniques used in mobile robots.	Analyze-K4
CO4: Apply mapping and localization methods including SLAM for autonomous mobile robot navigation.	Apply-K3
CO5: Apply planning and navigation strategies in collaborative and swarm robotic applications.	Apply-K3

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	-	-	-	1	1	-	2	3	3	3
CO2	3	3	2	2	3	-	-	-	1	1	-	2	3	3	3
CO3	3	3	2	3	3	-	-	-	1	1	-	2	3	3	3
CO4	3	2	2	2	3	-	-	-	1	1	1	2	3	3	3
CO5	3	3	2	2	3	-	-	-	1	1	1	2	3	3	3
AVG	3	2.6	2	2	3	-	-	-	1	1	0.4	2	3	3	3

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

23MEO015	**MARINE PROPULSION**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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**
CO 1: Explain the basics of propulsion system and ship dynamic movements	Understand (K2)
CO2: Familiarize with various components assisting ship stabilization.	Understand (K2)
CO3: Demonstrate the performance of the ship.	Apply (K3)
CO4: Classify the Propeller and its types, Materials etc.	Analyze (K4)
CO5: Categories the Rudder and its types, design criteria of rudder.	Analyze (K4)

CO - PO & PSO Mapping

Particular	PO	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO	PSO3

	1									**0**	**1**	**2**	**1**	**2**	
CO1	1	1	1	1	1	-	-	-	-	-	1	1	-	1	-
CO2	1	1	1	-	-	-	-	-	-	-	-	-	-	1	-
CO3	1	-	-	1	1	-	-	-	1	1	1	-	1	1	-
CO4	1	-	1	1	-	-	-	-	-	-	-	-	-	1	-
CO5	1	-	1	1	-	-	-	-	-	-	-	-	-	1	-
AVG	1	0.4	0.8	0.8	0.4	-	-	-	0.2	0.2	0.4	0.2	0.2	1	-
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23MEO016	**MARINE MERCHANT VESSELS**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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	

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**
CO 1: Acquire Knowledge on floatation of ships	Understand
CO2: Acquire Knowledge on features of various ships	Remember
CO3: Acquire Knowledge of Shipbuilding Materials	Understand
CO4: Acquire Knowledge to identify the different types of marine propeller and rudder	Apply
CO5: Understand the Roles and responsibilities of governing bodies	Understand
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
CO2	2	1	1	-	-	-	-	-	-	-	-	-	1	1	1
CO3	3	2	2	-	2	-	1	-	-	-	-	1	3	2	2
CO4	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO5	1	1	-	-	-	2	2	3	-	1	-	2	1	1	1
AVG	2.2	1.6	1.5	1	1.6	2	1.5	3	-	1	-	1.3	1.8	1.4	1.4

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

<table>
<tr><td rowspan="3">23MEO017</td><td rowspan="3">ELEMENTS OF MARINE ENGINEERING</td><td colspan="4">Category: OEC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Prerequisites

- NIL

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**
CO 1: Distinguish the role of various marine machinery systems.	Analyze (K4)
CO2: Relate the components of marine propulsion machinery system.	Understand (K2)
CO3: Explain the importance of marine auxiliary machinery system.	Understand (K2)
CO4: Acquire knowledge of marine boiler system.	Understand (K2)
CO5: Understand the importance of ship propellors and steering system.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	1	-	-	2	3	2	2
CO2	3	2	-	-	-	-	-	-	1	-	-	2	3	2	2
CO3	3	2	-	-	-	-	-	-	1	-	-	2	3	3	2
CO4	3	2	-	-	-	-	-	-	1	-	-	2	2	3	2
CO5	3	2	-	-	-	-	-	-	1	-	-	2	2	2	3
AVG	3	2	-	-	-	-	-	-	1	-	-	2	2.6	2.2	2.2

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

23ECO007	**DRONE TECHNOLOGIES**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the basics of drone concepts.
- To learn and understand the fundaments 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. Zavrsnik, “Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance”, Springer, 2018.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Know about a various type of drone technology, drone fabrication and programming.	Understand (K2)
CO2: : Execute the suitable operating procedures for functioning a drone	Understand (K2)
CO3: Select appropriate sensors and actuators for Drones	Apply (K3)
CO4: Develop a drone mechanism for specific applications	Analyze (K4)
CO5: Create the programs for various drones	Understand (K2)
CO - PO & PSO Mapping	

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

1 - Low, 2 - Medium, 3 - High3 , '-' No correlation

23CEO005	**GEOGRAPHICAL INFORMATION SYSTEM (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Understand basic concepts and components of GIS
- Explain spatial data models and database structures in GIS
- Apply data input, georeferencing, projections, coordinate transformations and topology concepts
- Analyze data quality measures and GIS standards
- Apply data management operations, conversions and map outputs in GISFUNDAMENTALS OF GIS

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 –318 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**
CO 1: Have basic idea about the fundamentals of GIS	Understand-K2
CO2: Understand the types of data models	Analyze-K4
CO3: Get knowledge about data input and topology	Apply-K3
CO4: Gain knowledge on data quality and standards	Evaluate-K5
CO5: Understand data management functions and data output	Apply-L3,Create-K6

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3

CO2	3	-	-	-	3	-	-	-	-	-	-	-	3	3	3
CO3	3	-	3	3	-	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	-	3	3	3
AVG	3	1.5	3	3	3	-	-	-	-	-	-	-	3	3	3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO006	**AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

NIL

Course Objective:

- To learn what entrepreneurship is and how businesses grow in India.
- To understand agribusiness and global trade rules.
- To develop basic management and financial skills for running a business.
- To know how government support and policies help entrepreneurs.
- To explore business opportunities in agriculture and related industries.

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
CO2: Evaluate basic concepts, principles and functions of financial management	Evaluate
CO3: Improve the skills on basic banking and insurance schemes available to customers	Apply/Analyze
CO4: Analyze various financial data for efficient farm management	Analyze
CO5: Identify the financial institutions	Remember
CO - PO & PSO Mapping	

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

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

23CEO010	BIODIVERSITY CONSERVATION (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To recognize .and describe the major components and levels of biological diversity.
- To understand taxonomic principles and apply them in identifying plants, animals, and microbes.
- To analyze patterns of species distribution, evolutionary relationships, and ecological interactions.
- To evaluate global and regional biodiversity issues, hotspot regions, and conservation challenges.
- To apply in-situ and ex-situ conservation strategies for sustainable biodiversity management.

Unit I	INTRODUCTION	9

Concept of Species, Variation; Introduction to Major Plant Groups; Evolutionary relationships between Plant Groups; Nomenclature and History of plant taxonomy; Systems of Classification and their Application; Study of Plant Groups; Study of Identification Characters; Study of important families of Angiosperms; Plant Diversity Application.

Unit II	INTRODUCTION TO ANIMAL DIVERSITY AND TAXONOMY	9
Principles and Rules of Taxonomy; ICZN Rules, Animal Study Techniques; Concepts of Taxon, Categories, Holotype, Paratype, Topotype etc; Classification of Animal kingdom, Invertebrates, Vertebrates, Evolutionary relationships between Animal Groups.		
Unit III	**MICROBIAL DIVERSITY**	**9**
Microbes and Earth History, Magnitude, Occurrence and Distribution. Concept of Species, Criteria for Classification, Outline Classification of Microorganisms (Bacteria, Viruses and Protozoa); Criteria for Classification and Identification of Fungi; Chemical and Biochemical Methods of Microbial Diversity Analysis		
Unit IV	**MEGA DIVERSITY**	**9**
Biodiversity Hot-spots, Floristic and Faunal Regions in India and World; IUCN Red List; Factors affecting Diversity, Impact of Exotic Species and Human Disturbance on Diversity, Dispersal, Diversity-Stability Relationship; Socio- economic Issues of Biodiversity; Sustainable Utilization of Bioresources; National Movements and International Convention/Treaties on Biodiversity.		
Unit V	**CONSERVATIONS OF BIODIVERSITY**	**9**
In-Situ Conservation- National parks, Wildlife sanctuaries, Biosphere reserves; Ex-situ 322 conservation- Gene bank, Cryopreservation, Tissue culture bank; Long term captive breeding, Botanical gardens, Animal Translocation, Zoological Gardens; Concept of Keystone Species, Endangered Species, Threatened Species, Rare Species, Extinct Species.		
Total periods:45 periods		
Text Books:		
1.A textbook of Botany: Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology. S. Chand, Limited, Pandey, B. P. January 2001		
2.Principles of Systematic Zoology, Mcgraw-Hill College, Ashlock, P.D., Latest Edition.		
3.Microbiology, MacGraw Hill Companies Inc, Prescott, L.M., Harley, J.P., and Klein D.A. (2022).		
4. Microbiology, Pearson Publisher, Gerard J. Tortora, Berdell R. Funke, Christine L.Case, 13th Edition 2019		
References:		
1. Ecological Census Technique: A Handbook, Cambridge University Press, Sutherland, W.		
2. Encyclopedia of Biodiversity, Academic Press, Simonson Asher Levin.		

Course Outcomes:	Blooms Taxonomy
CO1: An insight into the structure and function of diversity for ecosystem stability.	Understand
CO2: Understand the concept of animal diversity and taxonomy	Apply
CO3: Understand socio-economic issues pertaining to biodiversity	Analyze
CO4: An understanding of biodiversity in community resource management.	Evaluate
CO5: An understanding of biodiversity in community resource management.	Create

CO - PO & PSO Mapping

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	2	-	-	-	-	-	2	-	2	-	-	2	2	-
CO2	-	2	-	2	2	2	-	-	-	-	-	-	3	2	-
CO3	-	-	-	2	-	2	-	-	-	-	-	-	3	2	3
CO4	3	2	-	-	2	-	-	2	2	2	2	-	-	2	3
CO5	-	2	3	2	-	-	1	-	-	-	-	1	3	2	-
AVG	1.5	2	1.5	2	2	2	1	1.5	1	2	1	1	2.5	2	2

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

23EEO009	INTRODUCTION TO CONTROL SYSTEMS	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

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 & ROOTLOCUS 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 Edition2015.		
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 AnalysisandDesign, 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 Impression2010.		

Course Outcomes:	Blooms Taxonomy
CO 1: Design the basic mathematical model of physical System.	Apply (K3)
CO2: Analyze the time response analysis and techniques.	Analyze (K4)
CO3: Analyze the transfer function from different plots.	Analyze (K4)
CO4: Apply the stability concept in various criterion.	Apply (K3)
CO5: Assess the state models for linear and continuous Systems.	Evaluate (K5)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	-	-	-	-	-	-	2	3	3	3
CO2	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	-	3	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	3	3	3
CO5	3	3	3	1	1	-	-	-	-	-	-	1	3	3	3
AVG	3	3	2.8	2	1.6	-	-	-	-	-	-	1.6	3	3	3
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

- NIL

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	

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**
CO 1: Design a signal conditioning circuits for various application	Applying
CO2: Acquire a detail knowledge on data acquisition system interface and DCS system	Understanding
CO3: Understand the basics and Importance of communication buses in applied automation Engineering	Understanding
CO4: Ability to design PLC Programmes by Applying Timer/Counter and Arithmetic and Logic Instructions Studied for Ladder Logic and Function Block.	Applying
CO5: Able to develop a PLC logic for a specific application on real world problem.	Creating
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	PSO3

CO1	3	2	3	2	2	-	1	1	1	-	-	1	3	2	1
CO2	2	2	1	3	2	-	2	2	2	-	-	2	2	3	2
CO3	1	2	1	-	3	-	1	1	2	-	-	2	1	2	3
CO4	2	2	3	1	3	-	2	2	2	-	1	2	2	3	3
CO5	2	3	3	1	3	1	3	3	3	1	2	3	2	3	3
AVG	2	2.2	2.2	1.4	2.6	0.2	1.8	1.8	1.8	0.2	0.2	2	2.4	2	2.4
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23EEO010	**ENERGY TECHNOLOGY**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the fundamentals of energy, its types, and the global/Indian energy scenario.
- To explain the working, efficiency, merits, and demerits of conventional energy systems.
- To learn and analyze the various non-conventional and renewable energy technologies.
- To understand biomass conversion processes and modern fuel cell systems.
- To apply energy conservation methods and perform energy audits in process industries.

Unit I	**ENERGY TECHNOLOGY 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**
CO 1: Understand basic concepts, classification, and global/Indian energy scenarios.	Understand (K2)
CO2: Explain the principles and operation of conventional energy systems.	Understand (K2)
CO3: Analyze various non-conventional/renewable energy sources and their applications.	Analyze (K4)
CO4: Understand biomass conversion processes and fuel cell technologies.	Understand (K2)
CO5: Apply energy conservation techniques and conduct energy audits in process industries.	Apply (K3)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	2	3	3	-	-	-	1	1	-	3	1	1	3
CO2	2	3	1	3	3	-	-	-	1	1	-	3	2	1	3
CO3	2	2	2	3	3	1	1	-	1	1	-	3	2	1	3
CO4	2	2	1	3	3	1	1	1	1	-	1	3	1	1	3
CO5	2	2	1	3	3	1	1	1	1	-	1	3	2	1	3
AVG	2	2.4	1.4	3	3	0.8	0.8	0.6	1	0.4	0.6	3	1.6	1	3
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO007	ENVIRONMENT AND AGRICULTURE	Category: BSC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- **-NIL-**

Course Objectives:

- To emphasize on the importance of environment and agriculture on changing global scenario and the emerging issues connected to it.

Unit I	ENVIRONMENTAL CONCERNS	9

Environmental basis for agriculture and food – Land use and landscape changes – Water quality issues – Changing social structure and economic focus – Globalization and its impacts – Agro ecosystems.

Unit II	ENVIRONMENTAL IMPACTS	9

Irrigation development and watersheds – mechanized agriculture and soil cover impacts – Erosion and problems of deposition in irrigation systems – Agricultural drainage and downstream impacts – Agriculture versus urban impacts.

Unit III	CLIMATE CHANGE	9

Global warming and changing environment – Ecosystem changes – Changing blue-green-grey water cycles – Water scarcity and water shortages – Desertification.

Unit IV	ECOLOGICAL DIVERSITY AND AGRICULTURE	9

Ecological diversity, wild life and agriculture – GM crops and their impacts on the environment – Insets and agriculture – Pollination crisis – Ecological farming principles – Forest fragmentation and agriculture – Agricultural biotechnology concerns.

Unit V	EMERGING ISSUES	9

Global environmental governance – alternate culture systems – Mega farms and vertical farms – Virtual water trade and its impacts on local environment – Agricultural environment policies and its impacts – Sustainable agriculture.

Total periods: 45

Text Books:

1.M.Lakshmi Narasaiah, Environment and Agriculture, Discovery Pub. House, 2006

2.Arvind Kumar, Environment and Agriculture, ABH Publications, New Delhi, 2005.

References:

1.T.C. Byerly, Environment and Agriculture, United States. Dept. of Agriculture. Economic Research Service, 2006.

2.Robert D. Havener, Steven A. Breth, Environment and agriculture: rethinking development issues for the 21st century : proceedings of a symposium, Winrock International Institute for Agricultural Development, 1994

3.Environment and agriculture: environmental problems affecting agriculture in the Asia and Pacific region; World Food Day Symposium, Bangkok, Thailand. 198

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the Environmental Impact on Agriculture	Understand (K2)
CO2: Analyze the Ecological and Socio-economic Impacts of Agricultural Practices	Understand (K2)
CO3: Evaluate the Effects of Climate Change on Agriculture	Apply (K3)
CO4: Explore the Role of Biodiversity in Sustainable Agriculture	Understand (K2)
CO5: Investigate Emerging Agricultural Issues and Solutions for Sustainability	Analyze (K4)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-	1	-	3	3	-	-	-	-	-	2	1	-
CO2	3	3	2	2	-	3	3	1	-	-	-	-	3	2	-
CO3	3	3	2	3	1	3	3	1	-	-	-	-	3	2	1
CO4	2	2	1	2	-	3	3	-	-	-	-	-	2	3	1
CO5	3	3	3	3	2	3	3	1	-	1	-	-	3	3	2
AVG	2.6	2.6	1.6	2.2	0.6	3	3	0.6	-	0.2	-	-	2.6	2.2	0.8

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

23BTO004	FUNDAMENTALS OF FOOD ENGINEERING	Category: OEC			
		L	T	P	C
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- Acquaint and equip the students with different techniques of measurement of engineering properties.
- Make the students understand the nature of food constituents in the design of processing equipment.
- Enable the students to learn the principles of drying, dehydration, and selection of suitable drying equipment.
- Help the students understand size-reduction mechanisms, energy requirements, and related food processing machinery.
- Familiarize the students with mechanical separation methods such as centrifugation, filtration, and membrane processes used in food engineering.

Unit I	ENGINEERING PROPERTIES OF FOOD MATERIALS	9

Engineering properties of food materials: physical, thermal, aerodynamic, mechanical, optical and electromagnetic properties.

Unit II	DRYING AND DEHYDRATION PROCESSES AND EQUIPMENT	9

Drying and dehydration: Basic drying theory, heat and mass transfer in drying, drying rate curves, calculation of drying times, dryer efficiencies; classification and selection of dryers; tray, vacuum, osmotic, fluidized bed, pneumatic, rotary, tunnel, trough, bin, belt, microwave, IR, heat pump and freeze dryers; dryers for liquid: Drum or roller dryer, spray dryer and foammat dryers.

Unit III	SIZE REDUCTION PRINCIPLES AND FOOD COMMINUTION EQUIPMENT	9

Size reduction: Benefits, classification, determination and designation of the fineness of ground material, sieve/screen analysis, principle and mechanisms of comminution of food, Rittinger's, Kick's and Bond's equations, work index, energy utilization; Size reduction equipment: Principal types, crushers (jaw crushers, gyratory, smooth roll), hammer

mills and impactors, attrition mills, buhr mill, tumbling mills, tumbling mills, ultra fine grinders, fluid jet pulverizer, colloid mill, cutting machines (slicing, dicing, shredding, pulping).

Unit IV	MIXING THEORY AND MIXING EQUIPMENT IN FOOD PROCESSING	9
Mixing: theory of solids mixing, criteria of mixer effectiveness and mixing indices, rate of mixing, theory of liquid mixing, power requirement for liquids mixing; Mixing equipment: Mixers for lo.w- or medium-viscosity liquids (paddle agitators, impeller agitators, powder-liquid contacting devices, other mixers), mixers for high viscosity liquids and pastes, mixers for dry powders and particulate solids.		
Unit V	**MECHANICAL AND MEMBRANE SEPARATION PROCESSES IN FOOD ENGINEERING**	**9**
Mechanical Separations: Theory, centrifugation, liquid-liquid centrifugation, liquid-solid centrifugation, clarifiers, desludging and decanting machine, Filtration: Theory of filtration, rate of filtration, pressure drop during filtration, applications, constant-rate filtration and constant-pressure filtration, derivation of equation; Filtration equipment; plate and frame filter press, rotary filters, centrifugal filters and air filters, filter aids, Membrane separation: General considerations, materials for membrane construction, ultra-filtration, microfiltration, concentration, polarization, processing variables, membrane fouling, applications of ultra-filtration in food processing, reverse osmosis, mode of operation, and applications; Membrane separation methods, demineralization by electro dialysis, gel filtration, ion exchange, per-evaporation and osmotic dehydration.		
Total periods: 45 PERIODS		
Text Books:		
1. R.L. Earle. 2004. Unit Operations in Food Processing. The New Zealand Intitute of Food Science & Technology, Nz. Warren L. McCabe, Julian Smith, Peter Harriott. 2004.		
2. Unit Operations of Chemical Engineering, 7th Ed. McGraw-Hill, Inc., NY, USA. Christie John Geankoplis. 2003.		
3. Transport Processes and Separation Process Principles (Includes Unit Operations), 4th Ed. Prentice-Hall, NY, USA.		
4. George D. Saravacos and Athanasios E. Kostaropoulos. 2002. Handbook of Food Processing Equipment. Springer Science+Business Media, New York, USA.		
5. J. F. Richardson, J. H. Harker and J. R. Backhurst. 2002. Coulson & Richardson's Chemical Engineering, Vol. 2, Particle Technology and Separation Processes, 5th Ed.		
References:		
1. R.T. Toledo, *Fundamentals of Food Process Engineering*, Springer, 3rd Edition, 2007.		
2. Zeki Berk, *Food Process Engineering and Technology*, Academic Press, 3rd Edition, 2018.		
3. R. Paul Singh & Dennis R. Heldman, *Introduction to Food Engineering*, Academic Press, 5th Edition, 2013.		
4. George D. Saravacos & Athanasios E. Kostaropoulos, *Handbook of Food Processing Equipment*, Springer, 2016.		

Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand the engineering properties of food materials and their significance in food processing.	Understand (K2)
CO2: Understand the effect of various methods of processing on the structure and texture of food materials**.**	Understand (K2)
CO3: Understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation.	Apply (K3)
CO4: Understand the theory of mixing and the operation of different mixers used for food materials.	Understand (K2)
CO5: Understand the principles of mechanical separation and the working of centrifugation, filtration, and membrane separation equipment.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	1	-	-	-	-	-	-	-	3	2	-
CO2	3	2	2	1	1	-	-	-	-	-	-	-	3	2	-
CO3	3	3	3	2	2	-	-	-	-	-	-	-	3	3	-
CO4	2	2	2	1	1	-	-	-	-	-	-	-	2	2	-
CO5	3	2	3	2	1	-	-	-	-	-	-	-	3	3	-
AVG	2.8	2.2	2.4	1.4	1.2	-	-	-	-	-	-	-	2.8	2.4	0.6

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

23BTO005	**FOOD SAFETY AND QUALITY REGULATION**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To help become skilled in systems for food safety surveillance
- To ensure processed food meets global standards
- To characterize different type of food hazards, physical, chemical and biological in the industry and food service establishments
- To be aware of the regulatory and statutory bodies in India and the world
- To understand food safety hazards, quality control systems, and the national and global regulations governing food safety.

Unit I	INTRODUCTION TO FOOD SAFETY AND SECURITY	9
Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials. Control of rats, rodents, mice, birds, insects and microbes. Cleaning and Disinfection, ISO 22000 – Importance and Implementation		
Unit II	**FOOD QUALITY**	**9**
Food quality: Various Quality attributes of food, Instrumental, chemical and microbial Quality control. Sensory evaluation of food and statistical analysis. Water quality and other utilities.		
Unit III	**CRITICAL QUALITY CONTROL & HACCP SYSTEM**	**9**
Critical Quality control point in different stages of production including raw materials and processing materials. Food Quality and Quality control including the HACCP system. Food inspection and Food Law, Risk assessment – microbial risk assessment, dose response and exposure response modelling, risk management, implementation of food surveillance system to monitor food safety, risk communication		
Unit IV	**INDIAN AND GLOBAL REGULATIONS**	**9**
Indian and global regulations: FAO in India, Technical Cooperation programmes, Bio-security in Food and Agriculture, World Health Organization (WHO), World Animal Health Organization (OIE), International Plant Protection Convention (IPPC)		
Unit V	**CODEX ALIMENTARIUS COMMISSION & NATIONAL IMPLEMENTATION**	**9**
Codex Alimentarius Commission - Codex India – Role of Codex Contact point, National Codex contact point (NCCP), National Codex Committee of India – ToR, Functions, Shadow Committees etc.		
		Total periods: 45 PERIODS

Text Books:

1. Handbook of food toxicology by S. S. Deshpande, 2002
2. The food safety information handbook by Cynthia A. Robert, 2009
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979
4. Microbiological safety of Food by Hobbs BC, 1973

References:	
1. Microbiological safety of Food by Hobbs BC, 1973	
2. The food safety information handbook by Cynthia A. Robert, 2009	
Course Outcomes:	**Blooms Taxonomy**
CO 1: Understand food hazards and hygiene principles in food systems.	Understand (K2)
CO2: Demonstrate awareness of regulatory and statutory food safety bodies.	Understand (K2)
CO3: Apply food quality assessment techniques and analyses.	Apply (K3)
CO4: Analyze CCPs, HACCP, food laws, inspections, and risk assessment methods.	Analyze (K4)
CO5: Understand and interpret global standards like Codex and their national implementation.	Understand (K2)
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	2	1	-	-	-	-	1	1	-	2	3	2	-
CO2	3	2	2	1	-	-	-	-	1	2	-	2	3	2	-
CO3	3	3	3	2	2	1	-	-	2	2	-	3	3	2	2
CO4	3	3	3	3	2	1	-	-	3	3	2	3	3	3	2
CO5	2	3	2	1	-	-	-	-	1	2	-	2	3	2	-
AVG	2.8	2.4	2.2	1.2	1.2	0.7	-	-	1.2	2	0.7	2.4	2.6	2.4	1.2

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

23BTO006	**NUTRACEUTICALS**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To understand the basic concepts of Nutraceuticals and functional food, their chemical nature and methods of extraction.
- To understand the role of Nutraceuticals and functional food in health and disease.
- To introduce methods for assessing antioxidant activity and understanding their underlying mechanisms.
- To explain the health roles of major nutraceuticals and functional foods across different diseases and physiological systems.
- To provide awareness of safety, toxicity, health claims, and regulatory standards related to nutraceuticals.

Unit I	INTRODUCTION AND SIGNIFICANCE	9
Introduction to Nutraceuticals and functional foods; importance, history, definition, classification, list of functional foods and their benefits, Phytochemicals, zoochemicals and microbes in food, plants, animals and microbes.		
Unit II	**PHYTOCHEMICALS AS NUTRACEUTICALS**	**9**
Phytoestrogens in plants; isoflavones; flavonols, polyphenols, tannins, saponins, lignans, lycopene, chitin, caratenoids. Manufacturing practice of selected nutraceuticals such as lycopene, isoflavonoids, glucosamine, phytosterols. Formulation of functional foods containing nutraceuticals - stability, analytical and labelling issues.		
Unit III	**ASSESSMENT OF ANTIOXIDANT ACTIVITY**	**9**
In vitro and in vivo methods for the assessment of antioxidant activity, Comparison of different in vitro methods to evaluate the antioxidant, antioxidant mechanism, Prediction of the antioxidant activity of natural phenolics from electrotopological state indices, Optimising phytochemical release by process technology; Variation of Antioxidant Activity during technological treatments, new food grade peptidases from plant sources.		
Unit IV	**ROLE IN HEALTH AND DISEASE**	**9**
The health benefit of - Soy protein, Spirulina, Tea, Olive oil, plant sterols, Broccoli, omega3 fatty acid and eicosanoids. Nutraceuticals and Functional foods in Gastrointestinal disorder, Cancer, CVD, Diabetic Mellitus, HIV and Dental disease; Importance and function of probiotic, prebiotic and synbiotic and their applications, Functional foods and immune competence; role and use in obesity and nervous system disorders.		
Unit V	**SAFETY ISSUES**	**9**
Health Claims, Adverse effects and toxicity of nutraceuticals, regulations and safety issues International and national.		
Total periods: 45 PERIODS		
Text Books:		
1. Bisset, Normal Grainger and Max Wich H “Herbal Drugs and Phytopharmaceuticals”, 2nd Edition, CRC, 2001.		
2. Handbook of Nutraceuticals and Functional Foods: Robert Wildman, CRC, Publications. 2006		
3. WEBB, PP, Dietary Supplements and Functional Foods Blackwell Publishing Ltd (United Kingdom), 2006		
4. Ikan, Raphael “Natural Products: A Laboratory Guide”, 2nd Edition, Academic Press / Elsevier, 2005.		
References:		

1. Asian Functional Foods (Nutraceutical Science and Technology) by John Shi (Editor), Fereidoon Shahidi (Editor), Chi-Tang Ho (Editor), CRC Publications, Taylor & Francis, 2007
2. Functional Foods and Nutraceuticals in Cancer Prevention by Ronald Ross Watson (Author), Blackwell Publishing, 2007
3. Marketing Nutrition: Soy, Functional Foods, Biotechnology, and Obesity by Brian Wansink.
4. Functional foods: Concept to Product: Edited by G R Gibson and C M Williams, Wood head Publ., 2000
5. Hanson, James R. “Natural Products: The Secondary Metabolites”, Royal Society of Chemistry, 2003.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Acquire knowledge about the Nutraceuticals and functional foods, their classification and benefits.	K2 – Understand
CO2: Acquire knowledge of phytochemicals, zoochemicals and microbes in food, plants,animals and microbes	K2 – Understand
CO3: Attain the knowledge of the manufacturing practices of selected nutraceutical components and formulation considerations of functional foods.	K3 – Apply
CO4: Distinguish the various In vitro and In vivo assessment of Antioxidant activity of compounds from plant sources.	K4 – Analyze
CO5: Gain information about the health benefits of various functional foods and nutraceuticals	K5 – Evaluate
CO - PO & PSO Mapping	

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	-	-	-	-	-		-	1	3	1	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1	3	2	1
CO3	3	-	-	-	-	2	-	-	-	-	-	-	2	3	2
CO4	3	-	-	-	-	-	-	-	-	-	-	-	1	2	3
CO5	3	-	-	-	-	-	-	2	-	-	-	1	2	1	3
AVG	3	-	-	-	-	0.4	-	0.4	-	-	-	1	2.6	1.8	1.6

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

23CHO010	**BASICS OF DYEING AND PRINTING (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

Course Objectives:

- To enable students to understand the impurities present in fibres and the basics of grey fabric inspection.
- To provide knowledge on various pretreatment processes such as desizing, scouring, bleaching, and mercerizing and their mechanisms.
- To introduce the concepts of dyeing, dye classifications, and methods of dye application on textile materials.
- To help students understand the fundamentals of textile printing, printing styles, thickeners, and printing paste preparation.
- To familiarize students with different textile processing machines used in dyeing, printing, and garment 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	**DYING**	**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-13:978-81-908001-4-3.

Course Outcomes:	**Blooms Taxonomy**
CO1: Basics of grey fabric	Understand (K2)
CO2: Basics of pre treatment	Analyze (K4)
CO3: Concept of Dyeing	Apply (K3)
CO4: Concept of Printing	Analyze (K4)
CO5: Machinery in processing industry	Understand (K2)
CO - PO & PSO Mapping	

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

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

23CEO011	**FIBRE SCIENCE (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	0	0	3

Prerequisites

- NIL

Course Objectives:

- To understand the classification, structure and essential properties of natural and man-made textile fibres.
- To learn the production sequence and characteristics of regenerated cellulosic fibres such as viscose, acetate, modal and lyocell.
- To study the manufacturing process, polymer requirements and properties of major synthetic fibres including polyester, nylon, acrylic and polypropylene.
- To gain knowledge about speciality fibres with high modulus, high tenacity, flame retardant, and chemical resistance properties and their applications.
- To understand functional speciality fibres such as medical fibres, biodegradable fibres, elastomeric fibres, ultra-fine fibres and electrospun nanofibres along with their end uses

Unit I	**FIBRE SCIENCE**	**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	**REGENERATED FIBRES**	**9**
Production Sequence of Regenerated Cellulosic fibres: Viscose Rayon, Acetate rayon – High wet modulus fibres: Modal and Lyocel ,Tencel		
Unit III	**SYNTHEITC FIBRES**	**9**
Production Sequence of Synthetic Fibers: polymer-Polyester, Nylon, Acrylic and polypropylene. Mineral fibres: fibre glass ,carbon .Introduction to spin finishes and texturization		
Unit IV	**SPECIALITY 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 SPECIALITY 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: Explain the classification, structure, production and basic properties of natural textile fibres.	Understand-K2
CO2: Describe the production sequence and characteristics of regenerated fibres such as viscose, acetate, modal, and lyocell.	Understand-K2
CO3: Understand the production steps, polymer requirements and properties of major synthetic fibres.	Understand-K2
CO4: Explain the characteristics and end-uses of speciality fibres including high-modulus,flame-retardant.	Analyze-K4
CO5: Explain the characteristics of high-modulus,flame-retardant, and chemical-resistant fibres	Understand-K2

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	3	2	-	-	2	-	-	-	-	-	-	-	3	2	2
CO4	3	3	2	2	-	-	-	-	-	-	-	-	3	3	2
CO5	3	2	-	-	2	-	-	-	-	-	-	-	3	3	3
AVG	3	2	0.4	0.4	0.8	-	-	-	-	-	-	-	3	2.6	1.4

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

23CEO012	GARMENT MANUFACTURING TECHNOLOGY	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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.
- To understand the principles of pattern making, marker planning and cutting techniques used in garment manufacturing.
- To identify and apply appropriate seams, stitches, needles, components and trims in garment construction.
- To analyze garment quality through inspection, pressing, packing and care labelling processes.

Unit I	PATTERN MAKING, MARKER PLANNING, CUTTING	9

Anthropometry, specification sheet, pattern making – principles, basic pattern set drafting, grading, marker planning, spreading & cutting

Unit II	TYPES OF SEAMS, STITCHES AND FUNCTIONS OF NEEDLES	9

Different types of seams and stitches; single needle lock stitch machine – mechanism and accessories; needle – functions, special needles, needlepoint

Unit III	COMPONENTS AND TRIMS USED IN GARMENT	9

Sewing thread-construction, material, thread size, packages, accessories – labels, linings, interlinings, wadding, lace, braid, elastic, hook and loop fastening, shoulder pads, eyelets and laces, zip fasteners, buttons

Unit IV	GARMENT INSPECTION AND DIMENSIONAL CHANGES	9

Raw material, in process and final inspection; needle cutting; sewability of fabrics; strength properties of apparel; dimensional changes in apparel due to laundering, dry-cleaning, steaming and pressing.

Unit V	GARMENT PRESSING, PACKING AND CARE LABELING	9

Garment pressing – categories and equipment, packing; care 336abelling of apparels

Total periods:45 PERIODS
Text Books:
1. Carr H., and Latham B., "The Technology of Clothing Manufacture", Blackwell Science Ltd., Oxford, 1994.
2. Gerry Cooklin, "Introduction to Clothing Manufacture" Blackwell Science Ltd., 1995. 64
3. Harrison.P.W Garment Dyeing, The Textile Institute Publication, Textile Progress, Vol .19 No.2,1988.
References:
1. Winifred Aldrich., "Metric Pattern Cutting", Blackwell Science Ltd., Oxford, 1994
2. Peggal H., "The Complete Dress Maker", Marshall Caverdish, London, 1985
3. Jai Prakash and Gaur R.K., "Sewing Thread", NITRA, 1994
4. Ruth Glock, Grace I. Kunz, "Apparel Manufacturing", Dorling Kindersley Publishing Inc., New Jersey, 1995.
5. Pradip V.Mehta, "An Introduction to Quality Control for the Apparel Industry", J.S.N. Internationals, 1992.

Course Outcomes:	**Blooms Taxonomy**
CO 1: Pattern making, marker planning, cutting	Understand (K2)
CO2: Types of seams, stitches and functions of needles	Identify (K6)
CO3: Components and trims used in garment	Understand (K2)
CO4: Garment inspection and dimensional changes	Analyze (K4)
CO5: Garment pressing, packing and careabelling	Apply (K3)
CO - PO & PSO Mapping	

Particular	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	-	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
AVG	1.6	1.2	1	0.8	1.6	1	1.2	1	0.2	1.8	2.4	1.2	2	2.6	1

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

23CEO009	**INDUSTRIAL SAFETY**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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
- Develop skills to conduct workplace safety audits and implement emergency response procedures.
- Promote a culture of occupational health awareness and continuous improvement in industrial safety practices.

Unit I	INTRODUCTION	9
Need for developing Environment, Health and Safety systems in work places - Accident Case Studies - Status and relationship of Acts - Regulations and Codes of Practice - Role of trade union safety representatives. International initiatives - Ergonomics and work place.		
Unit II	**OCCUPATIONAL HEALTH AND HYGIENE**	**9**
Definition of the term occupational health and hygiene - Categories of health hazards - Exposure pathways and human responses to hazardous and toxic substances - Advantages and limitations of environmental monitoring and occupational exposure limits - Hierarchy of control measures for occupational health risks - Role of personal protective equipment and the selection criteria - Effects on humans - control methods and reduction strategies for noise, radiation and excessive stress.		
Unit III	**WORKPLACE SAFETY AND SAFETY SYSTEMS**	**9**
Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and colour, Ventilation and Heat Control – Electrical Safety – Fire Safety – Safe Systems of work for manual handling operations – Machine guarding – Working at different levels – Process and System Safety.		
Unit IV	**HAZARDS AND RISK MANAGEMENT**	**9**
Safety appraisal - analysis and control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques – major accident hazard control – Onsite and Offsite emergency Plans.		
Unit V	**ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT**	**9**
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and methods of its effective implementation and review – Elements of Management Principles – Education and Training – Employee Participation.		

Total periods: 45 PERIODS	
Text Books:	
1. Industrial Safety, Health & Environment Management Systems - by R.K. Jain & Sunil S. Rao. This aligns very closely with your syllabus topics on safety systems, legal frameworks, risk management.	
2. Environmental & Health Safety Management: A Guide - this is a practical, compliance-oriented guide that covers both environmental and occupational safety aspects.	
References:	
1**.** Environmental & Health and Safety Management by Nicholas P. Cheremisinoff - a classic reference covering both environmental regulation and on-site safety practices.	
2. Industrial Safety Management: 21st Century Perspectives of Asia - edited by J. Maiti & Pradip K. Ray; useful for region-specific safety practices and risk assessment.	
3**.** Occupational and Environmental Safety and Health -covers modern OSH practices, ergonomic risk, and automated environments.	
4. Occupational and Environmental Safety and Health VI: Risk Assessment, Management and Case Studies - for advanced risk assessment techniques and real-world case studies.	
Course Outcomes:	**Blooms Taxonomy**
CO1: Describe, with example, the common work-related diseases and accidents in occupational setting	Understand (K2)
CO2: Name essential members of the Occupational Health team	Apply (K3)
CO3: 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	Apply (K3)
CO4: Analyze work place hazards using safety appraisal and inspection technique , investigate accident and prepare reports, develop onsite/offsite emergency response plans	Analyze (K4)
CO5: Students can be able to formulate problems using the maintainability and availability analyses by using theoretical approach	Understand (K2)
CO - PO & PSO Mapping	

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

CO3	2	2	3	1	2	3	3	2	1	2	1	2	3	2	2
CO4	1	3	2	3	2	3	2	3	1	2	1	2	3	2	3
CO5	1	2	2	1	1	3	3	3	3	3	2	3	1	3	3
AVG	1.6	2	1.8	1.4	1.2	3	2.4	2.4	1	2.4	1.2	2.4	2.4	2.4	2
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23CEO013	**UNIT OPERATIONS IN PETRO CHEMICAL INDUSTRIES (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To introduce the fundamental principles of fluid mechanics, fluid flow behavior, and basic equations governing flow systems.
- To enable students to understand and apply mechanical operation concepts such as flow measurement, size reduction, filtration, and pump characteristics.
- To develop knowledge of conductive and convective heat transfer mechanisms, insulation concepts, and the working of industrial heat exchangers.
- To provide a clear understanding of mass transfer fundamentals, including diffusion mechanisms, diffusivity measurement, and mass transfer coefficients.
- To familiarize students with essential mass transfer operations such as extraction, distillation, and drying along with their industrial applications.

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 Periods		
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		
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. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.		
4. Heat Transfer J P Holman McGraw Hill International Ed.		

Course Outcomes:	**Blooms Taxonomy**
CO1: State and describe the nature and properties of the fluids..	Understand (K2)
CO2: Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.	Analyze (K4)
CO3: Comprehend the laws governing the heat and mass transfer operations to solve the problems.	Analyze (K4)
CO4: Design the heat transfer equipment suitable for specific requirement.	Analyze (K4)
CO5: Analyze and apply mass transfer operations such as extraction, distillation, and drying in petrochemical processes.	Apply (K3)
CO - PO & PSO Mapping	

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

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

23MEO018	**PLASTIC MATERIALS FOR ENGINEERS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- NIL

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 specialty 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, bioPP, bio-PET, polymers for biomedical applications		
	Total :45 Periods	
Text Books:		
1. Marianne Gilbert (Ed.)Brydson’s Plastics Materials, 8th Edition, Elsevier, 2017.		
2. J.A. Brydson Plastics Materials, 7th Edition, Butterworth-Heinemann, 1999		
3. Manas Chanda, Salil K. RoyPlastics Technology Handbook, 4th Edition, CRC Press, 2006.		

4. H. Dominighaus*Plastics for Engineers*, Hanser Publishers, Munich, 1988.

5. Charles A. Harper*Modern Plastics Handbook*, McGraw-Hill, 1999.

6. Olagoke Olabisi, Kolapo Adewale (Eds.)*Handbook of Thermoplastics*, 2nd Edition, CRC Press, 2016.

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: Study the importance, advantages, and classification of plastic materials	Understand (K2)
CO2: Summarize raw materials, sources, production, properties, and applications of engineering thermoplastics	Remember / Understand (K1–K2)
CO3: Understand applications of polyamides, polyesters, and other engineering thermoplastics and thermosetting resins	Understand / Apply (K2–K3)
CO4: Explain manufacture, properties, and uses of thermosetting resins (polyester, epoxy, silicone, PU)	Understand (K2)
CO5: Understand engineering applications of miscellaneous polymers and different biopolymers	Understand / Apply (K2–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	2	2	1	1	1	1	3	3	2	-
CO2	3	3	2	2	2	1	1	1	1	1	1	3	3	3	-
CO3	3	3	2	2	2	1	1	1	1	2	1	3	3	3	-
CO4	3	2	2	2	3	1	1	1	1	1	1	3	3	3	-
CO5	3	2	2	2	1	2	3	1	1	2	1	3	3	2	-
AVG	3	2.4	1.8	1.8	1.6	1.4	1.6	1.2	1	1.2	1.2	3	3	2.6	-

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

23MEO018	PROPERTIES AND TESTING OF PLASTICS (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)	Category: OEC			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To understand the relevance of standards and specifications as well as the specimen 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 specifications. 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, specific 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 PERIODS		
Text Books:		
1.Vishu Shah, Handbook of Plastics Testing Technology, Wiley-Interscience, 1998.		
2.Edith A. Turi (Ed.), *Thermal Characterization of Polymeric Materials*, Academic Press, 1997.		
3. I. M. Ward, J. Sweeney, *Mechanical Properties of Solid Polymers*, Wiley, 2004.		
4. J. V. Edwards, *Characterization of Polymers and Fibers*, Springer, 2000.		
5. Wolfgang Grellmann, Sabine Seidler, *Polymer Testing*, Hanser Publishers, 2013.		
6. Barbara H. Stuart, *Polymer Analysis*, Wiley, 2002.		
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.		
6. S. K. Nayak, S. N. Yadav, S. Mohanty, Fundamentals of Plastic Testing, Springer, 2010.		

Course Outcomes:	**Blooms Taxonomy**
CO1: Understand the relevance of standards and specifications.	Understand (K2)
CO2: Summarize the various test methods for evaluating the mechanical properties of the polymers.	Understand (K2)
CO3: To know the thermal, electrical & optical properties of polymers.	Understand (K2)
CO4: Identify various techniques used for characterizing polymers.	Apply (K3)
CO5: 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	3	2	1	-	-	-	-	2	-	1	-	2	3	1	1
CO2	3	3	1	2	1	-	-	-	-	1	-	2	3	2	2
CO3	2	2	-	1	-	-	-	-	-	1	-	2	3	1	1
CO4	3	2	2	3	3	-	-	-	-	1	1	2	2	3	2
CO5	2	3	2	3	2	-	-	-	1	2	-	2	1	2	3
AVG	2.6	2.4	1.6	2.4	1.6	-	-	1.2	0.8	1.4	0.6	2	2.8	1.8	1.8
1 - Low, 2 - Medium, 3 - High , '-' No correlation															

23ECO008	**VLSI DESIGN (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

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	**TRANSISTOR PRINCIPLES**	**9**
MOS 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

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**
CO1: Understand the working principle and characteristics of MOSFET	Understand (K2)
CO2: Design Combinational Logic Circuits	Apply (K3)
CO3: Design Sequential Logic Circuits and Clocking systems	Create (K6)
CO4: Understand Memory architecture and interconnects	Understand (K2)
CO5: Design of arithmetic building blocks.	Create (K6)

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	-	-	-	-	3	2	-
CO2	3	2	-	-	3	-	-	2	-	-	-	-	3	2	-
CO3	3	3	-	-	3	-	-	2	-	-	-	-	3	2	-
CO4	2	2	-	-	2	-	-	1	-	-	-	-	2	2	-
CO5	3	3	-	-	3	-	-	2	-	-	-	-	3	2	1
AVG	2.8	2.4	-	-	2.6	-	-	1.6	-	-	-	-	2.8	2.2	0.3

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

23CEO008	**BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT (Common to BME,BT,CIVIL,CHEMICAL,ECE,EEE,MECH)**	**Category: OEC**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites

- Nil

Course Objectives:

- To introduce students to the interdisciplinary approach of Integrated Water Resources Management (IWRM).
- To develop understanding of water management principles, including social equity, ecological sustainability, and economic efficiency.
- To analyze the impacts of different water use sectors and explore strategies to secure water for multiple uses.
- To understand the economic aspects of water resources, including pricing, economic instruments, and public- private partnerships.
- To build awareness of recent trends, institutional frameworks, and challenges in implementing IWRM effectively.

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%20iwrm/Tutorial _text.pdf

4. Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.

5. The 17 Goals, United Nations, https://sdgs.un.org/goals.

Course Outcomes:	**Blooms Taxonomy**
CO1: Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.	Understand (K2)
CO2: Discuss on the different water uses; how it is impacted and ways to tackle these impacts.	Understand (K2)
CO3: Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.	Analyze (K4)
CO4: Illustrate the recent trends in water management.	Apply (K3)
CO5: Understand the implementation hitches and the institutional frameworks.	Understand (K2)

CO - PO & PSO Mapping

Particular	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	3	2	2	1	-	2	1	1	1	1	1	1	-
CO2	2	2	3	2	2	1	-	2	1	1	1	1	1	1	-
CO3	2	2	3	3	2	1	-	2	1	1	1	1	2	1	-
CO4	2	2	3	2	2	1	-	2	1	1	1	1	1	1	-
CO5	2	2	3	2	2	1	-	2	1	1	1	1	1	2	-
AVG	2	2	3	2.2	2	1	-	2	1	1	1	1	1.2	1.2	

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