P.S.R. ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Sevalpatti (P.O), Sivakasi – 626 140.

B.E - BIOMEDICAL ENGINEERING

CURRICULAM
AND
SYLLABI

U.G. Regulations 2019

Department of Biomedical Engineering

CANDIDATES ADMITTED DURING 2019-2020 AND ONWARDS

INSTITUTE VISION AND MISSION

VISION

To contribute to the society through excellence in technical education with societal values and thus a valuable resource for industry and the humanity.

MISSION

- To create an ambience for quality learning experience by providing sustained care and facilities.
- To offer higher level training encompassing both theory and practices with human and social values.
- To provide knowledge based services and professional skills to adapt tomorrow's technology and embedded global changes.

DEPARTMENT VISION AND MISSION

VISION

- The vision of the Biomedical Engineering Department is to produce graduates with sound knowledge for the betterment of society and to meet the dynamic demands of industry and research.

MISSION

- Offering under graduate programmes by providing effective and balanced curriculum and equip themselves to gear up to the ethical challenges awaiting them
- Providing the technical, research and intellectual resources that will enable the students to have a successful career in the field of BiomedicalEngineering.
- Providing need based training and professional skills to satisfy the needs of society and industry.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- **PEO:1** Lead a professional career by acquiring the basic knowledge in the field of specialization and allied Engineering.
- **PEO:2** Assess the real life problems and deal with them confidently relevance to the society.
- **PEO:3** Engage in lifelong learning by pursuing higher studies and participating in professional organizations.
- **PEO:4** Exhibit interpersonal skills and able to work as a team for success.

PROGRAM SPECIFIC OUTCOMES (PSOs)

- **PSO:1**Acquire knowledge on fundamentals of engineering and biological sciences to identify and solve biomedical engineering problems.
- **PSO:2** To design and develop diagnostic and therapeutic devices that reduces physician burnout and enhance the quality of life for the end user by applying fundamentals of Biomedical Engineering.
- **PSO:3**To innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology.
- **PSO:4**To apply software skills in developing algorithms for solving healthcare related problems in various fields of Medical sector.

PROGRAMME OUTCOMES (POs)

- **PO:1Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO:2Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO:3Design / Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO:4Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO:5Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **PO:6The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **PO:7Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO:8Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **PO:9Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO:10Communication:**Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO:11Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO:12Life-long Learning:**Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change..

Department: BIOMEDICAL ENGINEERING Programme: **B.E. BIOMEDICAL ENGINEERING**

S.No	Theory Courses					Theory Cum Practical	Practical Courses			Mandatory Courses	Value Added Courses / Mandatory Courses	Total Credits
I	191HS11 Communicative English (2)	191HS12 Calculus and Linear Algebra (4)	191HS13 Engineering Physics (2)	191HS14 Engineering Chemistry (2)	191EEF1 Basic Electrical and Electronics Engineering (3)	191MEF1 Engineering Graphics(3)	191HS17 Physics & Chemistry Laboratory - I (1)	191EE17 Basic Electrical and Electronics Laboratory (1)	-			18
2	191HS21 Technical English (2)	191HS22 Differential Equations and Numerical Methods (4)	191HS23 Physics of Materials (2)	191HS24 Environmental Science (2)	191CSF1 Programming for Problem Solving(3)	191MEF7 Mechanical Workshop (3)	191HS27 Physics & Chemistry Laboratory – II(1)	191CSF7 C-Programming Laboratory(1)	-			18
3	191HS31 Transforms and Discrete Mathematics(3)	191BS31 Biology for Engineers (3)	191EC31 Circuits and Electronic Devices(4)	191EC32 Linear Integrated Circuits (3)	191BM31 Anatomy and Human Physiology(3)	191BM32 Biochemistry (4)	191EC37 Circuits and Devices Laboratory(1)	191BM37 Human Physiology Laboratory(1)	-	191HS37 – Communication Skills – I	VAC-1	22
4	191HS42 Probability and Statistics (3)	191EC42 Signals and Systems (4)	191EC43 Digital Systems (3)	191BM41 Medical Physics (3)	191BM42-Pathology and Microbiology (3)	191CS35 Data Structure Algorithms & C++ (4)	191BM47 Pathology and Microbiology laboratory (2)	191BM48 Analog and Digital ICs Laboratory(1)	-	191HS47 – Communication Skills - II	VAC-2	23
5	191EC51 Analog and Digital Communication (3)	191EC53 Digital Signal Processing and Architecture (3)	191BM51 Biomedical Instrumentation (3)	191BM52 Sensors and Measurements (4)	PE 1(3)	191EC54 Embedded Systems and IOT (4)	191BM57-Biomedical Instrumentation Laboratory (1)	191EC58 DSP and Signal Processors Laboratory (1)	-	191HS57 – Business English	MC-1	22
6	191EC62 Machine Learning (3)	191BM61 Bio Control Systems (3)	191BM62 Hospital Management (4)	PE2 (3)	OE 1(3)	191BM63 Diagnostic and Therapeutic Equipment – I (4)	191EC67-Machine Learning Laboratory(1)	191EC69 Mini Project (1)		191HS67 – Career English	MC-2	22
7	191EC71 Robotics and Artificial Intelligence (3)	191EC72 Digital Image Processing (3)	191BM71 Radiological Equipment's (3)	PE3(3)	OE2(3)	191BM72 Diagnostic and Therapeutic Equipment – II (4)	191EC77 Robotics and Artificial Intelligence Laboratory(1)	191EC78 Digital Image Processing Laboratory (1)	191EC79 Project- I (2)		MC-3	23
8	PE 4 (3)	PE 5 (3)		-	-		191EC89 Project – II (6)				MC-4	12
Total Number of Credits												**160**

SEMESTER – I					
S.NO	Course Code	Course Title	L-T-P	C	Category
1.	191HS11	Communicative English	2-0-0	2	HSMC
2.	191HS12	Calculus and Linear Algebra	3-1-0	4	BSC
3.	191HS13	Engineering Physics	2-0-0	2	BSC
4.	191HS14	Engineering Chemistry	2-0-0	2	BSC
5.	191EEF1	Basic Electrical and Electronics Engineering	3-0-0	3	ESC
6.	191MEF1	Engineering Graphics (Theory Cum Practical)	1-0-4	3	ESC
7.	191HS17	Physics and Chemistry Laboratory-I	0-0-2	1	BSC
8.	191EEF7	Basic Electrical and Electronics Laboratory	0-0-2	1	ESC
					No. of Credits: 18

SEMESTER – II					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191HS21	Technical English	2-0-0	2	HSMC
2.	191HS22	Differential Equations and Numerical Methods	3-1-0	4	BSC
3.	191HS23	Physics of Materials	2-0-0	2	BSC
4.	191HS24	Environmental Science	2-0-0	2	BSC
5.	191CSF1	Programming for Problem Solving	3-0-0	3	ESC
6.	191MEF7	Mechanical Workshop (Theory Cum Practical)	1-0-4	3	ESC
7.	191HS27	Physics and Chemistry Laboratory-II	0-0-2	1	BSC
8.	191CSF7	C Programming Laboratory	0-0-2	1	ESC
Total			**22**	**18**	

SEMESTER – III					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191HS31	Transforms and Discrete Mathematics	2-1-0	3	BSC
2.	191BS31	Biology for Engineers	3-0-0	3	BSC
3.	191EC31	Circuits and Electronic Devices	3-1-0	4	PC
4.	191EC32	Linear Integrated Circuits	3-0-0	3	PC
5.	191BM31	Anatomy and Human Physiology	3-0-0	3	PC
6.	191BM32	Biochemistry (Theory cum Practical)	3-0-2	4	ESC
7.	191EC37	Circuits and Devices Laboratory	0-0-2	1	PC
8.	191BM37	Human Physiology Laboratory	0-0-2	1	PC
9.	191HS37	Communication Skills –I	0-0-2	0	HSMC

Total	**27**	**22**	

SEMESTER – IV					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191HS42	Probability and Statistics	2-1-0	3	BSC
2.	191EC42	Signals and Systems	3-1-0	4	PC
3.	191EC43	Digital Systems	3-0-0	3	PC
4.	191BM41	Medical Physics	3-0-0	3	PC
5.	191BM42	Pathology and Microbiology	3-1-0	4	PC
6.	191CS35	Data Structure Algorithms & C++ (Theory cum Practical)	3-0-2	4	ESC
7.	191BM47	Pathology and Microbiology laboratory	0-0-2	1	PC
8.	191BM48	Analog and Digital ICs Laboratory	0-0-2	1	PC
9.	191HS47	Communication Skills –II	0-0-2	0	HSMC
Total			**28**	**23**	

SEMESTER – V					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191EC51	Analog and Digital Communication	3-0-0	3	BSC
2.	191BM51	Biomedical Instrumentation	3-0-0	3	PC
3.	191BM52	Sensors and Measurements	3-1-0	4	PC
4.	191EC53	Digital Signal Processing and Architecture	3-0-0	3	PC
5.	-	Elective I* (PE 1)	3-0-0	3	PC
6.	191EC54	Embedded Systems and IOT (Theory cum Practical)	3-0-2	4	ESC
7.	191BM57	Biomedical Instrumentation Laboratory	0-0-2	1	PC
8.	191EC58	DSP and Signal Processors Laboratory	0-0-2	1	PC
9.	191HS57	Business English	0-0-2	0	HSMC
Total			**27**	**22**	

SEMESTER – VI					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191BM61	Bio Control Systems	3-1-0	4	BSC

2.	191EC62	Machine Learning	3-0-0	3	PC
3.	191BM62	Hospital Management	3-0-0	3	PC
4.	-	Elective II* (PE 2)	3-0-0	3	PC
5.	-	Elective I* (OE 1)	3-0-0	3	PC
6.	191BM63	Diagnostic and Therapeutic Equipment – I (Theory cum Practical)	3-0-2	4	ESC
7.	191EC67	Machine Learning Laboratory	0-0-2	1	PC
8.	191HS67	Carrier English	0-0-2	0	HSMC
9.	191BM69	Mini Project	0-0-2	1	PROJ
Total			**27**	**22**	

SEMESTER – VII					
S.NO	Code	Course Title	L-T-P	C	Category
1.	191EC71	Robotics and Artificial Intelligence	3-0-0	3	BSC
2.	191BM71	Radiological Equipment's	3-0-0	3	PC
3.	191EC72	Digital Image Processing	3-0-0	3	PC
4.	-	Elective III* (PE 3)	3-0-0	3	PC
5.	-	Elective 1I* (OE 2)	3-0-0	3	PC
6.	191BM72	Diagnostic and Therapeutic Equipment – II (Theory cum Practical)	3-0-2	4	ESC
7.	191EC77	Robotics and Artificial Intelligence Laboratory	0-0-2	1	PC
8.	191EC78	Digital Image Processing Laboratory	0-0-2	1	PC
9.	191BM79	Project – I	0-0-4	2	PROJ
Total			**28**	**23**	

SEMESTER – VIII					
S.NO	Code	Course Title	L-T-P	C	Category
1.	-	Elective IV* (PE 4)	3-0-0	3	BSC
2.	-	Elective V* (PE 5)	3-0-0	3	PC
3.	191BM89	Project – II	0-0-12	6	PROJ
Total			**18**	**12**	

Programme Elective Courses

S.No.	Course Code	Course Title
1.	191BMEA	BioMEMS
2.	191BMEB	Nanotechnology and Applications
3.	191BMEC	Biomaterials and Artificial Organs
4.	191BMED	Bio signal Processing
5.	191BMEE	Biofluids and Dynamics
6.	191BMEF	Physiological Modeling
7.	191BMEG	Soft Computing Techniques for Biomedical Engineering
8.	191BMEH	Neural Engineering
9.	191BMEI	Medical Ethics and Standards
10.	191BMEJ	Rehabilitation Engineering
11.	191BMEK	Body Area Networks
12.	191BMEL	Principles of Tissue Engineering
13.	191BMEM	Electro Magnetic Interference and Compatibility
14.	191BMEN	Cryptography and Network Security
15.	191BMEO	Multimedia Compression and Networks
16.	191BMEP	Biometric Systems
17.	191BMER	Virtual Reality and Augmented Reality
18.	191BMES	Medical Optics
19.	191BMET	Biomechanics
20.	191BMEU	Hospital Waste Management
21.	191BMEV	Electrical Safety and Quality Assurance
22.	191BMEW	Ergonamics
23.	191BMEX	Medical Imaging Techniques
24.	191HSEA	Professional Ethics in Engineering

OPEN ELECTIVE COURSES

S.No.	Course Code	Course Title
1	191OE8A	Telehealth Technology
2	191OE8B	Speech Processing
3	191OE8C	Internet of Things in Medicine
4	191OE8D	Brain Computer Interface and its Applications

MANDATORY COURSES

S.No.	Course Code	Course Name	L-T-P	C	Category
1	191MC01	Design Thinking	2-0-0	-	MC
2	191MC02	Essence of Indian Traditional Knowledge	2-0-0	-	MC
3	191MC03	Indian Constitution	2-0-0	-	MC
4	191MC04	Universal Human Values	2-0-0	-	MC
5	191MC05	Yoga	2-0-0	-	MC

191HS11	COMMUNICATIVE ENGLISH			L-T-P	C
				2-0-0	2

Programme:	B.E./B.Tech. (Common to all Branches)	Sem:	1	Category:	HSMC

Prerequisites:	-
Aim:	To acquire basic Language Skills in order to communicate with English Language Speakers.
SDG	04,10

Course Outcomes with SDG mapping:

At end of this course, the students will be able to	BTL	SDG
CO1: Develop the basic reading and writing skills.	AP	04
CO2: Listen actively and grasp the contents of the speech.	UN	10
CO3: Develop their speaking skills and speak fluently in real contexts.	AP	10
CO4: Develop vocabulary of a general kind by developing their reading skills.	AP	04
CO5: Use the grammar effectively to exhibit their speaking and writing skill.	AP	04
CO6: Speak in English with clarity.	CR	10

SHARING INFORMATION RELATEDTO ONESELF, FAMILY AND FRIENDS.	**9**
Reading – Short comprehension passages, Practice in skimming and scanning. **Writing –** Sentence structures, Developing Hints. **Listening–** Short texts, Short formal and informal conversations. **Speaking** – Introducing oneself, Exchanging personal information. **Language Development** – WH questions, Asking and answering YES or NO questions, Parts of Speech. **Vocabulary Development –** Prefixes & Suffixes, Subject verb Agreement.	
GENERAL READING AND FREE WRITING	**9**
Reading – **Comprehension** – Pre-reading & Post-reading. Comprehension questions (Multiple choice questions, Short questions, Open-ended questions), Short narratives and Descriptions from Newspapers including Dialogues. **Writing –** Paragraph writing, Use of Phrases and Clauses in sentences, Listening Telephonic conversations. **Speaking** – Sharing information of a personal kind, Greetings. **Language Development –** Noun Pronoun agreement. **Vocabulary Development** – The Concept of Word Formation. (Norman Lewis' *Word Power Made Easy*)	
GRAMMAR AND LANGUAGE DEVELOPMENT	**9**
Reading – Short texts & Longer passages (Cloze reading). **Writing** – Importance of proper punctuation, Jumbled sentences. **Listening –** Listening to longer texts and filling up the table, Product description, Narratives from different sources. **Speaking –** Asking about routine actions and Expressing opinions. **Language Development** – Degrees of Comparison, Pronouns. **Vocabulary Development –** Misplaced modifiers, Relative clauses.	
READING AND LANGUAGE DEVELOPMENT.	**9**
Reading- Comprehension. **Reading** longer texts- reading different types of texts. **Writing**- letter Writing, informal or personal letters-Achieving Coherence. **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking**- Speaking about oneself- Speaking about one's friend. **Language Development**- Articles. **Vocabulary Development** – Root words from foreign languages and their use in English.	
EXTENDED WRITING	**9**

Reading- Longer texts- close reading. **Writing**- Organizing principles of paragraphs in documents. **Listening** – Listening to talks, conversations. **Speaking** – Participating in conversations, short group conversations.**Language Development** - Cliches, Tenses. **Vocabulary Development** - Prepositions.	
Total Periods:	**45**

Text books:

1. Board of Editors. *Fluency in English: A course book for Engineering and Technology*.Orient Blackswan, Hyderabad: 2016.
2. Kumar, Sanjay and Pushp Lata. *Communication Skills: A Workbook*. New Delhi: OUP, 2018

References:

1. **www.oxfordonlineenglish.com**
2. **www.ielts.up.com**
3. **www.ted.com**
4. **www.testpreppractice.com**
5. **www.beccambridgeenglish.org**

Extensive Reading

1. Shiv Khera, *You Can Win*, Macmillan Books, New Delhi, 2003.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO2	2	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-	3		2	-	-	-	-
CO4	2	-	-	-	-	-	-	1	-	-	-	2	-	-	-	-
CO5	2	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-
CO6	2	-	-	-	-	-	-	-	-	2	-	2	-	-	-	-

191HS12	CALCULUS AND LINEAR ALGEBRA				L-T-P	C
					3-1-0	4
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**1**	**Category:**	**BSC**	
Prerequisites:	Matrices, Differentiation and Integration.					
Aim:	The course is aimed at developing the basic mathematical skills of engineering students.					
SDG	04,09					

Course Outcomes:

At end of this course, the students will be able to	**BTL**	**SDG**
CO1: Find the inverse and the positive powers of a square matrix	UN	04
CO2: Apply the concept of orthogonal reduction to diagonalise the given matrix	AP	04
CO3: Determine the evolute of curves, Beta and Gamma Functions.	EV	04
CO4: Apply Lagrangian multiplier method for finding maxima and minima of an unconstrained problem	AP	09
CO5: Apply the concepts of Differentiation and Integration in Vectors.	AP	09
CO6: Predict an analytic function, when its real or Imaginary part is known.	EV	09

MATRICES	**12**
Characteristic equation - Eigen Values and Eigen vectors of a real matrix - Properties of Eigen values - Cayley-Hamilton Theorem (without proof) and its application - Orthogonal Transformation of a Symmetric matrix to diagonal form - Quadratic form - Orthogonal reduction to canonical form.	
CALCULUS	**12**
Radius of Curvature - Cartesian and Parametric Coordinates - Circle of Curvature - Involutes and Evolutes –Beta and Gamma functions and their properties.	
MULTIVARIABLE CALCULUS	**12**
Partial Derivatives - Total Derivative - differentiation of Implicit function – Jacobian - Taylor's Expansion - Maxima/Minima for function of two variables - Method of Lagrange's multipliers.	
VECTOR CALCULUS	**12**
Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelepiped.	
COMPLEX VARIABLE – DIFFERENTIATION	**12**
Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy– Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function(without proof) – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w = z + c, cz, 1/z, and bilinear transformation.	
Total Periods	**60**

Text books:

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th edition, Pearson, Reprint, 2002

References:

1. Veerarajan.*T.*, "Engineering Mathematics for first year", Fourth Edition, Tata Mc-Graw – Hill, New Delhi, 2008.

2. Erwin *Kreyszig*, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
3. G.B. Thomas and R.L. Finney, "Calculus and Analytic Geometry" 9th Edition, Pearson, Reprint, 2002.
4. N.P. Bali and Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, Reprint, 2008.
5. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 36th Edition, 2010.
6. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Edition., Mc-Graw Hill, 2004

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	-	1	-	-	-	-	-	-	-	3	2	-	-	-
CO2	2	3	-	3	-	-	-	-	-	-	-	2	2	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO4	1	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO5	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-	-
CO6	2	2	-	1	-	-	-	-	-	-	-	3	2	-	-	-

191HS13	ENGINEERING PHYSICS			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**1**	**Category:**	**BSC**
Prerequisites:	School Level Physics				
AIM:	To endow the students with the fundamentals of Physics and apply new ideas in the field of Engineering and Technology.				
SDG	04,09				

Course Outcomes:

At end of this course, the students will be able to	**BTL**	**SDG**
CO1: Interpret the theory and various crystal structures.	UN	04
CO2:Know about the basic configuration of a Laser, types of lasers and the industrial applications of laser.	RM	09
CO3: Illustrate the principle behind fiber optic communication and the electronic devices involved in the transmission and reception of data.	UN	09
CO4: Know about basics of properties of matter and its applications,	RM	04
CO5: Gain knowledge about basic equations of Quantum mechanics and its applications.	RM	04
CO6: Interpret the basic concepts of acoustics and ultrsonics.	UN	04,09

SOLID STATE PHYSICS	**9**
Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Crystal Defects-point, Line and surface defects - burger vector.	
WAVE OPTICS	**9**
LASERS: Introduction – Principle of Spontaneous emission and stimulated emission. Population inversion, pumping. Einsteins A and B coeffcients – Derivation- Types of lasers – CO_2, Nd-YAG - Industrial Applications - Lasers in welding, cutting and Soldering. **FIBER OPTICS:**Optical Fiber-Classification- Principle and propagation of light in optical fibres- Numerical aperture and Acceptance angle-Fibre optical communication system- Sensors (Active and passive) –Displacement and Temperature Sensors.	
PROP ERTIES OF MATTER	**9**
Elasticity–Stress - strain diagram and its uses -factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple- torsion pendulum: theory and experiment -bending of beams - bending moment–cantilever: theory and experiment–uniform and non-uniform bending: theory and experiment–I shaped girders - stress due to bending in beams.	
QUANTUM PHYSICS	**9**
Black body radiation-Planck's theory -Photoelectric effect-Matter waves–Schrödinger's wave equation – Time independent and time dependent equations-Physical significance of wave function – Particle in a one dimensional box.	
ACOUSTICS AND ULTRASONICS	**9**
ACOUSTICS: Classification of sound-loudness and intensity - Weber-Fechner Law -standard intensity	

and intensity level-decibel - reverberation - reverberation time - Sabine's formula -absorption coefficient and its determination-factors affecting acoustics of buildings : focusing, interference, echo, Echelon effect, resonance - noise and their remedies.**Ultrasonics**: Ultrasonics - production - magnetostriction and piezoelectric methods - acoustic grating - industrial applications - NDT.	
Total Periods	**45**

Text books:

1. Gaur R. K., Gupta S. C., "Engineering Physics" Dhanpat Rai Publications, New Delhi (2016)
2. Avadhanulu M. N., Kshirsagar, P. G., "A Text book of Engineering Physics", S.Chand and company, Ltd., New Delhi, 2017.

References:

1. Serway and Jewett., "Physics for Scientists and Engineers with Modern Physics",6th Edition, Thomson Brooks/Cole, Indian reprint (2016)
2. Arither Beiser, Concepts of Modern Physics, Tata Mc Graw Hill, NewDelhi (2015)

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	1	1	2	-	-	-	-	-	3	-	-	-	2	-	-	-
CO2	2	3	1	-	2	1	-	-	1	-	-	2	2	-	-	-
CO3	2	1	2	-	1	1	2	-	-	1	-	-	2	-	-	-
CO4	2	3	1	1	3	-	-	-	-	-	-	-	2	-	-	-
CO5	1	1	-	2	-	-	-	-	-	-	-	-	2	-	-	-
CO6	1	2	3	1	1	2	3	-		-	-	-	2	-	-	-

191HS14	ENGINEERING CHEMISTRY			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**1**	**Category:**	BSC
Prerequisites:	Basic Science				
Aim:	To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.				
SDG	06,09,12				

Course Outcomes:

At end of this course, the students will be able to	**BTL**	**SDG**
CO1: Demonstrate the essential concept of water and their properties and applications.	AP	06
CO2: Illustrate he treatment of water for potable and industrial purposes	UN	06
CO3: Interpret the operating principles and the reaction involved in electrochemistry.	UN	12
CO4: Know the principles and application of spectroscopy	UN	09
CO5: Learn the basic ingredients required for paint formulation	UN	09,12
CO6: Know the preparation techniques of consumer products	UN	12

WATER TECHNOLOGY	**9**
Hardness-Types and Estimation by EDTA method- alkalinity –types of alkalinity and determination -Domestic water treatment –disinfection methods – Boiler feed water– internal conditioning– external conditioning – desalination and reverse osmosis.	
ELECTROCHEMISTRY	**9**
Electrochemical cells – reversible and irreversible cells – EMF –measurement of emf – Single electrode potential – Nernst equation– reference electrodes –Standard Hydrogen electrode – Calomel electrode – Ion selective electrode – glass electrode and measurement of pH – electrochemical series	
SPECTROSCOPIC TECHNIQUES AND APPLICATIONS	**9**
Introduction of UV-Visible and IR spectroscopy and selection rules- principles and instrumentation of UV-Visible (electronic) spectroscopy – IR (vibrational) spectroscopy - its applications. Fluorescence spectroscopy and its applications in medicine-colorimetry – estimation of iron by colorimetry .	
INORGANIC&ORGANIC COATINGS	**9**
Paint–Definition–Components of Paints and their functions–Varnish–Definition–Preparation of Oil Varnish–Differences between Paint and Varnish–Special Paints–Luminescent Paints, Fire Retardant Paints- Aluminium Paints - Distemper.corrosion control– electroplating (Au) and electroless (Ni) plating.	
PREPARATION OF CONSUMER PRODUCTS	**9**
Washing Powder- Cleaning powder-phenoyls (white, Black & coloured)-Shampoo-liquid blue-inks-blue –red-green inks – Soap - bathing & detergent – oils-Face powder and bleaching powder.	
Total Periods	**45**

Text books:

1. P. Kannan, A. Ravikrishnan, “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009.
2. P.C.Jain and Monica Jain, “Engineering Chemistry” Dhanpat Rai Pub, Co., New Delhi (2002)

References:

1. S.S. Dara, S.S. Umare, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010.
2. B.K.Sharma, “Engineering chemistry” Krishna Prakasan Media (P) Ltd., Meerut (2001).
3. B.Sivasankar, “Engineering chemistry” Tata McGraw Hill Publishing Company (P) Ltd., New Delhi, 2006

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2		1	1	1	1	-	-	-	2	2	2	-	-	-
CO2	2	2	1	2	1	2	1	-	-	-	1	1	2	-	-	-
CO3	2	1	1	2	2	-	-	-	-	-		2	2	-	-	-
CO4	2	2	1		1	-	-	-	-	-	2	1	2	-	-	-
CO5	2	2	1		1	1	-	-	-	-	-	2	2	-	-	-
CO6	2	2	1	1	2	1	-		1	1	1	1	2	-	-	-

191EEF1	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING				L-T-P	C
					3- 0 -0	3
Programme:	B.E –Electrical and Electronics Engineering	**Sem:**	**1**	**Category**	ES	
Prerequisites:	Algebra, calculus and electrostatics					
Aim:	To provide comprehensive idea about AC and DC circuit analysis, working principles and applications of basic machines in electrical engineering and protection schemes in power system.					
SDG	07,09,12					

Course Outcomes:

The Students will be able to	**BTL**	**SDG**
CO1: Analyze DC circuits using basic laws.	AN	09
CO2: Analyze AC circuits using basic laws.	AN	09
CO3: Illustrate the operation of DC machines and its applications.	UN	07
CO4: Demonstrate about AC machines and its applications.	UN	07
CO5: Analyze and compare the construction, theory and characteristics of the semiconductor devices.	AN	09,12
CO6: Design basic combinational and sequential logic circuits.	AN	09,12

ELECTRICAL CIRCUITS & MEASUREMENTS	**12**
Ohm's Law – Kirchhoff's Laws –Reduction of series and parallel circuits-Mesh and Nodal Analysis of DC circuits – Introduction to AC Circuits - RMS Value, Average value, Form factor and peak factor phasor representation – Single Phase AC series circuits with R, RL, RC -Power and Power factor. Introduction to three phase circuits- Star and delta connected balanced load.	
DC MACHINES & TRANSFORMER (Qualitative treatment only)	**8**
DC Generators - construction, principle of operation, Types, EMF equations and applications. DC Motors - operation, Types, Speed and torque equation – speed control of DC shunt motors. Single Phase Transformer - Constructional details and operation, Types, EMF equation, transformation ratio.	
AC MACHINES (Qualitative treatment only)	**8**
Single phase induction motor - construction, operation and applications - Three phase induction motor – Types, Construction and operation, Torque equation, slip torque characteristics, Synchronous generators - construction and operation, EMF equation - Synchronous motors – principle of operation.	
SEMICONDUCTOR DEVICES (Qualitative treatment only)	**9**
Introduction to semiconductors-PN Junction Diode – characteristics, breakdown effect and applications - Half wave and Full wave rectifiers, Zener Diode - characteristics and voltage regulator. Bipolar Junction Transistor – operation of NPN and PNP, characteristics of CB, CE, CC configurations.	
DIGITAL ELECTRONICS (Qualitative treatment only)	**8**
Number System – Binary, octal, hexadecimal, Logic Gates (AND, OR,NOT,NAND,NOR,XOR,XNOR), Half and Full Adders – Flip-Flops –RS, JK, T and D - Counters – synchronous up counter, synchronous down counter, asynchronous up counter, asynchronous down counter, shift registers – shift right and shift left register	

Total Periods:	**45**

Text books:

1. Muthusubramanian R, Salivahanan S, "Basic Electrical, Electronics and Computer Engineering", McGraw Hill, New Delhi, 2009.
2. B L Theraja, AK Theraja,'A Text book of Electrical Technology: Volume 2 AC and DC Machines', S.Chand; Twenty Third edition, 2006.
3. R.S. Sedha, "A Textbook of Applied Electronics" S. Chand & Co., 2008.

References:

1. V N Mittle, Arvind Mittle "Basic Electrical Engineering", McGraw Hill, New Delhi, 2005.
2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford University press (2012).
3. V K Mehta, Rohitmehta "Principles of Electronics", S.Chand& Company Ltd, (2015).
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, (2014).
5. NPTEL Video Lecture Notes on "Basic Electronics " by Prof. M.B Patil, IIT Bombay

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	-	-	-	-	-	-	3	-	3	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	2	-	3	-	-	-
CO3	3	3	-	1	-	-	-	-	-	-	2	-	3	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	2	-	3	-	-	-
CO5	3	2	-	1	-	-	-	-	-	-	3	-	3	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	3	-	3	-	-	-

191MEF1	ENGINEERING GRAPHICS			L-T-P	C
				1-0-4	3
Programme:	**B.E. ,(ECE, CSE, BME)**	**Sem:**	**1**	**Category:**	**ESC**
Prerequisites:	Nil				
Aim:	To develop graphic skills in students				
SDG	09,12				

Course Outcomes:

The students will be able to	BTL	SDG
CO1:Follow the conventions used in engineering graphics	UN	09
CO2:Practice plane curves and free hand sketching	AP	12
CO3:Draw the projections of points, lines and plane	UN	09
CO4:Draw the projections of simple solids and their sectional views	UN	09
CO5:Describe the applications of development of surfaces	UN	09,12
CO6:Practice isometric and perspective projections	AP	09

Concepts and conventions (Not for Examination)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

PLANE CURVES	**15**
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.	
PROJECTION OF POINTS, LINES AND PLANE SURFACES	**15**
Projection of Points in all four quadrants - Projection of straight lines located in the first quadrant – inclined to both planes – Determination of true lengths and true inclinations – Projection of regular polygonal and circular lamina inclined to both reference planes.	
PROJECTION OF SOLIDS	**15**
Projection of simple solids like Prisms, Pyramids, Cylinder and Cone when the axis is inclined to one reference plane	
SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES	**15**
Sectioning of above solids in simple vertical position by cutting planes inclined to HP and perpendicular to VP – Obtaining true shape of section; Development of lateral surfaces of truncated solids – Prisms, Pyramids, Cylinder and Cone	
ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS	**15**
Principles of isometric projection – isometric scale – isometric projections of truncated Prisms, Pyramids, Cylinder and Cone; Conversion of Isometric Views to Orthographic Views and Vice-versa.	
Total periods:	**75**

Text books:

1. Natrajan K.V., **"A text book of Engineering Graphics",** Dhanalakshmi Publishers, Chennai (2015)
2. Basant Agarwal and Agarwal C.M., **"Engineering Drawing",** Tata McGraw Hill Publishing Company Limited, New Delhi, (2016)

References:

1. Venugopal K. and Prabhu Raja V., **"Engineering Graphics",** New Age International (P)Limited (2016)
2. Shah M.B. and RanaB.C., **"Engineering Drawing",** Pearson Education (2009)
3. John K.C., **"Engineering Graphics for degree"** PHI Learning Pvt. Ltd., New Delhi, (2015)
4. KumarM.S., **"Engineering Graphics",** D.D. Publications, (2015)

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	3	-	2	-	-	-	-	3	-	-	1	-	-	-
CO2	3	-	2	-	2	-	-	-	-	3	-	-	1	-	-	-
CO3	3	-	2	-	2	-	-	-	-	3	-	-	1	-	-	-
CO4	3	-	3	-	2	-	-	-	-	3	-	-	1	-	-	-
CO5	3	-	3	-	2	-	-	-	-	3	-	-	1	-	-	-
CO6	2	-	2	-	2	-	-	-	-	3	-	-	1	-	-	-

191HS17	PHYSICS AND CHEMISTRY LABORATORY-I			L-T-P	C
				0-0-2	1
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**1**	**Category:**	**BSC**
Pre/Corequisites:	Engineering Physics & Engineering Chemistry				
Aim:	To introduce the basic Physics concepts through experiments and to impart the basic analysis in chemistry.				
SDG	09				

Course Outcomes:

The Students will be able to	**BTL**	**SDG**
CO1:Understand the laser light propagation in optical fibre and the rigidity modulus of the materials	UN	09
CO2: Understand the velocity of sound in liquid and propagation light in the medium	UN	09
CO3: know about the stress analysis and thermal conductivity of the material	UN	09
CO4: Gain knowledge of water quality parameter of potable water	UN	09
CO5: Determine the unknown concentrations of chemicals	UN	09
CO6: Apply the instrumental technique for calculating the amount of unknown substance	AP	09

LIST OF EXPERIMENTS - PHYSICS PART

(A minimum of five experiments shall be offered)

S.No	**NAME OF THE EXPERIMENT**	
1)	(a) Determination of Particle Size using Diode LASER. (b) Determination of wavelength of the LASER source. (c) Determination of Acceptance angle and Numerical aperture ofan optical fibre.	3
2)	Torsional pendulum – Determination of rigidity modulus	3
3)	Determination of Velocity of sound and compressibility of liquid - Ultrasonic Interferometer.	3
4)	Determination of Dispersive power of a prism using Spectrometer.	3
5)	Determination of Young's modulus of the material - Non uniform bending	3
6)	Determination of thermal conductivity of a bad conductor - Lee's Disc method	3

LIST OF EXPERIMENTS – CHEMISTRY PART

S.No	**NAME OF THE EXPERIMENT**	
1)	Estimation of Total Hardness of their home town Water by EDTA method.	3
2)	Estimation of Alkalinity of Water sample	3
3)	Estimation of Chloride ion in water sample by Argentometric method.	3
4)	Estimation of Ferrous Ion by Potentiometric Titrations.	3
5)	Conductometric Titration of strong acid Vs strong base	3

References

1) Text book of Quantitative Inorganic Analysis, A.I.Vogel, ELBS,London,(2006)
2) "Practical A. Ravikrishnan Engineering Chemistry", Sri Krishna Publications, Chennai (2002)
3) Engineering Physics Laboratory Manual
4) Engineering Chemistry Laboratory Manual

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	-	-	-	-	-	-	3	-	2	-	-	-
CO2	3	3	3	-	-	1	-	-	-	-	3	-	2	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	2	-	2	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	2	-	2	-	-	-
CO5	3	2	-	-	-	1	-	-	-	-	3	-	2	-	-	-
CO6	3	3	3	-	-	1	-	-	-	-	3	-	2	-	-	-

191EEF7	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Electronics and Communication Engineering	**Sem:**	**1**	**Category:**	**ESC**
AIM:	To expose the students to basic laws, characteristics of diodes, operation of D.C and A.C machines and give them experimental skill.				
SDG	09				

Course Outcomes:

The Students will be able to	**BTL**	**SDG**
CO1: Facilitate the operation of fluorescent lamp, staircase wiring and simple wiring	AP	09
CO2: Apply the circuit theory concepts and analyze the outcome.	AP	09
CO3: Illustrate the VI characteristics of PN diode	UN	09
CO4: Examine the V-I characteristics of a Zener diode	AP	09
CO5: Obtain various characteristics of DC Machines.	UN	09
CO6: Model and analyze the performance characteristics of induction motors.	AN	09

LIST OF EXPERIMENTS – CHEMISTRY PART

NAME OF THE EXPERIMENT

1. Simple wiring connection
2. Staircase wiring
3. Fluorescent lamp wiring
4. Study of electronic components and equipments
5. Verifications of ohm's law and kirchoff's voltage law
6. Characteristics of semiconductor diode
7. Characteristics of zener diode
8. Speed control of dc shunt motor
9. Load test on dc shunt motor
10. Load test on single phase induction motor

Total Periods	**45**

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	1	-	-	-	3	-	3	-	3	-	-	-
CO2	3	2	-	2	1	-	-	-	3	-	2	-	3	-	-	-
CO3	3	2	-	2	1	-	-	-	3	-	2	-	3	-	-	-
CO4	3	3	2	2	1	-	-	-	3	-	2	-	3	-	-	-
CO5	3	2	-	2	1	-	-	-	3	-	3	-	3	-	-	-
CO6	3	2	-	2	1	-	-	-	3	-	3	-	3	-	-	-

191HS21	TECHNICAL ENGLISH			L-T-P	C
				2-0-0	2
Programme:	**B.E./B.Tech. (Common to all Branches)**	**Sem:**	**2**	**Category:**	**HSMC**
Prerequisites:	Acquire Proficiency in Technical Communication				
Aim:	To develop the students' intellectual, personal & Professional abilities.				
SDG	04				

Course Outcomes:

The Students will be able to	BTL	SDG
CO1: Remember words and its meanings for the specific purpose.		04
CO2: Illustrate the basic nuances of language	UN	04
CO3: Apply written communication methodologies at workplace.	AP	04
CO4: Develop Listening skill to respond and to gather information.	AP	04
CO5: Interpret the text using comprehending skill.	UN	04
CO6: Involve in professional correspondences confidently.	UN	04

UNIT I Introduction to Technical English	**9**
Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises. **Speaking** – Asking for and giving directions. **Reading** – reading short technical texts, Newspapers. **Writing** - Purpose statements, Extended definitions, Writing Instructions & Recommendations, Checklists. **Vocabulary Development** - Technical Vocabulary. **Language Development** – Subject Verb Agreement.	
UNIT II Reading and Study Skills	**9**
Listening - Listening to longer technical talks and completing exercises based on them. **Speaking** – Describing a process. **Reading** – Reading longer technical texts, News papers identifying various transitions in a text- paragraphing. **Writing** - Techniques for writing Precisely. **Vocabulary Development** -vocabulary used in formal letters/emails and reports. **Language Development** - Personal & Impersonal Passive voice, Numerical adjectives.	
UNIT III Technical Writing and Grammar	**9**
Listening - Listening to classroom lectures on Engineering / Technology. **Speaking** – Introduction to Technical presentations. **Reading** – Reading longer texts both general and Technical, practice in rapid reading. **Writing**- Describing a process, Use of sequence words, Causes and Effects **Vocabulary Development** - Sequence words, Nominal compounds, Misspelled words. **Language Development** - Embedded sentences.	
UNIT IV Report Writing	**9**
Listening- Listening to documentaries and Making notes. **Speaking** – Mechanics of presentations. **Reading** – Reading for detailed comprehension. **Writing** - Job application, cover letter, Resume preparation. **Vocabulary Development** - Finding suitable synonyms, Paraphrasing. **Language Development** – Clauses, If conditionals.	
UNIT V Group Discussion and Job Applications	**9**
Listening - TED/Ink talks. **Speaking** – Participating in a Group discussion. **Reading** – Reading and Understanding Technical articles. **Writing** – Writing reports, Minutes of Meeting, Introduction and Conclusion.**Vocabulary Development** - Verbal analogies**.Language Development** - Reported speech.	
Total Periods:	**45**

Text books:

1. Sudharshana,N.P. and C.Savitha. English for Technical Communication. New Delhi: Oxford University Press, 2017.

References:

1. **www.bbc.co.uk/learning english**
2. **www.bec cambridge english.**org
3. **www.englishenglish101.com**
4. **www.islcollective.com**

Extensive Reading

1. Kalam, Abdul. *The Wings of Fire*. Hyderabad: UP, 1999. Print.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-		-	1	-	-	-	-
CO3	3	-	--	-	-	-	-	1	-	2	-	1	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-

191HS22	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS			L-T-P	C
				3-1-0	4
Programme:	**B.E./B.Tech. (Common to all branches)**	**Sem:**	**2**	**Category:**	**BSC**
Prerequisites:	Engineering Mathematics-I				
Aim:	To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.				
SDG	04				

Course Outcomes:

The students will be able to	BTL	SDG
CO1: Use suitable method to solve higher order Differential Equations	AP	04
CO2: Use suitable method to solve higher order PDE	AP	04
CO3: Interpolate discrete data by means of continuous function.	AP	04
CO4: Discover Numerical integration using Trapezoidal and Simpson's 1/3rd rules	AP	04
CO5: Find the solution for the IVPs in ODE using single step and Multistep methods	AP	04
CO6: Find the solution of BVPs in PDE using finite difference methods	AP	04

ORDINARY DIFFERENTIAL EQUATIONS	**12**
Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.	
PARTIALDIFFERENTIALEQUATIONS	**12**
Formationofpartialdifferentialequations–Lagrange'slinearequation–Solutionsof standard typesoffirstorderpartialdifferentialequations (without reducing the standard type) –Linear homogenouspartialdifferential equationsofsecondandhigher order withconstantcoefficients.	
SOLUTION OF EQUATION & INTERPOLATION, NUMERICAL DIFFERENTIATION	**12**
Solutions of Polynomial and transcendental equations – Newton Raphson method - Interpolation using Newton's forward and backward difference formulae - Interpolation with unequal intervals- Newton's divided difference and Lagrange's formulae - Numerical differentiation using Newton's forward and backward difference formula - Numerical Integration – Trapezoidal rule and Simpson's 1/3rd rule..	
NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	**12**
Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge-Kutta method – Milne's predictor – corrector methods for solving first order equations – Finite difference methods for solving second order equation.	
BOUNDARY VALUE PROBLEMS OF PARTIAL DIFFERENTIAL EQUATIONS	**12**
Finite differences solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.	
Total Periods:	**60**

Text books:

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

References:

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition, The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi, (2007).
5. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Pearson Education Asia, New Delhi, (2006).

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	-	1	-	-	-	-	-	-	-	3	2	-	-	-
CO2	2	2	-	2	-	-	-	-	-	-	-	-	2	-	-	-
CO3	2	1	-	2	-	-	-	-	-	-	-	1	2	-	-	-
CO4	1	2	-	3	-	-	-	-	-	-	-	2	2	-	-	-
CO5	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO6	3	3	-	-	3	-	-	-	1	-	-	2	2	-	-	-

191HS23	PHYSICS OF MATERIALS			L-T-P	C
				2-0-0	2
Programme:	**B.E., (Common to all branches)**	**Sem:**	**II**	**Category:**	**BSC**
Prerequisites:	Engineering Physics				
AIM:	To endow the students with the fundamentals of physics, materials and apply new ideas in the field of Engineering and Technology.				
SDG	09				

Course Outcomes:

The Students will be able to	BTL	SDG
CO1: Illustrate the theory and processing of conducting, superconducting materials.	UN	09
CO2: Acquire knowledge of classification of semi conducting materials.	UN	09
CO3: Gain knowledge about the types of magnetic materials and their applications.	UN	09
CO4: Enhance the knowledge about dielectric materials and their applications	UN	09
CO5: Interpret on the functioning of optical materials for optoelectronics.	UN	09
CO6: Know about the basics of quantum structures and their applications in spintronics	UN	09

ELECTRICAL PROPERTIES OF MATERIALS	**9**
Conductors: classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory –Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals. **Super Conductors:** properties - Types of super conductors - Applications of superconductors – SQUID, cryotron, magnetic levitation.	
SEMICONDUCTOR PHYSICS	**9**
Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – Extrinsic semiconductors – carrier concentration derivation in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration– Hall effect –Determination of Hall coefficient – Applications.	
MAGNETIC AND DIELECTRIC MATERIALS	**9**
Magnetic Materials: Origin of magnetic moment – Bohr magneton – Dia and para magnetism – Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti – ferromagnetic materials – Ferrites – applications. **Dielectric Materials:** Polarization - electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation –dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.	
OPTICAL PROPERTIES OF MATERIALS	**9**
Classification of optical materials–carrier generation and recombination processes-Absorption - emission and scattering of light in metals, insulators and Semiconductors (concepts only)-photocurrent in a P-N diode–solar cell–photo detectors-LED-optical storage techniques	
NANOELECTRONIC DEVICES	**9**
Introduction-electron density in bulk material–Size dependence of Fermi energy–quantum confinement–quantum structures-Density of states in quantum well, quantum wire and quantum dot structures – Zener-Bloch oscillations–resonant tunneling – Carbon nanotubes: Properties and applications.	

Total Periods	**45**

Text books:

1. William D. Callister, Jr., **"Material Science and Engineering",** John Wiley & Sons Inc., Seventh Edition, New Delhi (2017).
2. Ragavan, V., **"Material science and Engineering"**, Prentice Hall of India (2004).
3. Kasap, S.O. **"Principles of Electronic Materials and Devices**", McGraw -Hill Education, 2016.
4. Umesh K Mishra & Jasprit Singh, "**Semiconductor Device Physics and Design**", Springer, 2014.

References:

1. Koch C., **"Nanostructured materials: processing, properties and applications",** William Andrew pub. (2011).
2. Charles P. Poole and Frank J.Ownen., **"Introduction to Nanotechnology"**, Wiley India (2016)
3. Charles Kittel., **"Introduction to solid state Physics"**, John Wiley & Sons, 7th editions, Singapore (2012)

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	-	-	3	-	-	1	-	-	1	2	-	-	-
CO2	3	2	2	1	-	1	-	-	-	-	-	1	2	-	-	-
CO3	1	-	2	1	-	2	1		1	-	-	-	2	-	-	-
CO4	2	2	1	1	-	2	-	1	-	-	-	-	2	-	-	-
CO5	3	1	3	2	2		-	-	-	-	-	-	2	-	-	-
CO6	3	3	3	2	3	2	1	-	-	-	-	-	2	-	-	-

191HS24	ENVIRONMENTAL SCIENCE				L-T-P	C
					2-0-0	2
Programme:	**B.E./B.Tech. (Common to all branches)**	**Sem:**	II	**Category:**	BSC	
Prerequisites:	Basic Science					
Aim:	To Impart the social groups and individuals to acquire knowledge of pollution and environmental degradation					
SDG	07,13,15					

Course Outcomes:

The student will be able to	**BTL**	**SDG**
CO1: Interpret the basic concepts of environment and energy resources	UN	07
CO2: Get knowledge about the ecosystem	UN	15
CO3: Identify and analyze causes, effects and control measures of various types of pollution.	AP	13
CO4: Get the knowledge about types of disaster and mitigation measures	UN	13
CO5 : Infer the impact of social issues and climate change	UN	13
CO6: Illustrate to create the green environment.	UN	15

ENVIRONMENT AND ENERGY RESOURCES	**9**
Environment- definition, scope and importance – Need for public awareness – Forest resources-deforestation–Energy resources: Growing energy needs, renewable (solar energy and wind energy) and non renewable energy sources-Nuclear energy – fission and fusion reactions and light water nuclear reactor for power generation (block diagram only), Petroleum processing and fractions	
ECOSYSTEM	**9**
Concept of an ecosystem – Structure and function of an ecosystem: Producers, consumers and decomposers, Energy flow in the ecosystem-Nitrogen cycle,Food chains, food webs and ecological pyramids - Introduction, types, characteristic features, structure and function of the Forest ecosystem and Aquatic ecosystems (lake and rivers)	
ENVIRONMENTAL POLLUTION	**9**
Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Marine pollution (d) Noise pollution .Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution –Disaster management: floods- landslides.	
SOCIAL ISSUES AND EARTH'S CLIMATE SYSTEM	**9**
Population-variation among nation-Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting– climate change, global warming, acid rain, Ozone layer depletion.	
GREEN CHEMISTRY	**9**
Introduction to green chemistry- 12 principles of green chemistry-toxicology and green chemistry-energy and green chemistry-education in green chemistry. Reuse and recycling technologies-material selection for green design-recycled water technology.	
Total Periods:	**45**

Text books:

1. A. Ravikrishnan, "Environmental Science and Engineering, Sri Krishna Hitech Publishing Company Private Limited, 2010.
2. Benny Joseph, "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.

References:

1. Anubha Kaushik, C.P. Kaushik, "Environmental Science and Engineering", New Age International Publishers, 2016.
2. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill Publishing Company Ltd, New Delhi, ISBN: 0070601690, 2006.
3. Raman Sivakumar, *Introduction to Environmental Science and Engineering*, Tata McGraw HillEducation Private Limited, New Del2010.
4. P.Meenakshi, Elements of Environmental Science and Engineering, PHI learning (P) Ltd., India.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	-	1	1	1	1	-	-	-	2	3	2	-	-	-
CO2	2	2	1	-	1	2	1	-	-	-	1	2	2	-	-	-
CO3	2	1	1	2	2	-	-	1	-	-		2	2	-	-	-
CO4	2	2	1	-	1	-	-	-	-	-	2	2	2	-	-	-
CO5	2	2	1	-	1	1	-	-	-	-		2	2	-	-	-
CO6	2	2	1	-	2	1	-	-	1	1	1	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High1)

191CSF1	PROGRAMMING FOR PROBLEM SOLVING			L-T-P	C
				3-0-0	3
Programme:	**B.E., (ECE,CSE,BME)**	**Sem:**	**2**	**Category:**	**ESC**
Prerequisites:	Nil				
Aim:	To provide an awareness to Computing and Programming.				
SDG	04				

Course Outcomes:

The students will be able to	BTL	SDG
CO1: Illustrate the basic terminologies of Computer and various Problem solving techniques.	UN	04
CO2: Write, compile and debug programs in C language.	UN	04
CO3: Use different data types in a computer program.	AP	04
CO4: Design programs involving decision structures, loops and functions.	AP	04
CO5: Interpret the dynamics of memory by the use of pointers.	UN	04
CO6: Use different data structures and create/update basic data files.	AP	04

INTRODUCTION	**9**
Generation and Classification of Computers- Basic Organization of a Computer - Number System - Binary - Decimal - Conversion - Problems. Software - Types, Development Steps. Algorithm - Pseudo code - Flow Chart. Problem formulation - Problem Solving.	
C PROGRAMMING BASICS	**9**
Introduction to Unix Operating System - Introduction to ' C' programming - fundamentals - structure of a 'C' program - compilation and linking processes - Constants, Variables - Data Types - Expressions using operators in 'C'- Managing Input and Output operations - Decision Making and Branching - Looping statements - solving simple scientific and statistical problems.	
ARRAYS AND STRINGS	**9**
Arrays - Initialization - Declaration - One dimensional and Two dimensional arrays. String- String operations - String Arrays. Simple programs –Bubble Sort – Linear Search -Matrix Operations.	
FUNCTIONS AND POINTERS	**9**
Function -Definition of function - Declaration of function - Pass by value - Pass by reference - Recursion -Pointers -Definition - Initialization -Pointers arithmetic -Pointers and arrays- Example Problems.	
STRUCTURES AND FILES	**9**
Introduction - need for structure data type - structure definition - Structure declaration - Structure within a structure - Union - Programs using structures and Unions - File Manipulation - Storage classes - Pre-processor directives.	
Total Periods	**45**

Text books:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2017.
2. Balagurusamy E, "Programming in ANSI C", Tata Mcgraw-Hill Education, 2016
3. ReemaThareja,"Computer Fundamentals and Programming in C", 2e, Oxford University Press, 2016.

References:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, 3rdEdition, McGraw-Hill, 2017.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, 4th Reprint, 2007.
3. Kernighan.B.W and Ritchie,D.M,"The C Programming language",2nd Edition,Pearsone Education,2006.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	-	-	-	-	3	2	-	3	-	-	-	2
CO2	3	3	3	-	-	-	-	-	2	1	-	3	-	-	-	1
CO3	-	3	2	-	-	-	-	-	2	-	-	2	-	-	-	-
CO4	-	3	3	-	-	-	-	-	3	-	-	3	-	-	-	2
CO5	2	3	2	-	-	-	-	-	-	-	-	2	-	-	-	-
CO6	-	2	3	-	-	-	-	-	2	-	-	3	-	-	-	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MEF7	MECHANICAL WORKSHOP (THEORY CUM PRACTICAL)			L-T-P	C
				1-0-4	3
Programme:	**B.E., (ECE,CSE,BME)**	**Sem:**	**2**	**Category:**	**ESC**
Prerequisites:	Nil				
Aim:	To Provide exposure to the students with hands on experience on various basic Engineering Practices				
SDG	04				

Course Outcomes:

The students will be able to	BTL	SDG
CO1: Make the square fitting, vee & step fitting	AP	04
CO2: Produce simple wooden joints using wood working tools	AP	04
CO3: Fabricate tray and funnel in sheet metal	AP	04
CO4: Create simple lap, butt and tee joints using arc welding equipments	AP	04
CO5: Identify the various pipe joints	AP	04
CO6: Make the pipe connections	AP	04

FITTING OPERATIONS & POWER TOOLS	**12**
Preparation of square fitting, vee & step – fitting models	
CARPENTRY	**12**
Study of the joints in roofs, doors, windows and furniture; Hands-on-exercise: Dismantling & Assembling of various wooden furniture; Preparation of T Joint, dove tail joint	
SHEET METAL FORMING	**12**
Preparation of tray and funnel	
WELDING	**12**
Preparation of arc welding of butt joints and lap joints	
PLUMBING	**12**
Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings; Hands-on-exercise - basic pipe connections – Mixed pipe material connection – Connections with different joining components	
Total Periods	**60**

LIST OF EQUIPMENTS (For a batch of 30 students)

1. Fitting vice (fitted to work bench) - 15Nos
2. Fitting Tools – 15 set
3. Carpentry vice (fitted to work bench) - 15 Nos.
4. Models of industrial trusses, door joints, furniture joints - 5 Nos.
5. Standard woodworking tools - 15 Sets
6. Hand Shear - 01
7. Standard tools and calipers for sheet metal work - 05
8. Arc welding transformer with cables and holders - 5Nos.
9. Welding booth - 5 Nos.
10. Welding accessories like welding shield, chipping hammer, Wire brush, etc., - 5Sets
11. Assorted components for plumbing consisting of metallic pipes, Plastic pipes, flexible pipes,

couplings, unions, elbows, plugs and other fittings - 15 Sets.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	3	-	1	-	-	-	3	-	-	3	-	-	-	-
CO2	2	-	3	-	1	-	-	-	3	-	-	3	-	-	-	-
CO3	2	-	3	-	1	-	-	-	3	-	-	3	-	-	-	-
CO4	2	-	3	-	1	-	-	-	1	-	-	3	-	-	-	-
CO5	2	-	3	-	1	-	-	-	1	-	-	3	-	-	-	-
CO6	2	-	3	-	1	-	-	-	3	-	-	3	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS27	PHYSICS AND CHEMISTRY LABORATORY-II			L-T-P	C
				0-0-2	1
Programme:	B.E/B.Tech (Common to all Branches)	**Sem:**	**2**	**Category:**	**BSC**
Pre/Corequisites:	Engineering Physics & Engineering Chemistry				
AIM:	To introduce the basic Physics concepts through experiments and to impart knowledge on the application of chemistry in engineering branches.				
SDG	04,06				

Course Outcomes:		
The Students will be able to	**BTL**	**SDG**
CO1: Learn the interference of light and young's modulus of the materials	UN	04
CO2: Understand the properties of flow of the liquid.	UN	04
CO3: Know the band gap of material and resistance of the given coil.	UN	04
CO4: Determine the quantity of unknown solution by instrumental technique.	AP	04
CO5: Determine the concentration of an identified analyte by volumetric analysis	AP	04
CO6: Analyze the characteristics of water.	AN	06

LIST OF EXPERIMENTS - PHYSICS PART

(A minimum of five experiments shall be offered)

S.No	**NAME OF THE EXPERIMENT**	
1)	Determination of thickness of thin wire – Air wedge method	3
2)	Determination of Young's modulus of the material – Uniform bending	3
3)	Determination of viscosity of liquid – Poiseuille's method.	3
4)	Determination of wavelength of mercury spectrum- Spectrometer Grating.	3
5)	Determination of Band Gap of a semiconductor material.	3
6)	Determination of specific resistance of a given coil of wire – Carey Foster Bridge.	3

LIST OF EXPERIMENTS – CHEMISTRY PART

S.No	**NAME OF THE EXPERIMENT**	
1)	Esimation of HCl by pH metry	3
2)	Estimation of Copper in brass by EDTA method.	3
3)	Estimation of iodine in iodized salt with thiosulfate	3
4)	Determination of percentage of calcium in limestone by EDTA method	3
5)	Determination of DO in water (Winkler's method)	3

References

1) Text book of Quantitative Inorganic Analysis, A.I.Vogel, ELBS,London, (2006).
2) "Practical A. RaviKrishnan Engineering Chemistry", Sri Krishna Publications, Chennai (2002)
3) Engineering Physics Laboratory Manual
4) Engineering Chemistry Laboratory Manual

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	1	1	1	-	1	-	-	-	-	1	2	-	-	-
CO2	2		1	1	1	-	1	-	-	-	-	1	2	-	-	-
CO3	2	2		1	1	-	1	-	-	-	-	1	2	-	-	-
CO4	2	2	1	-	2	-	1	-	-	-	-		2	-	-	-
CO5	3	2	2	-	2	-		-	-	-	-	2	2	-	-	-
CO6	3	2	2	2		-	2	-	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191CSF7	C PROGRAMMING LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E.,**(ECE,CSE,BME)**	**Sem:**	**2**	**Category:**	**ESC**
Pre/Corequisites:	Nil				
AIM:	To provide practical knowledge in developing C Programming.				
SDG	04,09				

Course Outcomes:		
The Students will be able to	**BTL**	**SDG**
CO1: Able to have fundamental concept on basics commands in Linux.	UN	04
CO2: Able to write,compileand debug programs in C language.	UN	04
CO3: Able to formulate problems and implement algorithms in C.	AP	04
CO4: Able to effectively choose programming components that efficiently solve computing problems in real-world.	AP	09
CO5: Able to design application oriented programs in C.	AP	04
CO6: Structures and unions through which derived data types can be formed..	AP	04

LIST OF EXPERIMENTS:	
1.	Draw a flowchart for various algorithms using Raptor
2.	C Programming using Simple statements and expressions.
3.	Scientific problem solving using decision making and looping.
4.	Simple programming for one dimensional and two dimensional arrays.
5.	Solving problems using String functions.
6.	Programs with user defined functions - Includes Parameter Passing.
7.	Program using Recursive Function and conversion from given program to flow chart.
8.	Programs using pointers
9.	Program using structures and unions.
10.	Program using files.
	Total Periods **30**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	2	-	-	-	-	-	2	-	-	1	-	-	-	2
CO2	3	2	2	-	-	-	-	-	2	-	-	1	-	-	-	2
CO3	3	2	3	-	-	-	-	-	2	-	-	1	-	-	-	2
CO4	2	3	2	-	-	-	-	-	2	-	-	1	-	-	-	2
CO5	3		2	-	-	-	-	-	2	-	-	1	-	-	-	2
CO6	2		2	-	-	-	-	-		-	-	1	-	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS31	TRANSFORMS AND DISCRETE MATHEMATICS				L-T-P	C
					2-1-0	3
Programme:	**B.E./B.Tech. (Common to all branches)**	**Sem:**	**III**	**Category:**		**BSC**
Aim:	To introduce basic mathematical ideas such as reasoning techniques, basic counting techniques and their applications .					
SDG	04.09.11					

Course Outcomes:

The students will be able to	BTL	SDG
CO1: Apply Laplace transform to solve first and second order differential equations with elementary Function	AP	09
CO2: Explain the Fourier transform and with their properties	UN	09
CO3: Determine Z-inverse transform using convolution theorem and partial fraction method	AP	09
CO4: Apply mathematical induction and prove a relation	AP	04
CO5: Invent Eulerian and Hamiltonian paths to find shortest paths	AP	11
CO6: Make use of graph theoretic models to solve basic problems in networks	AP	09,11

LAPLACE TRANSFORMS	**9**
Laplace transform —Properties of Laplace Transforms – Laplace Transform of periodic functions –Inverse Laplace transforms by partial fraction method and Convolution theorem (excluding proof) – Solving ODE using Laplace transformation techniques.	
FOURIER TRANSFORMS	**9**
Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosinetransforms–Properties–Transformsofsimplefunctions–Convolutiontheorem –Parseval'sidentity.	
Z-TRANSFORMS	**9**
Z-transforms–Elementaryproperties–InverseZ-transform–Convolutiontheorem– Formationofdifferenceequations–SolutionofdifferenceequationsusingZ-transform.	
INTRODUCTION TO COUNTING	**9**
Decision problems on Propositional logic – Basic counting techniques – inclusion & exclusion-Pigeonhole principle – Permutations and combinations-Recurrence relations-Solving Linear recurrence relationsandgenerating functions	
INTRODUCTION TO GRAPHS	**9**
Graphs andtheir basic properties– Graph terminology and special types of graphs - Representing graphs and graph isomorphism – Euler and Hamilton paths.	
Total Periods	**45**

Text Book

1. B.S.Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

Reference

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002.
2. Venkataraman.M.K., "Engineering Mathematics", Volume I and II Revised enlarged FourthEdition, The National Publishing Company, Chennai, 2004.
3. Trembly J. P and Manohar R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw–Hill Pub. Co. Ltd, NewDelhi, 30th Re-print (2007).
4. Dr.P.Kandasamy,Dr.K.Thilagavathy,Dr.K.Gunavathy,**"Transforms and Partial Differential Equation",** S.Chand& Company Ltd. Ram Nagar,New Delhi.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-
CO2	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-
CO3	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-
CO4	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	1	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC31	CIRCUITS AND ELECTRONIC DEVICES			L-T-P	C
				3-1-0	4
Programme:	**B.E.,(ECE,BME)**	**Sem:**	**3**	**Category:**	**PC**
Prerequisites:	Nil				
Aim:	To analyze, design, and implement electrical and electronic circuits for various engineering applications.				
SDG	09,12				

Course Outcomes:

The students will be able to	**BTL**	**SDG**
CO1: Interpret basic electrical laws for DC and AC circuits.	UN	09
CO2: Apply various network theorems.	AP	09
CO3: Examine the responses of RL, RC and RLC circuits.	AN	09
CO4: Demonstrate the construction and operation of transistors.	UN	09
CO5: Illustrate the characteristics of FETs.	UN	09
CO6: Interpret the characteristics of special diodes and devices.	UN	09,12

UNIT I -BASIC LAWS AND NETWORKS THEOREMS	**12**
Kirchoff's laws – series and parallel connection of independent sources – R, L and C – Network Theorems – Thevenin, Superposition, Norton, Maximum power transfer and duality – Star-delta conversion.	
UNIT II-TRANSIENT RESONANCE IN RLC CIRCUITS	**12**
Basic RL, RC and RLC circuits and their responses to pulse and sinusoidal inputs – frequency response – Parallel and series resonances – Q factor – single tuned and double tuned circuits.	
UNIT III-BIPOLAR JUNCTION TRANSISTORS	**12**
NPN and PNP Transistor-Configuration-I/O Characteristics of CE,CB and CC Configurations -h-Parameters for CE configuration-Comparison of CE ,CB and CC configurations-Bias Stability-Need for biasing-Fixed bias-Self bias-Stability factor-Bias Compensation	
UNIT IV-FIELD EFFECT TRANSISTORS	**12**
Construction and Operations of JFET -Drain and Transfer Characteristics-Parameters of JFET-Saturation Drain Current -Slope of the Transfer Characteristics at IDSS-Comparison of JFET and BJT-Construction and Operation of MOSFET-Depletion Type and Enhancement Type -Comparison of MOSFET with JFET-Biasing of FET and MOSFET-Charge Coupled Devices(CCD).	
UNIT V-SPECIAL SEMICONDUCTOR DEVICES	**12**
Tunnel diodes – PIN diode, varactor diode – SCR characteristics and two transistor equivalent model –UJT–Diac and Triac–Laser, CCD, Photodiode, Phototransistor, LED, LASERs, MISFETs,MESFETs, TFETs, HEMTs.	
Total Periods	**60**

Text Book:

1. Joseph A. Edminister, Mahmood, Nahri, "Electric Circuits" – Shaum series,Tata Mc Graw Hill, 2007.

References:

1. Nandhitha Das Gupta and Amitava Das Gupta "Semiconductor Devices: Modeling and Technology" Prentice Hall of India Pvt Ltd, 4th edition, 2004.
2. Adel S. Sedra and Kenneth C.Smith, "Microelectronic Circuits", Oxford University Press, 6th edition, 2009.

3. Simon M.Sze and Kwok K.Ng, "Physics of Semiconductor Devices", John wiley& sons, 3rd edition, 2006.
4. S. Salivahanan, N. Suresh kumar and A. Vallavanraj, "Electronic Devices and Circuits",Tata McGraw Hill,
2nd edition, (2008).
5. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5thedition,2008.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO3	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO5	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO6	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC32	LINEAR INTEGRATED CIRCUITS			L-T-P	C
				3-0-0	3
Programme:	B.E.,**(ECE,BME)**	**Sem:**	3	**Category:**	**PC**
AIM:	To learn the basic concepts of linear integrated circuits and their applications.				
SDG	09,12				

Course Outcomes:

The students will be able to	**BTL**	**SDG**
CO1: Interpret the operational amplifier and its characteristics.	UN	09
CO2: Construct operational amplifier applications.	AP	09,12
CO3: Illustrate the concepts of analog multiplier IC and PLL IC.	UN	09
CO4: Classify digital-to-analog and analog-to-digital converters.	UN	09,12
CO5: Construct different types of waveform generators.	AP	09
CO6: Apply special function ICs for waveform generation.	AP	09

UNIT I-CIRCUIT CONFIGURATION FOR LINEAR ICs **9**

Advantages of ICs over discrete components –General operational amplifier stages and internal circuit diagrams of IC 741– DC and AC performance characteristics – Slew rate – Open and Closed loop configurations.

UNIT II- APPLICATIONS OF OPERATIONAL AMPLIFIERS **9**

Scale Changer – Adder and Subtractor – Instrumentation amplifier – Phase Shift Circuits – Voltage Follower – V-to-I and I-to-V converters – Peak detector – Clipper and Clamper – Differentiator – Integrator – Comparators – Schmitt trigger –Low-pass, high-pass and band-pass filters.

UNIT III-ANALOG MULTIPLIER ICs AND PLL ICs **9**

Analog Multiplier ICs and its applications — Operation of the basic PLL, Closed loop analysis of PLL, Voltage Controlled Oscillator(VCO), Block diagram of PLL IC 565 and its applications for frequency synthesizing, frequency multiplication and division.

UNIT IV-A/D AND D/A CONVERTERS **9**

Analog and Digital Data Conversions, D/A converter – specifications - Weighted resistor type, R-2R Ladder type, Voltage Mode R-2R Ladder and Current-Mode R-2R Ladder types - Sampling Process-High speed sample and hold circuit, A/D Converters – specifications - Flash type - Successive Approximation type - Single Slope type - Dual Slope type - A/D Converter using Voltage-to-Time Conversion.

UNIT V-WAVEFORM GENERATORS AND SPECIAL FUNCTION ICs **9**

Sine-wave generators, Multivibrators, Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555-GeneralDescription - Monostable and Astable operation of Timer IC 555 – LM317 adjustable voltage regulators.

Total Periods **45**

TEXT BOOK

1.RoyChoudhry.D, Shail Jain, Linear Integrated Circuits, New Age International Pvt. Ltd.,4thEdition, 2014.

REFERENCES

1. Salivahanan.S &KanchanaBhaskaran.V.S., "Linear Integrated Circuits",3rdEdition, McGraw Hill 2018.
2. Sonde.B.S., "System design using Integrated Circuits" , New Age Pub, 2nd Edition, 2001
3. Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 2005.
4. Ramakant.A.Gayakwad, "OP-AMP and Linear Ics", Prentice Hall / PE, 4th edition, 2001.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO3	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM31	ANATOMY AND HUMAN PHYSIOLOGY			L-T-P 3-0-0	C 3
Programme:	B.E. Biomedical Engineering	**Sem:**	**3**	**Category:**	**PC**
Aim:	To demonstrate their knowledge of importance of anatomical features and physiology of human systems				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Illustrate the basic structure and functions of cel	UN	03
CO2:	Outline the functions of respiratory, lymphatic and endocrine systems	UN	03
CO3:	Infer the importance of blood group and its functions	UN	03
CO4:	Explain the organ of digestive systems	UN	03
CO5:	Illustrate the structure and function of heart	UN	03
CO6:	Extend the basic concept of nervous systems and its types	UN	03

UNIT I -CELL AND TISSUE STRUCTURE — **9**

Structure of Cell – structure and functions of sub organelles – Cell Membrane –Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling – Cell Division. Types of Specialized tissues – Functions.

UNIT II- SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS — **9**

Skeletal::Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements.Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration.

UNIT III- CARDIOVASCULAR AND LYMPHATIC SYSTEMS — **9**

Cardiovascular: Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure.Lymphatic: Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels.

UNIT IV- NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS — **9**

Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain : Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. Endocrine - Pituitary and thyroid gland, Sense Organs: Eye and Ear

UNIT V- DIGESTIVE AND URINARY SYSTEMS — **9**

Digestive: Organs of Digestive system – Digestion and Absorption.Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex.

Total Periods — **45**

Text Books:

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publsihers. 2014
2. Elaine.N. Marieb , ―Essential of Human Anatomy and Physiology‖, Eight Edition, Pearson Education, New Delhi, 200

References:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014

2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013
3. William F.Ganong, ―Review of Medical Physiology‖, 22nd Edition, Mc Graw Hill, New Delhi, 2010
4. Eldra Pearl Solomon, ―Introduction to Human Anatomy and Physiology‖, W.B. Saunders Company, 2015
5. Guyton & Hall, ―Medical Physiology‖, 13th Edition, Elsevier Saunders, 2015.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	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	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM32	BIOCHEMISTRY(Theory cum Practical)			LTP 3-0-2	C 4
Programme:	B.E. Biomedical Engineering	**Sem:**	**3**	**Category:**	**ESC**
Aim:	To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Illustrate the basic principles of chemistry to biological systems.	UN	03
CO2:	Interpret the structural and functional properties of the biomolecules	UN	03
CO3:	Describe the synthesis of biomolecules and their role in metabolic pathways.	UN	03
CO4:	Acquire knowledge in the metabolic concepts related to metabolic diseases and disorders.	UN	03
CO5:	Explain the hierarchical organization of proteins and nucleic acid.	UN	03
CO6:	Identify the classification of enzymes and its clinical applications.	UN	03

INTRODUCTION TO BIOCHEMISTRY — **15**

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

CARBOHYDRATES — **15**

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease

LIPIDS — **15**

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat..Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism.

NUCLEIC ACID & PROTEIN — **15**

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism.

ENZYME AND ITS CLINICAL APPLICATION — **15**

Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non-competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical enzymology. Measurement of enzyme activity and interpretation of units.

Total Periods — **75**

Text Books:

1. RAFI MD ―Text book of biochemistry for Medical Student‖ Second Edition, University Press, 2014.
2. David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell, ―Harper‘s Review of Biochemistry‖, LANGE Medical Publications, 1981.

References:

1. Keith Wilson & John Walker, ―Practical Biochemistry - Principles & Techniques‖, Oxford University Press, 2009.
2. Pamela.C.Champe & Richard.A.Harvey, ―Lippincott Biochemistry Lippincott‘s Illustrated Reviews‖, Raven publishers,1994.

LAB COMPONENET

LIST OF EXPERIMENTS:

1. General guidelines for working and functional component of biochemistry lab
2. Preparation of solutions:
   - Percentage solutions,
   - Molar solutions,
   - Normal solutions
3. Standardization of pH meter, preparation of buffers, emulsions.
4. Spectroscopy: Determination of absorption maxima (λmax) of a given solution.
5. General tests for carbohydrates, proteins and lipids.
6. Identification of Blood Collection Tubes and Phlebotomy equipments
7. Preparation of serum and plasma from blood.
8. Estimation of Haemoglobin
9. Estimation of blood glucose.
10. Estimation of creatinine.
11. Estimation of urea.
12. Estimation of Uric acid
13. Estimation of cholesterol
14. Assay of SGOT/SGPT.
15. ELISA test
16. Separation of proteins by SDS electrophoresis(Demo)
17. Separation of amino acids by thin layer chromatography (Demo).

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	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	PSO4
CO1	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-
CO3	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-
CO4	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-
CO5	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-
CO6	3	-	-	3	-	2	-	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BS31	BIOLOGY FOR ENGINEERS			L-T-P 3-0-0	C 3
Programme:	B.E./B.Tech. (Common to all Branches)	**Sem:**	**III**	**Category:**	**BSC**
Aim:	To address complex real-world challenges at the intersection of biology and engineering.				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Illustrate various structures and functions of biological elements.	UN	03
CO2:	Explain basic concepts of thermodynamics and energy transactions.	UN	03
CO3:	Summarize different aspects of molecular computing.	UN	03
CO4:	Apply the Mendelian laws of inheritance.	AP	03
CO5:	Make use of cellular architecture to design an engineering system.	AP	03
CO6:	Apply sensor biology fundamental concepts in and communication systems.	AP	03

UNIT I-INTRODUCTION **9**

Biological analogy in engineering science, Biological elements-Carbohydrate, protein, amino acids, lipids and nucleic acids structure and function. Primary, secondary, tertiary and quaternary structure of protein. Protein as enzymes, transporter, receptors and structural elements.

UNIT II METABOLISM AND ENGINEERING **9**

Engineering aspects in thermodynamics of energy transactions, exothermic and endothermic versus endergonic and exergonic reactions. ATP as an energy source, glycolysis, Krebs cycle and photosynthesis. Energy yielding and energy consuming reactions. Enzymes classification, mechanism of enzyme action, enzyme kinetics and kinetic parameters

UNIT III- GENETICS AND TRANSFORMATION TECHNOLOGY **9**

Molecular basis of information transfer. DNA as a genetic material. Concept of genetic code. Mendal's laws, concept of segregation and independent assortment. Concept of allele, Gene mapping, Gene interaction, Epistasis, concepts of recessiveness and dominance and their relativeness to programming. Cell multiplication. Phenotype and genotype. Single gene disorders in humans and human genetics.

UNIT IV- CLASSIFICATION AND SYSTEM ENGINEERING **9**

Structure, function and relativeness to engineering of prokaryotes and eukaryotes. Habitats- aquatic or terrestrial. Molecular taxonomy-three major kingdoms. Microbial species and strains. Identification and classification of microorganisms. Industrial application of microorganisms. Sterilization and media compositions. Growth kinetics.

UNIT V-SENSOR BIOLOGY AND COMMUNICATION SYSTEMS **9**

Sensory system, circulatory system and excretory system and their relativeness to communication engineering. Hormonal regulation. General defense mechanism in human. Major human disorder and diseases.

Total Periods **45**

Text Books:

1. Arthur T. Johnson, CRC Press, New York2011
2. ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P., Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., "Biology for Engineers", Tata McGraw-Hill, New Delhi, 2012

References:

1. Rajiv Singal, Gaurav Agarwal, Ritu Bir, Biology for Engineers, CBS Publisher,2019

2. Charles Molnar and Jane Gair, Concepts of Biology-1st Canadian Edition, OpenStax Publication, 2013.
3. Raven Johnson, Biology, 11th Edition, Mc Graw Hill Publication, 2017

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1										1	3			
CO2	2	1				1	1					1	3			
CO3	2	1	1			1	1	1				1	3			
CO4	2	2	1	1		1	1	1				1	3			
CO5	2	2	1	1	1	1	1	1				1	3			
CO6	2	2	1	1		1	1					1	3			

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC37	CIRCUITS AND DEVICES LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E.,**(ECE,BME)**	**Sem:**	**III**	**Category:**	**PC**
Aim:	To analyze network theorems and the characteristics of electronic devices.				
SDG	09				

Course Outcomes:

The students will be able to		**BTL**	**SDG**
CO1:	Apply network theorems using T, π and impedance Matching Networks.	AP	09
CO2:	Construct different analog filter circuits.	AP	09
CO3:	Analyze the characteristics of RLC circuits.	AN	09
CO4:	Analyze the characteristics of voltage regulators.	AN	09
CO5:	Analyze the characteristics of BJT and JFET.	AN	09
CO6:	Examine the characteristics of LED, PIN, Photo Diode.	AN	09

List of Experiments

1. Construct T, π and impedance Matching Networks using NetworkTheorems.
2. Construct and analyze of LPF & HPF using RC and LC Circuits.
3. Determination of Q factor of parallel and series LC circuit.
4. Construct a half wave and full wave rectifier using diodes.
5. Design and analyze the characteristics of Voltage Regulators.
6. Design and analyze filter circuit(L & C) for rectification.
7. Analyze the input and output characteristics of Bipolar Junction Transistor and JFET.
8. Analyze the V-I characteristics of LED, LDR, Photo diode and PIN Diode.

TOTAL PERIODS	**30**

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1				1	1	1	1	2			
CO2	3	2	1	1	1				1	1	1	1	2			
CO3	3	3	2	2	1				1	1	1	1	2			
CO4	3	3	2	2	1				1	1	1	1	2			
CO5	3	3	2	2	1				1	1	1	1	2			
CO6	3	3	2	2	1				1	1	1	1	2			

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM37	HUMAN PHYSIOLOGY LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E.,**(BME)**	**Sem:**	**III**	**Category:**	**PC**
Aim:	To analyze blood parameters, including blood grouping, cell counts, hemoglobin estimation, ESR, and clotting factors, along with assessing hearing and visual acuity using standard tests.				
SDG	03				

COURSE OUTCOMES :

At end of the course, Students would be able to

CO1:	Identify and enumerate of blood samples.	**AP**	**03**
CO2:	Infer the various of Hematological parameters	**UN**	**03**
CO3:	Demonstrate the visual activity and hearing test	**UN**	**03**

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 Count.
6. Total WBC Count.
7. Differential Count of Blood Cells.
8. Estimation of ESR.
9. PCV, MCH, MCV, MCHC.
10. Hearing Test – Tuning Fork.
11. Visual Activity – Snellen's Chart and Jaeger's Chart.

TOTAL PERIODS	**30**

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS : Requirement for a batch of 30 students

- Microscope 2Nos.
- Centrifuge Normal 1No.
- Wintrobe's tube 2Nos.
- PCV tube 2Nos.
- Neubaur's Chamber 2Nos.
- Heparinized Syringe 1box.
- Haemoglobineometer 1No.
- Blood grouping kit 1No.
- Capillary tubes 1box.
- Ophthalmoscope 1No.
- Tuning fork (256Hz to 512Hz) 5Nos.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	3	3	-	-	-	-	3	2	-	2	3	-	-	-
CO2	3	-	3	3	-	-	-	-	3	2	-	2	3	-	-	-
CO3	3	-	3	3	-	-	-	-	3	2	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS37	COMMUNICATION SKILLS - I			L-T-P	C
				0-0-2	0
Programme:	B.E./ B.Tech. (Common to all Branches)	**Sem:**	**3**	**Category:**	**HS**
AIM:	To create an Environment to improve learner's communication skill using Professional English module.				
SDG	04				

Course Outcomes:		
The Students will be able to	BTL	SDG
CO1: Interpretbasicsof LanguagerelatingtoBusiness Communication. (UN)	UN	04
CO2: Inferthe basicsof Grammar relating to Business Communication. (UN)	**UN**	**04**
CO3: Demonstrate accurate and appropriate Communication. (UN)	**UN**	**04**
CO4: Build writing skills fortechnical report preparation. (AP)	**AP**	**04**
CO5: Make use of Technical Communication skills for effective listening. (AP)	**AP**	**04**
CO6: Develop speaking skill for effective communication. (AP)	**AP**	**04**

NAME OF THE EXPERIMENT

Language & Grammar 2

1. Use of Verb, Article, Adjectives, Adverbs, Preposition, Conjunction, Comparative Superlative,
2. Noun –Antecedent & Precedent
3. Spelling &Punctuation
4. Concord
5. Use of Active & Passive voice
6. Use of Conditional Sentence & Reported speech

Reading 4

1. Reading technical reports for Gist
2. Reading Technical Article, Graphs, Charts, Adverts, Notices & Proposals for Structure and detail

Writing 3

1. Writing E-mails for giving Instruction/ Summarizing/Persuading/Giving assurance/asking a Comment
2. Writing an Introduction to Report/Proposal/Technical Description
3. Writing Instructions & Recommendations for User manuals/Equipment's/devices/New Inventions

Listening 3

1. Listening to Technical News for Gist
2. Listening to Technical Interviews for gathering information

3. Listening to a Presentation for inferring meaning Speaking 6 1. Self-Introduction 2. Have your say- Recent gadgets/Technical Innovations/ Scientific Inventions.
Total Periods | **18**

TEXT BOOKS
1. Technical Writing: Process and Product, Gerson, Pearson Education India, 2007, ISBN: 8131709280, 9788131709283 2. Business Benchmark Pre-Intermediate to Intermediate: Student's Book BEC Preliminary Edition, Norman Whitby, PB + 2 Audio CDs,ISBN: 9780521759397.

CO's- PO's & PSO's MAPPING

Course Outcomes	**Program Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO2	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-
CO3	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO4	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO5	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-
CO6	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-

191HS42	PROBABILITY AND STATISTICS			L-T-P	C
				2-1-0	3
Programme:	**B.E. / B.Tech. (CIVIL, CSE, EEE, MECH, BIO-TECH & BME)**	**Sem:**	**4**	**Category:**	**BSC**
Aim:	To analyze the engineering problems using the techniques and the mathematical skills acquired by studying ODE and PDE uses numerical methods.				
SDG	09				

Course Outcomes:

The students will be able to	BTL	SDG
CO1: Interpret discrete and continuous random variables.	UN	09
CO2: Analyze the binomial, Poisson, geometric, uniform, exponential and normal distribution(AP)	**AN**	**09**
CO3: Compute the probability distributions of two dimensional Random Variables.	**AP**	**09**
CO4: Analyze the differences between means & standard deviations	AN	09
CO5: Examine Wiener - Khintchine relation and correlation properties	**AP**	**09**
CO6: Summarize the Properties of Power spectral density	**UN**	**09**

PROBABILITY AND RANDOM VARIABLES	**9**
Probability spaces – Conditional probability – Bayes rule - Discrete and continuous random variables – Moments - Moment generating functions and their properties.	
DISCRETE AND CONTINOUS PROBABILITY DISTRIBUTION	**9**
Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and normal distributions – Function of Random Variable	
TWO DIMENSIONAL RANDOM VARIBLES	**9**
Joint distributions - Marginal and conditional distributions – Covariance - Correlation and Regression - Transformation of random variables - Central limit theorem (for 2-D random variables)	
STATISTICS	**9**
Curve fitting by the method of least squares – fitting of Straight lines , Second degree parabolas and more general curves – Test of significance – Large sample test for single proportion , difference of proportions, single mean, difference of means and difference of standard deviations.	
TESTING OF HYPOTHESIS	**9**
Sampling distributions – Testing of hypothesis for mean, variance, proportions and differences using Normal, t, Chi-square and F distributions - Tests for independence of attributes and Goodness of fit.	
Total Periods:	**45**

Text Book

1. B.S. Grewal, 'Higher Engineering Mathematics', Thirty Sixth Edition, Khanna Publishers, Delhi, 2005.
2. Grewal B.S. and Grewal J. S., "Numerical Methods in Engineering and Science", Khanna Publishers, New Delhi, (2004).

Reference

1. Greenberg. *M.D*. "Advanced Engineering Mathematics, Second Edition, Pearson Education Inc. (First Indian reprint), 2002
2. Venkataraman. M.K., "Engineering Mathematics", Volume I and II Revised enlarged Fourth Edition, The National Publishing Company, Chennai, 2004.
3. Kreyszig, E., Advanced Engineering Mathematics, 8th edition, John Wiley Sons, 2001.
4. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata Mc-Graw Hill, New Delhi, (2007).
5. Gerald C.F., and Wheatley P.O., "Applied Numerical Analysis", Pearson Education Asia, New Delhi, (2006).

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	-	-	-	1	-	-	-	-	1	-	2	-	-	-
CO2	1	2	2	-	-	-	2	-	-	-	-	1	2	-	-	-
CO3	2	1	2	-	-	-	-	-	-	-	-	-	2	-	-	-
CO4	1	2	2	-	-	2	-	-	-	-	2	-	2	-	-	-
CO5	-		2	-	-	1	-	-	-	-	1	-	2	-	-	-
CO6	-	2	3	-	-	2	-	-	-	-	2	-	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC42	SIGNALS AND SYSTEMS			L-T-P	C
				3-0-0	3
Programme:	B.E.,**(ECE,BME)**	**Sem:**	**4**	**Category:**	**PC**
Aim:	To study and analyze the characteristics of continuous, discrete signals and systems.				
SDG	09				

Course Outcomes:

The students will be able to		BTL	SDG
CO1:	Characterize basic continuous time and discrete time signals and systems.	UN	09
CO2:	Interpret the continuous time signal using Fourier transform and Laplace transform.	UN	09
CO3:	Apply Laplace transform to Continuous Time Systems.	AP	09
CO4:	Illustrate the reconstruction of continuous time signal from discrete time signal.	UN	09
CO5:	Identify linear time invariant discrete time system using Z-Transform.	AP	09
CO6:	Compute DFT and IDFT coefficients of a given discrete time sequence using Fast Fourier Transform algorithms.	AP	09

CLASSIFICATION OF SIGNALS AND SYSTEMS **9**

Basic signals, Classification of signals – Continuous and Discrete signals, Periodic and Aperiadic signals, Deterministic and Random signals, Energy and Power signals – Classification of systems – Continuous and Discrete systems, Static and Dynamic, Linear and Nonlinear, Time-variant and Time-invariant, Causal and Non causal, Stable and Unstable, linear and circular convolution.

ANALYSIS OF CONTINUOUS TIME SIGNALS **9**

Fourier series analysis - Fourier and Laplace Transforms– Properties of Fourier and Laplace Transforms.

LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS **9**

Differential Equation-Block diagram representation-impulse response, convolution integrals-Laplace transform in Analysis of CT systems.

ANALYSIS OF DISCRETE TIME SIGNALS **9**

Baseband Sampling – Aliasing, Reconstruction of CT signal from DT signal- DTFT & its properties - Z Transform & its Properties.

LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS **9**

Difference Equations-Block diagram representation-Impulse response – Convolution sum-. Discrete Fourier Transform, Properties of DFT, FFT, Radix 2 DIF-FFT, Radix 2 DIT-FFT.

Total Periods: **45**

Text Book:

1. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, Signals and Systems, PHI, 2nd Edition, 2008
2. Anand Kumar, Signals and Systems - PHI; 3rdedition, 2013

References:

1. Simon Haykin and Van Veen, Signals & Systems, Wiley, 3rd Edition, 2007.
2. Michel J. Robert, Fundamentals of Signals and Systems, MGH International Edition, 2008.
3. B.P. Lathi, Signals, Systems & Communications, BS Publications, 2008.
4. Narayan Iyer and K Satya Prasad,Signals & Systems, Cenage Pub, 2011

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO2	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC43	DIGITAL SYSTEMS				L-T-P	C
					3-0-0	3
Programme:	B.E.,**(ECE,BME)**	**Sem:**	**4**	**Category:**		**PC**
Aim:	The course aims at Circuit schematic development, Computer modelling, Simulation of digital system and verifies their functionality using the Hardware description Language (Verilog).					
SDG	09					

Course Outcomes:

The students will be able to		BTL	SDG
CO1:	Interpret number system and its conversion.	UN	09
CO2:	Make use ofK-map and Queen Mc-Cluskey methods to simplify Boolean expressions. (UN	UN	09
CO3:	Design combinational circuits. (AP)	AP	09
CO4:	Design sequential circuits. (AP)	AP	09
CO5:	Illustrate different digital logic families and programmable logic devices. (UN)	UN	09
CO6:	Develop the HDL Programs for digital circuits. (AP)	AP	09

NUMBER SYSTEM & MINIMIZATION TECHNIQUES	**9**
Number system , Binary Arithmetic Operation , 1's and 2's complements,9's and 10's complement, Classification of binary Codes, Boolean logic operations and laws, De-Morgan's Theorem, Minimization of Boolean expressions , Sum of Products (SOP) , Product of Sums (POS), Karnaugh map Minimization (Three & Four variable), Quine-McCluskey method.	
LOGIC GATES & COMBINATIONAL CIRCUITS	**9**
Logic Gates, Mixed Logic, Half adder & Half Subtractor , Full Adder & Full Subtractor , Parallel binary adder, Parallel binary Subtractor, Fast Adder, Binary Multiplier, Binary Divider, Multiplexer / Demultiplexer, Decoder / Encoder , Parity checker, Parity generators , Code converters, Magnitude Comparator.	
SEQUENTIAL CIRCUITS	**9**
Flip-flops – SR, JK, D, T, and Master-Slave, Characteristic table and equation,Triggering of flip flops, Realization of one flip flop using other flip flops. Counters – Asynchronous & Synchronous Up/Down counter.Registers – Shift registers, Shift register counters. Design using Algorithmic State Machines and Finite State Machines, Design of Hazard Free Switching circuits.	
MSI AND PLD COMPONENTS	**9**
Fixed-function devices-TTL, ECL, RTL, CMOS, RAM/ROM, Programmable devices-PROMs, PALs and PLDs, FPGAs	
COMPUTER-AIDED DESIGN	**9**
Hardware description languages (HDLs) - Introduction to Verilog, Logic compilation, Two-level and multi-level logic synthesis, Technology-independent optimization, Technology mapping, Sequential-logic synthesis.	
TOTAL PERIODS	**45**

Text Book:

1. M.Morris Mano, Digital Design, 5th Edition, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2013.

References:

1. Donald D.Givone, Digital Principles and Design, TMH, 2007.
2. Donald P.Leach, Albert Paul Malvino, Goutam Shah "Digital principles & applications",7th edition, 2011
3. S. Salivahanan and S. Arivazhagan, Digital Circuits and Design, 3rd edition, Vikas Publishing House Pvt. Ltd, New Delhi, 2007.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	-	-	-	-	-	-	-	-	1	3	-	-	-
CO2	2	1	1	-	-	-	-	-	-	-	-	1	3	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	1	3	-	-	-
CO6	3	2	1	1	2	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM41	MEDICAL PHYSICS					L	T	P	C
						3	0	0	3
Programme:	B.E. Biomedical Engineering	**Sem:**	**IV**	**Category:**		**PC**			
Aim:	To effects of radiation in matter and how isotopes are produced.								
SDG	09								

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain about non-ionizing radiation, interaction with tissue and its effects	UN	09
CO2:	Compare the intensities of sensory stimuli	UN	09
CO3:	Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare	UN	09
CO4:	Explain the fundamentals of radioactivity and radioactive isotopes	UN	09
CO5:	Illustrate the methods of detecting and recording the ionizing radiation and its interaction with matter	UN	09
CO6:	Describe the production of radio nuclides	UN	09

NON-IONIZING RADIATION AND ITS MEDICAL APPLICATIONS	**9**
Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Debye model, Cole–Cole model, Overview of non-ionizing radiation Effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Ultraviolet	
PHYSICS OF THE SENSES	**7**
Introduction and objectives - Cutaneous sensation - The chemical senses – Audition –Vision - Psychophysics	
PRINCIPLES OF RADIOACTIVE NUCLIDES	**10**
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 Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclides, radionuclide Generator-Technetium generator.	
RADIOACTIVE DECAY AND INTERACTIONOF RADIATION WITH MATTER	**11**
Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-PositronDecay-Electron Capture-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.	
SCINTILLATION, SEMICONDUCTOR and GAS FILLED DETECTORS	**8**
Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger–Müller Counters	
Total Periods:	**45**

Text Books:

1. Gopal B. Saha, ―Physics and Radiobiology of Nuclear Medicine‖, 4th Edition, Springer, 2013.

2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, ―Medical Physics and Biomedical Engineering‖, 2nd Edition, IOP Publishers.2001.

References:

1. S.Webb ― The Physics of Medical Imaging‖, Taylor and Francis, 1988
2. J.P.Woodcock, ―Ultrasonic,Medical Physics Handbook series 1‖, Adam Hilger, Bristol, 2002
3. HyltonB.Meire and Pat Farrant ―Basic Ultrasound‖ John Wiley & Sons, 1995.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-	-
CO5	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-	-
CO6	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM42	PATHOLOGY AND MICROBIOLOGY				L	T	P	C
					3	0	0	3
Programme:	B.E. Biomedical Engineering	**Sem:**	**4**	**Category:**	**PC**			
Aim:	Gain a knowledge on the structural and functional aspects of living organisms.							
SDG	03							

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Infer the importance of cell degeneration and repair	UN	03
CO2:	Explain the methods involved in treating the pathological diseases	UN	03
CO3:	Summarize the structural and functional aspects of living organisms	UN	03
CO4:	Illustrate the functions of microscope	UN	03
CO5:	Outline the remedies in treating the pathological diseases	UN	03
CO6:	Interpret the morphological features and structural organization of bacteria and virus.	UN	03

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.

FLUID AND HEMODYNAMIC DERANGEMENTS **9**

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

MICROBIOLOGY **9**

Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria , culture media and its types , culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

MICROSCOPES **9**

Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.

IMMUNOPATHOLOGY **9**

Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE.Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

Total Periods: **45**

Text Books:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, ―Pathologic Basis of Diseases‖, 7th edition,WB Saunders Co. 2005 (Units I & II).
2. Ananthanarayanan & Panicker, ―Microbiology‖ Orientblackswan, 2017 10th edition.

(Units III,IV and V).

References:

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Dubey RC and Maheswari DK. ―A Text Book of Microbiology‖ Chand & Company Ltd, 2007
3. Prescott, Harley and Klein, ―Microbiology‖, 10th edition, McGraw Hill, 2017.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	-	-	-	-	2	2	-	-	-	-	3	3	-	-	-
CO2	3	-	-	-	-	2	2	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	2	2	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	-	-	-	-	2	2	-	-	-	-	2	3	-	-	-
CO6	3	-	-	-	-	2	2	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191CS35	DATA STRUCTURE ALGORITHMS AND C++ (Theory cum Practical)	L	T	P	C
		3	0	2	4

Programme:	B.E.,(ECE,BME)	Sem:	IV	Category:	ESC
Prerequisites:	-				
AIM:	To provide an in-depth knowledge in basic concepts of object oriented programming and fundamental concepts of data structures.				
SDG	09				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Interpret the principles of object oriented programming. (UN)	UN	09
CO2:	Demonstrate the concepts of classes and objects.(UN)	UN	09
CO3:	Summarize various object oriented features.(UN)	UN	09
CO4:	Build the programs using linear data structures. (AP)	AP	09
CO5:	Develop programs using non-linear data structures.(AP)	AP	09
CO6:	Analyzedifferent sorting algorithms. (AN)..	AN	09

PRINCIPLES OF OBJECT ORIENTED PROGRAMMING	15
Introduction – Beginning with C++, Tokens, Expressions, Control Structures, Functions in C++, Classes and objects, Operators overloading and type conversions.	
BASIC CONCEPTS OF OBJECT ORIENTED PROGRAMMING	15
Inheritance, Constructors and destructors, Pointers, Virtual functions and polymorphism, Exception handling.	
LINEAR DATA STRUCTURES	15
Arrays and its representations – Stacks and Queues – Linked lists – Linked list-based implementation of Stacks and Queues – Evaluation of Expressions.	
NON LINEAR DATA STRUCTURES	15
Trees – Binary trees – Binary tree representation and traversals –Binary Search Trees, Graph Algorithms – Representation – Shortest path algorithms: Dijkstra's algorithm – Minimum spanning tree.	
SORTING	15
Sorting – Preliminaries – Bubble Sort, Insertion sort, Shell sort, Merge sort, Quick sort, Bucket sort.	

LAB COMPONENT

LIST OF EXPERIMENTS :

1. Basic Programs for OOPS concepts.
2. Array implementation of stacks and queues.
3. Linked list implementation os stacks and queues.
4. Application of Stacks and Queues.
5. Implementation Sorting.

TEXT BOOKS :

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", 3rd Edition, Pearson Education Asia, 2014.
2. E. Balagurusamy, "Object Oriented Programming with C++", 4th edition, McGraw Hill CompanyLtd., 2009.

REFERENCE :

1. Michael T.Goodrich, "Data Structures and Algorithm Analysis in C++", Wiely student edition,2007.
2. Seymour, "Data Structures",The McGraw-Hill, 2007.
3. Jean – Paul Trembaly and Paul G.Sorenson, An Introduction to Data Structures with Applications, tata McGraw Hill 2nd edition, 2007.
4. John R.Hubbard, Schaum's "Outline of Theory and Problem of Data Structure with C++, McGraw-Hill, New Delhi,2004.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	2	-	-	-	1	1	1	1	-	-	-	2
CO2	2	1	1	1	2	-	-	-	1	1	1	1	-	-	-	2
CO3	2	1	1	1	2	-	-	-	1	1	1	1	-	-	-	2
CO4	3	2	1	1	2	-	-	-	1	1	1	1	-	-	-	2
CO5	3	2	1	1	2	-	-	-	1	1	1	1	-	-	-	2
CO6	3	3	2	2	2	-	-	-	1	1	1	1	-	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM47	PATHOLOGY & MICROBIOLOGY LABORATORY	L-T-P	C
Programme: B.E. Biomedical Engineering	**SEM- 04**	0-0-2	**1**
AIM	❖ Use Compound microscope ❖ Practice on chemical examinations, Cryoprocessing, Histopathological examinations		
SDG	03		

Course Outcomes

The students will be able to	BTL	SDG
CO1: Demonstrate proficiency in aseptic techniques for handling microbial cultures	AP	03
CO2: Identify different types of microbial media and their uses.	**AP**	**03**
CO3: Interpret results obtained from plated cultures to assess microbial growth and purity.	**UN**	**03**
CO4: Prepare histological slides of benign and malignant tumors for microscopic analysis.	**AP**	**03**
CO5: Apply differential staining methods such as Gram staining and acid-fast staining to differentiate microbial species.	**AP**	**03**
CO6: Perform immunoelectrophoresis techniques to separate and identify proteins.	**AN**	**03**

LIST OF EXPERIMENTS

1. Introduction to principles of sterile techniques and cell propagation
2. Microbial medium and culture preparation
3. Plating or culturing techniques-pour plate, streak plate and spread plate
4. Study of parts of Compound Microscope
5. Simple Staining
6. Differential Staining Techniques
7. Capsule Stain
8. Acid-Fast Stain
9. Basic Staining – Hematoxylin and Eosin Staining
10. Histopathological slides preparation of Benign and Malignant Tumors
11. Special staining- Periodic Acid-Schiff (Pas) staining
12. Antigen-Antibody Reaction Immunoelectrophoresis

REFERENCE

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

TOTAL: 30 PERIODS

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	3	-	-	3	-	-	-	-	2	2	-	2	3	-	-	-
CO2	3	-	-	3	-	-	-	-	2	2	-	2	3	-	-	-
CO3	3	-	-	2	-	-	-	-	2	2	-	2	3	-	-	-
CO4	3	-	-	2	-	-	-	-	2	2	-	2	3	-	-	-
CO5	3	-	-	3	-	-	-	-	2	2	-	2	3	-	-	-
CO6	3	-	-	3	-	-	-	-	2	2	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM48	ANALOG AND DIGITAL ICS LABORATORY			L-T-P	C
				0-0-2	1
Programme:	B.E. Biomedical Engineering	**Sem:**	**4**	**Category:**	**PC**
AIM:	To expose the students to integrated circuits, operational amplifiers, digital circuits and SPICE software and give them experimental skill.				
SDG	09				

Course Outcomes:

The Students will be able to	BTL	SDG
CO1 : Analyze and implement op-amp configurations like amplifiers, filters, integrators, and oscillators	AN	09
CO2 : Design and construct active filters for signal processing applications	AP	09
CO3 : Create and test multivibrators and Schmitt triggers using op-amps and NE555 timers	AP	09
CO4 : Design and implement digital circuits, including code converters, adders, multiplexers, counters, and shift registers	AP	09
CO5 : Construct regulated DC power supplies using LM317 and LM723	AP	09
CO6: Design and implement digital circuits, including code counters, and shift registers and study SPICE simulation	AP	09

LIST OF EXPERIMENTS

1. Inverting, Non inverting and Differential amplifiers.
2. Integrator and Differentiator.
3. Instrumentation amplifier
4. Active low-pass, High-pass and band-pass filters.
5. Astable & Monostable multivibrators and Schmitt Trigger using op-amp.
6. RC Phase shift and Wien bridge oscillators using op-amp.
7. Astable and monostable multivibrators using NE555 Timer.
8. DC power supply using LM317 and LM723.
9. Design and implementation of code converters using logic gates
(i) BCD to excess-3 code and vice versa (ii) Binary to gray and vice-versa
10. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC 7483
11. Design and implementation of Multiplexer and De-multiplexer using logic gates
12. Design and implementation of encoder and decoder using logic gates
13. Design and implementation of 3-bit synchronous up/down counter
14. Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops.
15. SPICE Simulation studies.

Total Periods | **45**

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	3	3	3	-	-	-	-	2	2	-	2	3	-	-	-
CO2	3	3	3	3	-	-	-	-	2	2	-	2	3	-	-	-
CO3	3	3	3	3	-	-	-	-	2	2	-	2	3	-	-	-
CO4	3	3	3	3	-	-	-	-	2	2	-	2	3	-	-	-
CO5	3	3	3	3	-	-	-	-	2	2	-	2	3	-	-	-
CO6	3	3	3	3	3	-	-	-	2	2	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS47	COMMUNICATION SKILLS - II			L-T-P	C
				0-0-2	0
Programme:	B.E./ B.Tech. (Common to all Branches)	**Sem:**	**4**	**Category:**	**HS**
AIM:	To create an Environment to experiment Professional English communication module with Intermediate resources.				
SDG	04				

Course Outcomes:		
The Students will be able to	BTL	SDG
CO1: Be competent in Presentation skill	UN	04
CO2: Develop their accuracy in Written Communication	**AP**	**04**
CO3: Improve their ability to understand Technical Presentations.	**UN**	**04**
CO4: Improve their ability to understand Conversations	**UN**	**04**
CO5: Give the exposure with Internal workplace Communication	**AP**	**04**
CO6: Give the exposure with External workplace Communication	**AP**	**04**

NAME OF THE EXPERIMENT

A. Reading 4

1. Reading Technical Articles, Reports, Proposals for gathering information

2. Reading Technical Journals, User manuals, annual reports for matching information

B. Writing 6

1. Writing E-mail to inform/respond/Insist/Convince/comment

2. Writing Technical Report (Format, Types, Abstract)

3. Writing Project Introduction/Website/Product

4. Writing User Manuals/Guidelines

5. Writing Product Reviews

6. Writing Useful Expressions for Persuading, Summarizing, gathering information

C. Listening 2

1. Listening to Telephonic conversation for filling the gaps

2. Listening to Group discussion to gather information

3. Listening to Interviews for writing short answers

4. Listening to Technical Presentation for evaluation

D. Speaking 6

1. Mini-Presentation on Technical Themes (Samples):

a) Cloud computing b) 4g c) Mission to Mars

d) Water Resource e) Sixth Sense Technology

2. Group Discussion on Social and Technical issues

A. Speaking 6

3 Self-Introduction

4 Have your say- Recent gadgets/Technical Innovations/ Scientific Inventions

Total Periods 18

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO2	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-
CO3	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO4	2	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO5	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-
CO6	2	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC51	ANALOG AND DIGITAL COMMUNICATION		L	T	P	C
			3	0	0	3
Programme:	B.E.,**(ECE,BME)**	**Sem: V**	**Category: PC**			
AIM:	To analyze the various analog and digital modulation and demodulation techniques, transmitters & receivers used in communication systems.					
SDG	09					

Course Outcomes:

The students will be able to		**BTL**	**SDG**
CO1:	Compare various amplitude modulation techniques.	UN	09
CO2:	Develop the various frequency modulation techniques.	AP	09
CO3:	Explain the different waveform encoding process.	UN	09
CO4:	Categorize the various techniques used in the channel and source coding process.	AN	09
CO5:	Develop various digital modulation techniques.	AP	09
CO6:	Examine the spread spectrum and multiple access techniques.	AN	09

AMPLITUDE MODULATION **9**

Need for modulation, Amplitude modulation, Virtues and limitations of Amplitude modulation, Linear modulation schemes, DSB-SC Modulation, Coherent detection, Costas receiver, Quadrature carrier multiplexing, SSB Modulation, vestigial side band modulation, Television signals, Frequency translation, Comparison of amplitude modulation systems.

ANGLE MODULATION **9**

Frequency and phase modulation. spectrum of FM Wave, modulation index and Bandwidth of FM Signal, NBFM and WBFM, Comparison between FM and PM Signals, FM and AM signals, AM and NBFM Signals, Generation of FM signals, Demodulation of FM signals, slope detector, ratio detector, Foster Seeley discriminator, Pre-emphasis & De-emphasis, – Capture effect, threshold effect.

DIGITAL TRANSMISSION AND DATA COMMUNICATION **9**

Introduction, pulse modulation, PCM – PCM sampling, sampling rate, signal to quantization noise rate, companding – analog and digital – percentage error, delta modulation, adaptive delta modulation, differential pulse code modulation, pulse transmission – ISI, eyepattern, source and error control coding, Entropy, Source encoding theorem, Shannon Fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem,Error control coding, linear block codes, cyclic codes, convolution codes, viterbi decoding algorithm.

DIGITAL COMMUNICATION **9**

Introduction, Shannon limit for information capacity, digital amplitude modulation, frequency shift keying, FSK bit rate and baud, FSK transmitter, BW consideration of FSK, FSK receiver, phase shift keying – binary phase shift keying – QPSK, Quadrature Amplitude modulation, bandwidth efficiency, carrier recovery – squaring loop, Costas loop, DPSK.

SPREAD SPECTRUM AND MULTIPLE ACCESS TECHNIQUES **9**

Introduction, Pseudo-noise sequence, DS spread spectrum with coherent binary PSK, processing gain, FH spread spectrum, multiple access techniques – wireless communication, TDMA and FDMA, wireless communication systems, source coding of speech for wireless communications.

TOTAL PERIODS: 45

TEXT BOOKS
1. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, PearsonEducation, 2009.
REFERENCES
1.Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2004 2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007 3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007. 4. B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press, 2007. 5. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002. 6. Martin S.Roden, "Analog and Digital Communication System", 3rd Edition, Prentice Hall of India, 2002. 7. B.Sklar, "Digital Communication Fundamentals and Applications" 2nd Edition Pearson Education 2007.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO3	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-	-
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO6	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM51	BIOMEDICAL INSTRUMENTATION			L	T	P	C
				3	0	0	3
Programme:	B.E.,(BME)	**Sem:**	**V**	**Category:**		**PC**	
Aim:	To study the different measurement techniques for non-physiological parameters						
SDG	03,09						

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Explaine the different biopoential electrodes and their equivalent circuits	UN	03
CO2:	Illustrate Measurements and recording of biopotential using different electrode placement	UN	03
CO3:	Design of signal conditioning for various physiological signals	UN	03
CO4:	Explain various technique for non-electrical physiological measurements	UN	03
CO5:	Outline the different biochemical measurements and sensors	UN	09
CO6:	Explain the functional blocks of various biochemical analyzer	UN	03

BIOPOTENTIAL ELECTRODES	**9**
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - motion artifacts, measurement with two electrodes.	
BIOPOTENTIAL MEASUREMENTS	**9**
Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven ‘s triangle, standard 12 lead system, Principles of vector cardiography.EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG and EGG**.**	
SIGNAL CONDITIONING CIRCUITS	**9**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.	
MEASUREMENT OF NON-ELECTRICAL PARAMETERS	**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 measurement.	
BIOCHEMICAL MEASUREMENT AND BIOSENSORS	**9**
Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.	
Total Periods:	**45**

Text Books:

1. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.

References:

1. John G. Webster, ―Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical Equipment Technology‖, Pearson Education, 2004.
3. Myer Kutz, ―Standard Handbook of Biomedical Engineering and Design‖, McGraw Hill Publisher, 2003.

4. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, 3rd edition, Tata McGraw-Hill New Delhi, 2014.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	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	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	-
CO3	3	3	2	-	-	-	-	-	-	-	-	2	3	-	3	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM52	SENSORS AND MEASUREMENTS	L	T	P	C
		3	1	0	4

Programme:	B.E. Biomedical Engineering	Sem:	V	Category:	PC
Aim:	To study the principle of transduction, classifications and the characteristics of different transducers				
SDG	09				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Compare various electrical parameters with accuracy, precision, resolution	UN	09
CO2:	Explain the various sensors and transducers of displament and pressure measurements	UN	09
CO3:	Interpret the appropriate passive or active transducers for measurement of Temperature	UN	09
CO4:	Infer appropriate light sensors for measurement of physical phenomenon	UN	09
CO5:	Outline the AC and DC bridges for relevant parameter measurement	UN	09
CO6:	Illustrate the Multimeter, CRO and different types of recorders for appropriate measurement	UN	09

SCIENCE OF MEASUREMENT — **15**

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.

DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS — **15**

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

PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS — **15**

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.

SIGNAL CONDITIONING CIRCUITS — **15**

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering.

DISPLAY AND RECORDING DEVICES — **15**

Digital voltmeter – Multi meter – 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.

Total Periods: — **75**

Text Books:

1. A.K.Sawhney, ―Electrical & Electronics Measurement and Instrumentation‖,10thedition, DhanpatRai& 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.

References:

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

2. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, 3rd edition, Tata McGraw-Hill, New Delhi, 2014.
3. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.
4. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques‖, Prentice Hall of India, 1stedition, 2016.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	2	-
CO5	3	3	2	-	-	-	-	-	-	-	-	2	3	-	2	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	-	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC53	DIGITAL SIGNAL PROCESSING ANDARCHITECTURE	L	T	P	C
		3	0	0	3

Programme:	B.E. .,(ECE, BME)	Sem: 5	Category: PC
AIM:	To design and implement IIR and FIR filters in digital signal processors		
SDG	09		

Course Outcomes:

The students will be able to		BTL	SDG
CO1:	Construct IIR filters for given specifications.	AP	09
CO2:	Build FIR filters for given specifications.	AP	09
CO3:	Make use of parametric and non-parametric methods for power spectrum estimation.	AP	09
CO4:	Interpret finite word length effects.	UN	09
CO5:	Illustrate the architecture of various digital signal processors.	UN	09
CO6:	Infer the programming concepts of various digital signal Processors.	UN	09

INFINITE IMPULSE RESPONSE FILTERS **9**

Review of DFT, FFT, Characteristics of practical frequency selective filters. characteristics of commonly used analog filters - Butterworth filters, Chebyshev filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

FIR FILTER DESIGN **9**

Symmetric and Antisymmetric FIR filters - Linear phase FIR filter - Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window and Blackmann Windows), Frequency sampling techniques - Realization of FIR filters – Transversal, Linear phase and Polyphase structures.

POWER SPECTRUM ESTIMATION **9**

Estimation of spectra from Finite duration observation of signals, non- parametric methods for power spectrum estimation -Welch, Bartlett methods, parametric methods for power spectrum estimation -Yule-Walker method for the AR model parameters

FINITE WORD LENGTH EFFECTS **9**

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

INTRODUCTION TO DIGITAL SIGNAL PROCESSORS **9**

DSP functionalities - circular buffering – DSP architecture – Fixed and Floating point architecture principles, Introduction to ADSP- 2100 family of processors – Programming – Architecture of DSP chip TMS320C54x and TMS320C55x, TMS320C6X DSP chip CPU Operation

TOTAL PERIODS 45

TEXT BOOKS

1. John G. Proakis& Dimitris G.Manolakis, Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.

REFERENCES

1. Emmanuel C.Ifeachor& Barrie. W. Jervis, Digital Signal Processing, Second Edition, Pearson

Education / Prentice Hall, 2002.
2. A. V. Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8thIndian Reprint, Pearson, 2004.
3. Sanjit K. Mitra, Digital Signal Processing – A Computer Based Approach, Tata Mc Graw Hill, 2007.
4. Andreas Antoniou, Digital Signal Processing, Tata Mc Graw Hill, 2006.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO4	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO5	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-
CO6	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC54	EMBEDDED SYSTEMS AND IOT (Theory cum Practical)	L	T	P	C
		3	0	2	4

Programme:	B.E.,(BME,ECE)	Sem: V	Category: PC
AIM:	To design and develop embedded computer systems to adopt IoT.		
SDG	09		

Course Outcomes

The students will be able to		BTL	SDG
CO1:	Interpret the characteristics of embedded systems.	UN	09
CO2:	Summarizethe functions of various device drivers and buses.	UN	09
CO3:	Illustrate the various interrupt servicing mechanisms.	UN	09
CO4:	Apply RTOS mechanisms for scheduling.	AP	09
CO5:	Experiment with the internet of things components.	AP	09
CO6:	Develop programs for the internet of things based applications.	AP	09

INTRODUCTION TO EMBEDDED SYSTEMS **15**

Definition and Classification – Characteristics of embedded systems –Challenges of embedded systems – Overview of processors and hardware units in an embedded system – Software embedded into the system – Exemplary embedded Systems –Embedded system design process.

DEVICES DRIVERS ,BUSES AND INTERRUPT SERVICING MECHANISM **15**

Overview of Embedded programming in ALP and C – Device drivers – Parallel port device drivers in a system- Serial port device drivers in a system- Device drivers for internal programmable timing devices – Embedded Buses – 12C- USB and CANBuses- Interrupt servicing mechanism – Context and period for context switching- Deadline and Interrupt latency.

REAL TIME OPERATING SYSTEMS **15**

Definitions of process, tasks and threads –Operating system services- Goals and structures - Kernel services – Concept of semaphores - RTOS task scheduling models – Co-operative Round Robin scheduling – Cyclic scheduling with time slicing– Preemptive scheduling model – Critical section service by a preemptive scheduler – Fixed (static) real time scheduling of tasks – Priority inversion problem and deadlock situations.

INTERNET OF THINGS **15**

Definition – phases – Foundations – Policy– Challenges and Issues - identification - security –privacy. Components in internet of things: Control Units – Sensors – Communication modules – Power Sources – Communication Technologies – RFID – Bluetooth – Zigbee – Wifi – Rflinks – Mobile Internet – Wired Communication.

PROGRAMMING THE MICROCONTROLLER FOR IOT **15**

Basics of Sensors and actuators – examples and working principles of sensors and actuators – Cloud computing and IOT – Arduino/ Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors Communication: Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using wifi / Ethernet

LIST OF EXPERIMENTS:

1. Simple Assembly language programming using 8051.
2. Configuring and interfacing 8051 I/O ports using KEIL IDE.
3. Interfacing, Programming of Stepper Motor /Servo Motor& DC Motor Speed control.
4. Making different LED pattern design using Arduino Board.
5. Buzzer/LCD interface using Arduino Board
6. Basic RTOS Application Design.

7. Mobile server Hacking using IoT
8. Client Server Model using IoT
9. Basic Robotic Kit using TIVA processor and IoT
10. Voice Activate Robot using IoT

TOTAL PERIODS 75

TEXT BOOKS

1. Rajkamal, "Embedded Systems Architecture, Programming and Design", Tata McGraw-Hill, 2nd Edition , 2009.
2.Dieter Uckelmann et.al, "Architecting the Internet of Things", Springer, 2011.

REFERENCES

1. Steve Heath, "Embedded Systems Design", 2nd Edition, Elsevier Publications, 2002.
2. David E-Simon, "An Embedded Software Primer", Pearson Education, 2007.
3. Frank Vahid and Tony Gwasrgie, "Embedded system Design", John Wiley and Sons, 2002.
4. Wayne Wolf, "Computers as Components – Principles of Embedded Computer System Design", 3rd Edition Morgan Kaufmann Publisher, 2006.
5.Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly, 2011.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	-	-	-	1	1	1	1	3	-	-	-
CO2	2	1	1	1	1	-	-	-	1	1	1	1	3	-	-	-
CO3	2	1	1	1	1	-	-	-	1	1	1	1	3	-	-	-
CO4	3	2	1	1	1	-	-	-	1	1	1	1	3	-	-	-
CO5	3	2	1	1	1	-	-	-	1	1	1	1	3	-	-	-
CO6	3	2	1	1	1	-	-	-	1	1	1	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM57	BIO MEDICAL INSTRUMENTATION LABORATORY				L-T-P	C
					0-0-2	1
Programme:	B.E.,**(BME)**	**Sem:**	V	**Category:**	**PC**	
AIM:	To provide hands-on training on designing of bio signal acquisition system and measurement of physiological parameters, biochemical parameters.					
SDG	03,09					

Course Outcomes:

The students will be able to		**BTL**	**SDG**
CO1:	Design preamplifiers and amplifiers for various bio signal recordings	AP	03
CO2:	Experiment with measuring various non-electrical parameters using suitable sensors/transducers	AP	03
CO3:	Design PCB layout for any bio amplifier	AP	09

LIST OF EXPERIMENTS:

LIST OF EXPERIMENTS:

1. Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC‘s
2. Design of ECG Amplifiers with appropriate filter to remove power line and other artifacts.
3. Design of EMG amplifier
4. Design a suitable circuit to detect QRS complex and measure heart rate
5. Design of frontal EEG amplifier
6. Design of EOG amplifier to detect eye blink
7. Design a right leg driven ECG amplifier.
8. Design and study the characteristics of optical Isolation amplifier
9. Design a Multiplexer and Demultiplexer for any two biosignals.
10. Measurement of pulse-rate using Photo transducer.
11. Measurement of pH and conductivity.
12. Measurement of blood pressure using sphygmomanometer.
13. Measurement and recording of peripheral blood flow
14. Design a PCB layout for any bio amplifier using suitable software tool.

TOTAL PERIODS 30

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	3	-	-	-	-	2	2	-	2	3	-	-	-
CO2	3	2	-	3	-	-	-	-	2	2	-	2	3	-	-	-
CO3	3	-	-	3	2	-	-	-	2	2	-	2	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC58	DSP AND SIGNAL PROCESSORS LABORATORY				L-T-P	C
					0-0-2	1
Programme:	B.E.,**(ECE, BME)**	**Sem:**	V	**Category:**	**PC**	
AIM:	To develop skills in implementing digital signal processing techniques using MATLAB and Processors.					
SDG	09					

Course Outcomes:

The students will be able to		**BTL**	**SDG**
CO1:	Interpret different continuous and discrete time waveforms.	UN	09
CO2:	Develop algorithms for convolution and Fourier Transform.	AP	09
CO3:	Examine FIR and IIR filters.	AN	09
CO4:	Inspect power spectrum of a signal.	AN	09
CO5:	Construct multirate filters.	AP	09
CO6:	Make use of DSP Processor to generate signal and convolution operation.	AP	09

LIST OF EXPERIMENTS:

MATLAB / EQUIVALENT SOFTWARE PACKAGE

1. Generation of sequences (functional & random)
2. Linear and Circular Convolutions
3. FIR filter design
4. IIR filter design
5. Multirate Filters
6. Determination of Power Spectrum of a given signal

DSP PROCESSOR BASED IMPLEMENTATION

1. Study the architecture of DSP chips – TMS 320C 5X/6X Instructions and its addressing modes
2. Generation of sine, square and triangular waveforms
3. Implementation of linear and circular convolution
4. Sampling of input signal and display
5. Implementation of FIR filter
6. Implementation of IIR filter
7. Implementation of Radix – 2 FFT using ADSP 21XX processor.
8. Adaptive filter for noise cancellation
9. Implementation of Multirate signal processing – Decimation and Interpolation filter

(Note: Experiments may be done using any one of the TMS320C5X/ TMS320C67XX/ ADSP21XX family of processors)

TOTAL PERIODS 30

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	1	-	-	-	2	1	1	1	3	-	-	-
CO2	3	2	1	1	1	-	-	-	2	1	1	1	3	-	-	-
CO3	3	3	2	2	1	-	-	-	2	1	1	1	3	-	-	-
CO4	3	3	2	2	1	-	-	-	2	1	1	1	3	-	-	-
CO5	3	2	1	1	1	-	-	-	2	1	1	1	3	-	-	-
CO6	3	2	1	1	1	-	-	-	2	1	1	1	3	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS57	BUSINESS ENGLISH	L	T	P	C
		0	0	2	0

Programme:	B.E., / B. Tech Common to All Branches	Category:	HSMC
Aim:	To Improve learner's Communication Skills in English.		
SDG	04		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1.	Familiarize in Language Skills, Soft Skills, Inter Personal Skills, Decision Making and Business Communication	UN	04
CO2.	Competent in Presentation skill.	AP	04
CO3.	Imbibe the knowledge of effective classroom speaking and presentation	UN	04
CO4.	Provide opportunities to learners to practice their communicative skills to become proficient users of English	AP	04
CO5.	Write job applications	AN	04
CO6.	Acquire knowledge about the various principles of communication.	UN	04

UNIT-I	**6**
Elements of effective presentation – Structure of presentation – Presentation tools – Voice Modulation – Audience analysis – Body language – Video samples	
UNIT-II	**6**
Time management – Articulateness – Assertiveness – Psychometrics – Innovation and Creativity – Stress Management & Poise – Video Samples	
UNIT-III	**6**
Covering letter – strategies to write, resume and it's various kinds.	
Total Periods	**18**

References

1. Dr. Bala Ramadurai, "Karmic Design Thinking", First EditionTRIZ Innovation India, 2020.
2. Karl T. Ulrich, "Design Creation of Artifacts in Society", Trustees of the University of Pennsylvania Publisher, USA, 2011
3. Alma R. Hoffmann, "Sketching as Design Thinking", Taylor & Francis, UK, 2019
4. Michael Lewrick, Patrick Link and Larry Leifer, "The Design Thinking Playbook", Wiley, USA, 2018.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PSO 4
CO1	-	2	2	-	-	-	-	-	3	3	3	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-		3	-	2	-	-	-	-
CO3	-	-	-	-	2	-	-	-	2	3	-	2	-	-	-	-
CO4	-	-	-	-	-	-	-		2	3	-	2	-	-	-	-
CO5	-	-	-	-	-	-	-	3	-	3	-	1	-	-	-	-
CO6	-	-	-	-	-	-	-	3	-	3	-	1	-	-	-	-

correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM61	BIOCONTROL SYSTEMS	L	T	P	C
		3	1	0	4

Programme:	B.E. Biomedical Engineering	Sem:	6	Category:	PC
Aim:	To apply mathematical modelling principles in understanding the various fundamental biological systems .				
SDG	03,09				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Apply the concept behind feedback and continuum in various systems and subsystems.	AP	09
CO2:	Analyze the time response of various systems and discuss the concept of system stability	AN	09
CO3:	Analyze the frequency response characteristics of various systems using different charts.	AN	09
CO4:	Select the concept of modeling basic physiological systems	AP	03
CO5:	Examine the application aspects of time and frequency response analysis in physiological control systems	AN	03
CO6:	Identify the need for mathematical modeling of various biological systems,	AP	03

INTRODUCTION **12**

Open and Closed loop Systems, Modeling and Block Diagrams, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control system.

TIME RESPONSE ANALYSIS **12**

Step and impulse responses of first order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability.

FREQUENCY RESPONSE ANALYSIS **12**

Frequency domain specifications - Polar plots, Bode plots, Nyquist plot, Nyquist stability criterion, closed loop stability, Constant M and N circles, Nichol‘s chart.

BIOLOGICAL SYSTEM MODELS **12**

Distributed parameter versus lumped parameter models, Model development of Cardiovascular system- Heart model-circulatory model, Pulmonary mechanics- Lung tissue visco-elastance-chest wall- airways, Interaction of Pulmonary and Cardiovascular models, Static analysis of physiological systems – Regulation of cardiac output, Regulation of ventilation.

BIOLOGICAL CONTROL SYSTEM ANALYSIS **12**

Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

Total Periods: **60**

Text Books:

1.J. Nagarath and M. Gopal ―Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.(UNIT

2.Michael C K Khoo, ―Physiological Control Systems‖, IEEE Press, Prentice Hall of India, 2005

References:

1. Benjamin C. Kuo, ―Automatic Control Systems‖, Prentice Hall of India, 1995.
2. John Enderle Susan Blanchard, Joseph Bronzino ―Introduction to Biomedical Engineering‖, second

edition, Academic Press, 2005.
3. Richard C. Dorf, Robert H. Bishop, ―Modern control systems‖, Pearson, 2004.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO6	3	3	3	-	-	-	-	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC62	MACHINE LEARNING	L	T	P	C
		3	0	0	3

Programme:	B.E.,(ECE, BME)	Sem: 6	Category: PC
AIM:	To understand the new approaches in machine learning to design appropriate algorithms for problem solving		
SDG	09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Illustrate the principles and concepts of machine learning.	UN	09
CO2:	Apply the classification and regression algorithms for different problems.	AP	09
CO3:	Explain the clustering and dimensionality reduction techniques.	UN	09
CO4:	Analyze neural networks for machine learning.	AN	09
CO5:	Elaborate reinforcement learning technique.	UN	09
CO6:	Employ the tools of machine learning for various applications.	AP	09

INTRODUCTION **9**

Learning Problems – Perspectives and Issues – Concept Learning – Version Spaces and Candidate Eliminations – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

NEURAL NETWORKS AND GENETIC ALGORITHMS **9**

Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – SupportVector Machine

BAYESIAN AND COMPUTATIONAL LEARNING **9**

Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm – Probability Learning – Sample Complexity – Finite and Infinite Hypothesis Spaces – Mistake Bound Model.

INSTANT BASED LEARNING **9**

K- Nearest Neighbour Learning – Locally weighted Regression – Radial Bases Functions – Case Based Learning.

ADVANCED LEARNING **9**

Learning Sets of Rules – Sequential Covering Algorithm – Learning Rule Set – First Order Rules – Sets of First Order Rules – Induction on Inverted Deduction – Inverting Resolution – Analytical Learning – Perfect Domain Theories – Explanation Base Learning – FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning

TOTAL PERIODS 45

TEXT BOOKS

1. Tom M. Mitchell, ―Machine Learning‖, McGraw-Hill Education (India) Private Limited, 2013.

REFERENCES

1. EthemAlpaydin, ―Introduction to Machine Learning (Adaptive Computation and Machine Learning)‖, The MIT Press 2004.
2. Stephen Marsland, ―Machine Learning: An Algorithmic Perspective‖, CRC Press, 2009

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	3
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-	3
CO3	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	3
CO4	3	3	2	2	-	-	-	-	-	-	-	1	3	-	-	3
CO5	2	1	1	1	-	-	-	-	-	-	-	1	3	-	-	3
CO6	3	2	1	1	2	-	-	-	-	-	-	1	3	-	-	3

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM62	HOSPITAL MANAGEMENT				L	T	P	C
					3	0	0	3
Programme:	B.E. Biomedical Engineering	**Sem:**	**6**	**Category:**			**PC**	
Aim:	To study the various information management systems and relative supportive services.							
SDG	03,08,09							

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Outline the fundamentals of hospital administration and management	UN	03
CO2:	Interpret the quality and safety aspects in hospital	UN	03
CO3:	Explain the principles of Marketing Research Process	UN	09
CO4:	Summarize the importance of Human resource management	UN	08
CO5:	Infer the safety procedures followed in hospitals	UN	03
CO6:	Illustrate the Information management systems and its uses.	UN	09

OVERVIEW OF HOSPITAL ADMINISTRATION **9**

Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning- Equipment Planning – Functional Planning - Current Issues in Hospital Management – Telemedicine - Bio-Medical Waste Management

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, Communication – nature, scope, barriers, styles and modes of communication

MARKETING RESEARCH PROCESS **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 - The buyer decision process - Model of business buyer behavior – Major types of buying situations - WTO and its implications

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.

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 – Environment Management Systems. NABA, JCI, NABL. 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**

Text Books:

1. R.C.Goyal, ―Hospital Administration and Human Resource Management‖, PHI – Fourth Edition, 2006.
2. G.D.Kunders, ―Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth

Reprint 2007.

References:

1. Cesar A.Caceres and Albert Zara, ―The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Norman Metzger, ―Handbook of Health Care Human Resources Management‖, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. Peter Berman ―Health Sector Reform in Developing Countries‖ - Harvard University Press, 1995.
4. William A. Reinke ―Health Planning For Effective Management‖ - Oxford University Press.1988
5. Blane, David, Brunner, ―Health and SOCIAL Organization: Towards a Health Policy for the 21st Century‖, Eric Calrendon Press 2002.
6. Arnold D. Kalcizony & Stephen M. Shortell, ―Health Care Management‖, 6th Edition Cengage Learning, 2011.

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	-	-	-	-	3	3	-	2	-	-	-
CO2	-	-	-	-	-	-	-	3	-	-	3	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
CO4	-	-	-	-	-	3	-	-	-	3	3	-	-	-	-	-
CO5	-	-	-	-	-	3	-	3	-		3	-	2	-	-	-
CO6	-	-	-	-	-	-	-	3	-	3	3	-	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM63	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT-1	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Sem:	VI	Category:	PC
Aim:	Gain the knowledge of measure the biological signals in diagnostic and therapeutic equipment's.				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Interpret the devices for measurement of parameters are related to cardiology	UN	03
CO2:	Infer the measurement of EEG and its use	UN	03
CO3:	Explain the working and recording of all basic neurological equipment's	UN	03
CO4:	Compare the diagnostic and therapeutic equipments to EMG	UN	03
CO5:	Classify the parameters are related to respiratory system	UN	03
CO6:	Explain the concept of sensory measurement	UN	03

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.	
NEUROLOGICAL EQUIPMENT	**8**
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.	
MUSCULAR AND BIOMECHANICAL MEASUREMENTS	**10**
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	
RESPIRATORY MEASUREMENT SYSTEM	**10**
Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer – Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators	
SENSORY MEASUREMENT	**8**
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**

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. Myer Kutz, ―Standard Handbook of Biomedical Engineering & Design‖, McGraw Hill, 2003.
2. L.A Geddes and L.E.Baker-Principles of Applied Biomedical Instrumentation‖, 3rd Edition, 2008
3. Leslie Cromwell, ―Biomedical Instrumentation and Measurement‖, Pearson Education, New Delhi, 2007.
4. Antony Y.K.Chan,‖Biomedical Device Technology,Charles Thomas Publisher Ltd, Illinois, USA, 2008.
5. B H Brown, R H Smallwood, D C Barber-Medical Physics and Biomedical Engineering‖, 2nd Edition, IOP Publishers. 2001.

LAB COMPONENT

LIST OF EXPERIMENTS:

1. Measurement of visually evoked potential
2. Galvanic skin resistance (GSR) measurement
3. Measurement of Respiratory parameters using spirometry.
4. Study of medical stimulator
5. Recording of Audiogram
6. Study the working of Defibrillator and pacemakers
7. Analysis of ECG, EEG and EMG signals
8. Study of ventilators

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-
CO2	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-
CO3	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-
CO4	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-
CO5	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-
CO6	3	-	-	-	-	2	-	-	-	-	-	2	3	3	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC67	MACHINE LEARNING LABORATORY		L	T	P	C
			3	0	0	1
Programme:	B.E.,**(ECE, BME)**	**Sem: 6**	**Category: PC**			
AIM:	Enable students to make use of Data sets in implementing the machine learning algorithms					
SDG	03,09					

Course Outcomes

The students will be able to		**BTL**	**SDG**
CO1:	Develop algorithm for finding the most specific hypothesis based on given training data. (AP)	AP	09
CO2:	Build Artificial Neural Network and test for the given dataset. (AP)	AP	09
CO3:	Make use of Naïve Baye's classifier to classify the given data. (AP)	AP	09
CO4:	Apply clustering algorithms to cluster the given set of data. (AP)	AP	09
CO5:	Design regression algorithm to fit the given data points. (AP)	AP	09
CO6:	Analyze machine learning algorithms to solve real world problems. (AN)	AN	03

LIST OF EXPERIMENTS

1. Implement FIND-S Algorithm for finding the most specific hypothesis based on a given set of training samples.
2. Build an Artificial Neural Network by implementing the back propagation algorithm
3. Implement Naïve Bayesian Classifier
4. Implement classifier using Support Vector Machine
5. Implement K-Nearest Neighbor Classifier
6. Implement K-Means segmentation
7. Implement linear regression
8. Implement dimensionality reduction algorithm (PCA)
9. Implement random forest classifier.
10. Implement deep learning algorithm
11. Implement prediction of heart disease with machine learning

TOTAL PERIODS 45

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	-	-	-	2	1	-	1	3	-	-	3
CO2	3	2	1	1	1	-	-	-	2	1	-	1	3	-	-	3
CO3	3	2	1	1	1	-	-	-	2	1	-	1	3	-	-	3
CO4	3	2	1	1	1	-	-	-	2	1	-	1	3	-	-	3
CO5	3	2	1	1	1	-	-	-	2	1	-	1	3	-	-	3
CO6	3	3	2	2	1	-	-	-	2	1	-	1	3	-	-	3

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191HS67	CARREER ENGLISH	L	T	P	C
		0	0	2	0

Programme:	B.E., / B. Tech Common to All Branches			Category:	HSMC

Aim:	To Improve learner's Communication Skills in English.
SDG	04

Course Outcomes:

Students will be able to		BTL	SDG
CO1.	Exposethe aptitudeandreasoningskills. (AP)	AP	04
CO2.	Explorethebarriersthat affect communicationinaprofessionalset up. (AP)	AP	04
CO3	Acquire group discussion skills. (AP).	AP	04
CO4.	Make use of linguistic skills for employability. (AP)	AP	04
CO5.	Developtheircareerprospectsthroughoralcommunication. (AP)	AP	04
CO6.	Develop communication skills for recruitment. (AP)	AP	04

UNIT-I **6**

Verbal analogy, verbal reasoning, error spotting, sentence completion

UNIT-II **6**

Why is GD part of selection process? – Structure of GD – Moderator – Strategies in GD – Team work – Body Language – Mock GD – Video samples

UNIT-III **6**

Kinds of interviews – Required Key Skills – Corporate culture – Mock interviews – Video samples

1. Resume / Report Preparation

2. Presentation Skills: Students make presentations on given topics. (8)

3. Group Discussion: Students participate in group discussions. (6)

4. Interview Skills: Students participate in Mock Interviews (8)

Total Periods **18**

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO2	-	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO3	-	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO4	-	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-
CO5	-	-	-	-	2	-	-	1	2	3	-	1	-	-	-	-
CO6	-	-	-	-	1	-	-	1	2	3	-	1	-	-	-	-

191BM69	MINI PROJECT			L-T-P	C
				0-0-2	1
Programme:	B.E. Biomedical Engineering	**Sem**	**6**	**Category**	**EEC**
AIM:	To develop a simplified electronic circuits and communication systemmodel suitable for any application				
SDG	03,04,09,12				

Course Outcomes:

The Students will be able to	BTL	SDG
CO1. Identify suitable problem in the field of Biomedical engineering.	AP	03,09
CO2:Apply the knowledge of fundamental engineering.	AP	**04,09**
CO3:Investigate the feasibility of the chosen problem.	AP	09,12
CO4:Examinesolution for the problem as a team.	AN	09
CO5:Optimize the product performance and cost.	AN	12
CO6:Analyze the observed results and report.	AN	04

Syllabus Contents:

The students are required to search / gather the material / information on a specific a topic
Comprehend it and present / discuss in the class. They can take up small problems in the field of desig engineering as mini project. It can be related to solution to an engineering problem, verification and analysis o experimental data available, conducting experiments on various engineering subjects, material characterization studying a software tool for the solution of an engineering problem

Total Periods	**30**

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	2	1	1	1	2	1	1	1	3	-	2	3
CO2	3	2	1	1	2	1	1	1	2	1	1	1	3	-	2	3
CO3	3	2	1	1	2	1	1	1	2	1	1	1	3	-	2	3
CO4	3	3	2	2	2	1	1	1	2	1	1	1	3	-	2	3
CO5	3	3	2	2	2	1	1	1	2	1	1	1	3	-	2	3
CO6	3	3	2	2	2	1	1	1	2	1	1	1	3	-	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC71	ROBOTICS AND ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Programme:	B.E.,**(ECE, BME)**	Sem: VII	Category:BSC
AIM:	To design the robotic systems using artificial intelligence concepts.		
SDG	09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Classify the different types of Robots.	UN	09
CO2:	Illustrate the concept of intelligent agents.	UN	09
CO3:	Apply AI methods to solve various problems.	AP	09
CO4:	Apply the State-Space Search problem-solving paradigm for Game playing.	AP	09
CO5:	Develop knowledge base sentences using propositional logic and first order logic.	AP	09
CO6:	Explain the different planning strategies of AI.	UN	09

INTRODUCTION **9**

Types of Robot–Technology-Robot classifications and specifications-Degree of freedom and degree of motion-Manipulation of various components-sensors, Need for AI in Robotics, Thinking and acting humanly, Intelligent agents, structure of agents.

PROBLEM SOLVING **9**

Production System, State-Space Search, Control Strategies, Characteristics of problem,Uninformed Search Techniques, Heuristic search Techniques, Constraint Satisfaction.

PROBLEM REDUCTION AND GAME PLAYING **9**

Problem Reduction - Game Playing - Bounded Look-Ahead Strategy - Alpha-Beta Pruning -Two-Player Perfect Information Games.

LOGIC CONCEPTS AND LOGIC PROGRAMMING **9**

Propositional Calculus, Propositional Logic, Natural Deduction System, Semantic Tableau System, Resolution Refutation, Predicate Logic, Logic Programming..

PLANNING **9**

Types of planning systems, Block World Problem, Logic-Based Planning, Linear Planning Using a Goal Stack, Means-Ends Analysis, Non-Linear Planning Strategies, Learning Plans.

TOTAL PERIODS 45

TEXT BOOKS

1. Stuart Russell, Peter Norvig, “Artificial Intelligence: A modern approch”, Pearson Education, India2003.
2. Negnevitsky, M, “Artificial Intelligence: A guide to Intelligent Systems”,. Harlow: Addison-Wesley, 2002.

REFERENCES

1. David Jefferis, “Artificial Intelligence: Robotics and Machine Evolution”, Crabtree Publishing Company, 1992.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	1	-	1	-	1	2	-	-	-
CO2	2	1	1	1	-	-	-	-	-	-	-	1	2	-	-	-
CO3	3	2	1	1	1	-	-	-	1	-	-	1	2	-	-	-
CO4	3	2	1	1	1	-	-	-	1	-	-	1	2	-	-	-
CO5	3	2	1	1	1	-	-	-	1	-	-	1	2	-	-	-
CO6	2	1	1	1		-	-	-		-	-	1	2	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM71	RADIOLOGICAL EQUIPMENTS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Sem:	VII	Category:	PC
Aim:	To study the principles and its types of radiological equipment's				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Describe the working principle of X ray machine and its application	UN	03
CO2:	Identify the generations of CT and image reconstruction techniques	AP	03
CO3:	Explain the fundamental concept of MRI	UN	03
CO4:	Explain the applications of radionuclide imaging	UN	03
CO5:	Interpret the various radiation therapy equipments in medical field	UN	03
CO6:	Outline the radiation measuring instruments with radiation protection in healthcare system	UN	03

MEDICAL X-RAY EQUIPMENT	9
Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnetic induction, Line focus principle and the heel effect, Causes of x-ray tube failure: Electron arcing/filament burn out, Failure to warm up tube, High temp due to over exposure, x-ray tube rating charts'-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.	
COMPUTED TOMOGRAPHY	**9**
Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back projection and iterative method. Spiral CT, 3D Imaging and its application	
MAGNETIC RESONANCE IMAGING	**9**
Fundamentals of magnetic resonance- 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 Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.	
NUCLEAR MEDICINE TECHNIQUES	**9**
Nuclear imaging – Anger scintillation camera –Nuclear tomography – single photon emission computer tomography, positron emission tomography – Recent advances .Radionuclide imaging-Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques-hematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole -body counting, surface counting.	
RADIATION THERAPY AND RADIATION SAFETY	**9**
Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – 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. Steve Webb, ―The Physics of Medical Imaging‖, Adam Hilger, Philadelpia, 1988 (Units I, II, III & IV).
2. R.Hendee and Russell Ritenour ―Medical Imaging Physics‖, Fourth Edition William, Wiley-Liss, 2002.

References:

1. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine‖- Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, ―Medical physics and Biomedical Engineering‖, - CRC Press, 1999.
3. Myer Kutz, ―Standard handbook of Biomedical Engineering and design‖, McGraw Hill, 2003.
4. P.Ragunathan, ―Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques‖,Paperback – Import, 2007

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3		-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	3	3	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO5	3	-	-	-	-	3	-	2	-	-	-	3	3	-	-	-
CO6	3	-	-	-	-	-	-	2	-	-	-	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC72	DIGITAL IMAGE PROCESSING			L-T-P	C
				3-0-0	3
Programme:	B.E.,**(ECE, BME)**	**Sem:**	**VII**	**Category:**	**PC**
AIM:	To analyze digital image fundamentals and familiar with image compression and segmentation techniques				
SDG	09				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the digital image fundamentals.(UN)	UN	09
CO2:	Interpret the image enhancement techniques. (UN)	UN	09
CO3:	Develop the image restoration techniques. (AP)	AP	09
CO4:	Build the image segmentation methods. (AP)	AP	09
CO5:	Examine the image compression techniques. (AN)	AN	09
CO6:	Interpret the various image representation and recognition techniques. (UN)	UN	09

DIGITAL IMAGE FUNDAMENTALS	**9**
Introduction – Origin – Steps in Digital Image Processing – Components – Elements of VisualPerception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationshipsbetween pixels - Color image fundamentals -RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.	
IMAGE ENHANCEMENT	**9**
Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – **Frequency Domain:** Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.	
IMAGE RESTORATION AND SEGMENTATION	**9**
Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band passFilters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filteringSegmentation:Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation-Morphological processing- erosion and dilation - Segmentation by morphological watersheds.	
WAVELETS AND IMAGE COMPRESSION	**9**
Wavelets – Subband coding - Multiresolution expansions - Compression: Fundamentals – ImageCompression models – Error Free Compression – Variable Length Coding – Bit-Plane Coding –Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Compression Standards.	
IMAGE REPRESENTATION AND RECOGNITION	**9**
Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.	
TOTAL PERIODS	**45**
TEXT BOOKS	

1. 1.Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, PearsonEducation, 2018.
2. 2.Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.

REFERENCES

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
2. Willliam K Pratt, “Digital Image Processing”, John Willey, 2002.
3. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI LearningPvt. Ltd., 2011.
4. http://eeweb.poly.edu/~onur/lectures/lectures.html.
5. http://www.caen.uiowa.edu/~dip/LECTURE/lecture.html

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	1	1	1	-	-	-	-	-	-	-	1	2	-	-	2
CO2	2	1	1	1	-	-	-	-	-	-	-	1	2	-	-	2
CO3	3	2	1	1	-	-	-	-	-	-	-	1	2	-	-	2
CO4	3	2	1	1	-	-	-	-	-	-	-	1	2	-	-	2
CO5	3	3	2	2	-	-	-	-	-	-	-	1	2	-	-	2
CO6	2	1	1	1	-	-	-	-	-	-	-	1	2	-	-	2

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM72	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT- II	L	T	P	C
		3	0	2	4

Programme:	B.E. Biomedical Engineering	Sem:	VII	Category:	PC
Aim:	To study the principles of diagnostic and therapeutic equipment's.				
SDG	03				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the types of diathermy and its applications	UN	03
CO2:	Illustrate the Importance and function of basic procedure in ultrasound and its applications in medicine	UN	03
CO3:	Explain the concept of various extracorporeal and special diagnostic devices used in hospitals	UN	03
CO4:	Summarize the various equipment's in ICU and its applications of telemetry	UN	03
CO5:	Illustrate the working principle of dialyzer	UN	03
CO6:	Interpret the importance of patient safety against electrical hazard.	UN	03

PATIENT MONITORING AND BIOTELEMETRY **9**

Patient monitoring systems, ICU/CCU Equipment's, bed side monitors, Infusion pumps, Central consoling controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.

DIATHERMY **9**

IR and UV lamp and its application. Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine - Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

ULTRASONIC EQUIPMENTS **9**

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool – Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES **9**

Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenators, finger pump, roller pump, electronic monitoring of functional parameters. Hemo Dialyser unit, Lithotripsy, Principles of Cryogenic technique and application, Endoscopy, Laparoscopy, Otoscopes. Thermography – Recording and clinical application.

PATIENT SAFETY **9**

Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – 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

Total Periods: **45**

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. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.
2. Richard Aston ―Principles of Biomedical Instrumentation and Measurement‖, Merril Publishing Company, 1990.
3. L.A Geddas and L.E.Baker ―Principles of Applied Biomedical Instrumentation‖ 2004.
4. Myer Kutz ―Standard Handbook of Biomedical Engineering & Design‖, McGraw-Hill Publisher, 2003.
5. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, 3rd edition,Tata McGraw-Hill, New Delhi, 2014.

LAB COMPONENT

LIST OF EXPERIMENTS:

1. Study of shortwave and ultrasonic diathermy
2. Measurement of various physiological signals using biotelemetry
3. Study of hemodialysis model
4. Electrical safety measurements
5. Analyze the working of ESU – cutting and coagulation modes
6. Study of Ultrasound Scanners
7. Study of heart lung machine model

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	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	PSO4
CO1	3	2	3	3	-	-	-	2	3	3	-	2	3	3	2	-
CO2	3	2	3	3	-	-	-	2	3	3	-	2	3	3	2	-
CO3	3	2	2	3	-	-	-	2	3	3	-	2	3	3	2	-
CO4	3	2	3	3	-	-	-	-	3	3	-	2	3	3	2	-
CO5	3	3	2	3	-	-	-	2	-	-	-	2	3	3	2	-
CO6	3	3	3	3	-	-	-	2	3	3	-	2	3	3	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191EC77	ROBOTICS AND ARTIFICIAL INTELLIGENCE LABORATORY	L	T	P	C
		0	0	2	1
Programme:	B.E.,**(ECE, BME)**	**Sem: VII**	**Category: PC**		
AIM:					
SDG	09				

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Develop bluetooth controlled and voice controlled RSLK.(AP)	AP	09
CO2:	Control RSLK through blynk application. (AP)	AP	09
CO3:	Design free roaming RSLK with the use of sensors.(AP)	AP	09
CO4:	Develop pick and place robot. (AP)	AP	09
CO5:	Build robot for color and shape identification.(AP).	AP	09
CO6:	Develop robot for industrial process. (AP)	AP	09

LIST OF EXPERIMENTS

1. 1. Study of Engergia Software
2. Simple forward and backward navigation of Robotic System Learning Kit (RSLK)
3. Bluetooth Controlled RSLK
4. Voice Controlled RSLK
5. Free roaming decision making RSLK
6. Controlling and Monitoring RSLK Through Blynk Cloud
7. Simulation and Robot Programming for pick and place
8. Simulation and Robot Programming for color identification
9. Simulation and Robot Programming for shape identification

Simulation and Robot Programming for any industrial process

TOTAL PERIODS 30

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-
CO2	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-
CO3	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-
CO4	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-
CO5	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-
CO6	3	2	1	1	1	-	-	-	2	1	1	1	2	2	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (Hi

191EC78	DIGITAL IMAGE PROCESSING LABORATORY		L	T	P	C
			0	0	2	1
Programme:	B.E.,**(ECE, BME)**	**Sem: VII**	**Category:PC**			
AIM:	To analyze and estimate the various image processing methods					
SDG	09					

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Analyze the image enhancementtechniques in spatial and frequency domain.(AN)	AN	09
CO2:	Apply transform techniques for digital image analysis. (AP)	AP	09
CO3:	Inspect edge, region based and morphological image segmentation.(AN)	AN	09
CO4:	Examine the image compression techniques. (AN)	AN	09
CO5:	Simulate image restoration algorithms.(AP)	AP	09
CO6:	Analyze the images with different color models. (AN)	AN	09

LIST OF EXPERIMENTS

Simulation using MATLAB

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 (DCT, IDCT)
6. Histogram Processing and Basic Thresholding functions
7. Image Enhancement-Spatial filtering
8. Image Enhancement-Filtering in frequency domain
9. Image segmentation–Edge detection, line detection and point detection.
10. Basic Morphological operations and Segmentation using watershed transformation
11. Region based Segmentation
12. Analysis of images with different color models.
13. Study of DICOM standards
14. Image compression and Image restoration techniques

TOTAL PERIODS 30

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	-	-	-	2	1	1	1	2	-	-	2
CO2	3	2	1	1	1	-	-	-	2	1	1	1	2	-	-	2
CO3	3	3	2	2	1	-	-	-	2	1	1	1	2	-	-	2
CO4	3	3	2	2	1	-	-	-	2	1	1	1	2	-	-	2
CO5	3	2	1	1	1	-	-	-	2	1	1	1	2	-	-	2
CO6	3	2	1	1	1	-	-	-	2	1	1	1	2	-	-	2

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM79	PROJECT - I	L	T	P	C
		0	0	4	2
Programme:	**B.E./B.Tech. Biomedical Engineering**	**Category:**		**EEC**	
AIM:	To develop student's knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers.				
SDG:	03,04,09,12				

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Interpret the fundamentals of Biomedical Engineering.	UN	03,09
CO2:	Identify the problem statements from societal and industrial requirements.	AP	03,09
CO3:	Perform literature survey of research articles and Patents.	AP	04
CO4:	Analyze solutions for the problems as a team.	AN	09
CO5:	Develop the product using modern tools and hardware. (AN) 09,12	AN	09,12
CO6:	Make use of the observed results for report preparation and presentation. (AN) 04	AN	04

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	-	-	-	-	-	2	3	3	3	3
CO2	3	3	2	2	2	2	2	2	-	-	-	2	3	3	3	3
CO3	3	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
CO4	3	3	2	2	2	2	2	2	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	2	2	2	2	2	2	3	3	3	3	3
CO6	3	3	2	2	2	-	-	2	2	2	2	2	3	3	3	3

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BM89	PROJECT - II	L	T	P	C
		0	0	12	6
Programme:	**B.E./B.Tech. Biomedical Engineering**	**Category:**		**EEC**	
AIM:	To develop students knowledge for solving technical problems through structured project research study in order to produce competent and sound engineers				
SDG:	03,04,09,12				

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Make use of latest technology to update the technical knowledge on the selected project title.	AP	04,09
CO2:	Analyze the problem statement, formulation and solution to meet the needs of industry, research and society	AN	03,09
CO3:	Make use of modern tools for project planning, scheduling and execution.	AP	04,09
CO4:	Analyze ethical practices and tools used for different technologies.	AN	12
CO5:	Design software/hardware, related to project for serving the society	AP	03,12
CO6:	Document project report and presentations.	AN	04

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	3	3	2			3	3	3	3	3	3	3	3
CO2	3	3	3	3	2	2	2	2	2	2	3	2	3	3	3	3
CO3	3	2	2	2	3	2	2	2	2	3	3	3	3	3	3	3
CO4	3	3	2	2	3	2	2	3	3	3	3	2	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO6	3	3	2	2	2			2	2	2	2	2	3	3	3	3

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEA	BIO MEMS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Sem:	Category:	PE
Aim:	Study the various MEMS fabrication techniques			
SDG	03,06,07,09			

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the different types of MEMS materials	UN	09
CO2:	Outline the various MEMS fabrication techniques	UN	09
CO3:	Compare the different types of mechanical and thermal, sensors and actuators and their principles of operation at the micro scale level.	UN	09
CO4:	Illustrate the principles and operation of electrostatic and piezoelectric sensors and actuators	UN	07,09
CO5:	Interpret the concept of Microfluidic systems	UN	03,06
CO6:	Explain the applications of BIOMEMS	UN	03

MEMS MATERIALS AND FABRICATION	9
Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezo resistors, Gallium Arsenide, quartz, polymers. Micromachining photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA	
MECHANICAL AND THERMAL SENSORS AND ACTUATORS	**9**
Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. 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, flow sensor	
ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS	**9**
Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.	
MICROFLUIDIC SYSTEMS	**9**
Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in micro conduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, micro fluid dispenser, microneedle, micro pumps-continuous flow system, micro mixers	
APPLICATIONS OF BIOMEMS	**9**
CAD for MEMS, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor.	
Total Periods	**45**

Text Books:

1. Tai Ran Hsu, ―MEMS and Microsystems Design and Manufacture‖, Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
2. Wanjun Wang, Stephen A.Soper, ‖BioMEMS: Technologies and Applications‖, CRC Press, New York, 2007.(Unit V).

References:

1. Marc J. Madou ―Fundamentals of Microfabrication: the Science of Miniaturization‖, CRC Press,2002.
2. Nadim Maluf, Kirt Williams. ―An introduction to Microelectro Mechancial Systems Engineering‖, Second Edition, Artech House Inc, MA, 2004.
3. Chang Liu,‘ Foundations of MEMS‘, Pearson Education International, New Jersey, USA,2006
4. 4. Nitaigour Premchand Mahalik, ―MEMS‖, Tata McGraw Hill Publishing Company, New Delhi, 2007 .

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	2	2	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	2	2	-	-	-	2	3	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	2	2	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	3	2	-	-	-	-	-	-	-	-	2	3	-	2	
CO6	3	2	2	-	2	2	2	2	-	-	-	2	3	-	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEB	NANOTECHNOLOGY AND APPLICATIONS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates		
SDG	03,07,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the fundamental properties, kinetics, and applications of nanostructures.	UN	09
CO2:	Illustrate the fabrication methods and characterization of nanomaterials.	UN	09
CO3:	Interpret the optical properties of Nanomaterials.	UN	09
CO4:	Explain the measurement of nanomaterials	UN	07,09
CO5:	Explain the basics of nanostructures and their applications.	UN	03
CO6:	Illustrate the applications of nanotechnology.	UN	03

INTRODUCTION TO NANOTECHNOLOGY	**9**
Basic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, bio Nano-particles	
FABRICATION AND CHARACTERIZATION OF NANOMATERIALS	**9**
Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Bucky balls, Nanotubes); Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.	
PROPERTIES AND MEASUREMENT OF NANOMATERIALS	**9**
Optical Properties: Absorption, Fluorescence, and Resonance; Methods for the measurement of nanomaterials; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.	
NANO STRUCTURES	**9**
Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures. Reinforcement in Ceramics, Drug delivery, Giant magnetoresistance, etc. Cells response to Nanostructures.	
APPLICATIONS OF NANOTECHNOLOGY	**9**
Nano electronics, Nano sensors, Nanotechnology in Diagnostics applications, Environmental and Agricultural Applications of nanotechnology, Nano technology for energy systems	
Total Periods:	**45**

Text Books:

1. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.(Unit I – V)
2. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004. (Unit I – V)

References:

1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited by Tseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	3	2	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	3	2	2	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	3	2	2	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	3	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEC	BIO MATERIALS AND ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the compatibility and functioning of artificial organs inside the living system.		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Illustrate the response of biomaterials in living system.	UN	03
CO2:	Classify the different types of materials and its application in biomedical field.	AP	09
CO3:	Explain about the polymeric materials and composites in tissue replacements.	UN	03
CO4:	Explain the role of decellularized matrix biomaterials and stem cell-based transplants in tissue repair and regeneration.	UN	03
CO5:	Explain soft and hard tissue replacement for biomedical applications.	UN	03
CO6:	Demonstrate the compatibility and functioning of artificial organs inside the living system.	AP	03

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY	**9**
Definition and classification of bio-materials, mechanical properties, visco elasticity, wound-healing process, body response to implants, blood compatibility, HLA compatibility.	
IMPLANT MATERIALS	**9**
Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminium oxides, hydroxyapatite, glass ceramics, carbons, medical applications.	
POLYMERIC IMPLANT MATERIALS	**9**
Polymerization, polyamides, Acrylic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Medical Textiles: silica, chitosan, PLA, composites, Sutures, wound dressings. Materials for ophthalmology: contact lens, Intra ocular lens. Membranes for plasma separation and blood oxygenation.	
TISSUE REPLACEMENT IMPLANTS	**9**
Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft-tissue replacements, types of transplant by stem cell, sutures, surgical tapes, Tissue adhesive/glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Pancreas replacement	
ARTIFICIAL ORGANS	**9**
Artificial Blood, Artificial Skin, Artificial Heart, Prosthetic Cardiac valves, Artificial Lung(Oxygenator), Artificial Kidney (Dialyzer Membrane), Dental Implants, Retinal Implants	
Total Periods:	**45**

Text Books:

1. Sujata V. Bhatt, "Biomaterials", Narosa Publishing House, 7th Edition, 2005.
2. JoonB.Park Joseph D. Bronzino, "Biomaterials - Principles and Applications", CRC press, 2003.

References:

1. H.H.Willard,D.L.Merrit, “Instrumental Methods of Analysis”,CBS Publishers, 1992.
2. ParkJ.B., “Biomaterials Science and Engineering’’, Plenum Press,1984.
3. Myer Kutz, “ “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003
4. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, “”Introduction to Biomedical Engineering”, Elsevier, 2005.
5. AC Anand, JF Kennedy, M. Miraftab, S.Rajendran, “Medical Textiles and Biomaterials for Health Care’’, Woodhead Publishing Limited, 2006.
6. D F Williams, “Medical and Dental Materials: A comprehensive Treatment-Volume 14”, VCH Publishers, 1992.
7. BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, “”An introduction to Materials in Medicine”, Academic Press, 1996.

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO2	3	-	-	-	-	-	2	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	-	2	-	-	-	-	2	3	-	2	-
CO4	3	-	-	-	-	-	-	2	-	-	-	2	3	-	2	-
CO5	3	-	-	-	-	-	-	2	-	-	-	2	3	3	2	-
CO6	3	-	-	-	-	-	2	2	-	-	-	2	3	3	2	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMED	BIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study and Understand choice of filters to remove noise and artifacts from biomedical signals.		
SDG	03,09		

Course Outcomes:

The Students will be able to	BTL	SDG
CO1: Illustrate the characteristics of different types of biomedical signals and identify their spectral components	UN	03
CO2: Apply different filters on biomedical signals and identify the filter performance.	**AP**	03
CO3: Infer the physiological interferences and artifacts affecting ECG signal	**UN**	03
CO4: Interpret the power and correlation spectra of EEG signal	**UN**	03
CO5: Analyze waveform shaping techniques for biomedical signals.	AN	03,09
CO6: Analyze the signal classification and recognition in biomedical applications	**AN**	03,09

INTRODUCTION TO BIOMEDICAL SIGNALS **9**

Bio signal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

FILTERING FOR REMOVAL OF ARTIFACTS **9**

Time-domain Filters - synchronized averaging, Moving Average Filters, Derivative-based operators to remove low-frequency artifacts. Frequency-domain filters - Removal of High Frequency noise, Removal of low frequency noise, Removal of periodic artifacts, optimal filter- Wiener filter, Adaptive filters for removal of interference

CARDIOVASCULAR APPLICATIONS **9**

Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Adaptive noise cancelling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets. Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modelling and analysis of PCG signals.

NEUROLOGICAL APPLICATIONS **9**

EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Nonlinear modelling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels. Evoked potentials- noise characteristics, Noise reduction by linear filtering.

ANALYSIS ON WAVESHAPE, SIGNAL CLASSIFICATION AND RECOGNITION **9**

Modelling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD).

Total Periods:	**45**

Text Books:

1. Rangayyan, ―Biomedical Signal Analysis‖, Wiley 2002.
2. Semmlow, ―Biosignal and Biomedical Image Processing‖, Marcel Dekker, 2004

References:

1. Arnon Cohen, ―Bio-Medical Signal Processing Vol I and Vol II‖, CRC Press Inc., Boca Rato, Florida 1999.
2. D.C.Reddy, ―Biomedical Signal Processing: Principles and techniques‖ , Tata McGraw Hill, New Delhi, 2005
3. Willis J Tompkins, ―Biomedical Digital Signal Processing‖, Prentice Hall, 1993
4. Bruce, ―Biomedical Signal Processing & Signal Modeling,‖ Wiley, 2001
5. Sörnmo, ―Bioelectrical Signal Processing in Cardiac & Neurological Applications‖, Elsevier 2005.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-	
CO2	3	3	2	-	-	-	-	-	-	-	-	2	3	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	2	3	-	-	2
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEE	BIOFLUIDS AND DYNAMICS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the mathematical modelling of fluid biological system		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Choose fluid mechanics principles and their applications to bio-viscoelastic fluids and blood flow dynamics.	AP	03
CO2:	Identify the cellular biomechanics, mechanotransduction, and the biomechanics of ocular and tissue cells.	AP	03
CO3:	Make use of blood rheology and arterial biomechanics in relation to hemodynamics.	AP	03
CO4:	Illustrate the cardiorespiratory mechanics and space medicine	UN	03,09
CO5:	Apply computational fluid dynamics (CFD) methods to solve fluid motion problems using conservation laws and boundary conditions.	AP	09
CO6:	Develop multiphysics computational models for cardiac flow and virtual cardiography.	AP	03,09

BIOFLUID MECHANICS **8**

Intrinsic fluid properties - Density, Viscosity, Compressibility, Surface tension, Hydrostatics Fluid characteristics and viscosity – Displacement and velocity, Sheer stress and viscosity Bernoulli equation, Introduction to pipe flow – Reynolds number, Poiseuille‘s law, Flow Rate, Womersley number, Constitutive equations – Newtonian fluid, Non-Newtonian viscous fluid, Diameter, velocity and pressure of blood flow relationship, Resistance against flow, Viscoelasticity – Viscoelastic models, Response to Harmonic variation, Use of viscoelastic models, Bio-Viscoelastic fluids – Protoplasm, Mucus, Saliva, Synovial fluids

CELLULAR AND OCCULAR MECHANICS **8**

Cellular Biomechanics – Eukaryotic cell architecture, Cytoskeleton, Cell-matrix interactions, Mechanical property measurement – Atomic Force microscopy, Optical Trapping, Magnetic bead microrheometry, Micropipette aspiration, Models of cellular biomechanical behavior, Computational model of a chondrocyte in its matrix, Mechanotransduction, Techniques for mechanical stimulation of the cells, Tissue cell mechanobiology – Endothelial, smooth muscle cells, Chondrocytes, Osteoblasts, Ocular Biomechanics – Occular anatomy, Biomechanics of Glaucoma, Ocular blood flow. .

BLOOD RHEOLOGY AND BLOOD VESSEL MECHANICS **10**

Viscometry, Elements of Blood, Blood characteristics – Viscosity of blood, Einstein‘s equation, Biomechanics of red cell membrane, Apparent and relative viscosity, Blood viscosity variation,Casson‟s equation, Rheology of Blood In Micro vessels – Fahraeus-Lindquist effect and its inversion, Anatomy and physiology of blood vessels, Arterial wall as membrane – Uniaxial loading, Biaxial loading, Torsion, Hemodynamics of Large arteries – Ventricular outflow and the aorta, Pressure-flow relations and Vascular Impedance, Wave propagation and reflection

CARDIO RESPIRATORY MECHANICS AND SPACE MEDICINE **9**

Cardiac cycle – Pressure volume diagrams, Changes in contractility, Ventricular performance, Congestive heart failure, Pulsality index, Physics of valvular diseases, Prosthetic heart valves and replacements, Respiratory System – Alveolar ventilation-lung volumes and capacities, Mechanics of breathing, Work of breathing – Lung compliance, Airway resistance, Gas exchange and transport, Oxygen dissociation curve, Lung surfactant, Pulmonary pathologies, Space Medicine – Hypoxia, Physiology of decompressive sickness, Human response to acceleration, Thermal Stress	
COMPUTATIONAL FLUID DYNAMICS	**10**
Computational fluid dynamics – CFD Code, Problem solving with CFD, Conservation Laws of Fluid Motion and Boundary Conditions, Turbulence and its modelling, The Finite Volume Method for Diffusion Problems and Convection-Diffusion Problems, Solution Algorithms for Pressure-Velocity Coupling in steady flows, Solution of Discretized Equations, The Finite Volume Method for Unsteady flows, Implementation of Boundary Conditions Application – Multiphysics computational models for cardiac flow and virtual cardiography.	
Total Periods:	**45**

Text Books:

1. Krishnan B. Chandran, Ajit P. Yoganathan, Stanley E. Rittgers, ―Biofluid Mechanics- The human circulation‖, CRC Taylor and Francis, 2007.
2. Y.C Fung, ―Biomechanics- Mechanical properties of living tissues‖, 2nd Edition, Springer-Verlag, 1993.
3. Jeffery R. Davis et. Al., ―Fundamentals of Aerospace Medicine‖, Wolter Kluwer Health, Lippincott Williams and Wilkins, 2008

References:

1. Jung HeeSeo, Vijay Vedula, Theodore Abraham and Rajat Mittal, ―Multiphysics computational models for cardiac flow and virtual cardiography‖, Int. J. Numer. Meth. Biomed. Engng. (2013) Published online in Wiley Online Library
2. Lee Waite, Jerry Fine, ―Applied Biofluid Mechanics‖, McGraw Hill, 2007
3. John K-J Li, ―Dynamics of Vascular System‖, World Scientific, 2004
4. C. Ross Ethier, Craig A Simmons, ―Introduction to Biomechanics- From Cells to Organisms‖, Cambridge Texts in Biomedical Engineering, 2007
5. H K Versteeg, W Malalasekera, ―An Introduction to Computational Fluid Dynamics The Finite Volume Method‖, Longman Scientific and Technical, 1995

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	1	-	-	-	-	-	-	-	3	3	-	-	-
CO2	3	3	3	2	-	-	-	-	-	-	-	3	3	-	-	-
CO3	3	3	2	1	-	-	-	-	-	-	-	3	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO5	3	3	2	1	2	-	-	-	-	-	-	3	3	-	-	3
CO6	3	3	2	1	2	-	-	-	-	-	-	3	3	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEF	PHYSIOLOGICAL MODELING	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the dynamic models, simulate and visualize, dynamic responses of physiological models using software.		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the application of Physiological models and vital organs	UN	03
CO2:	Develop the methods for analysis and synthesis of dynamic models	AP	09
CO3:	Build Nonlinear models of physiological systems.	AP	03
CO4:	Solve the differential equations to describe the compartmental physiological model	AP	03
CO5:	Develop the physiological systems using Simulation software.	AP	09
CO6:	Identify the Simulation of physiological systems	AP	03,09

INTRODUCTION TO PHYSIOLOGICAL MODELING **9**

Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modeling.Introduction to physiology (homeostasis, cell biology) Modeling physicalsystems, linearmodels of physiological systems,the Laplace transform, Transfer functions and block diagram analysis Physiology

MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM **9**

Dynamic systems and their control, modeling 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

NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS **9**

Nonparametric Modeling-Volterra Models.Wiener Models. Efficient Volterra Kernel Estimation.Parametric Modeling- Basic Parametric Model Forms and Estimation Procedures-Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

COMPARTMENTENTAL PHYSIOLOGICAL MODEL **9**

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modeling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation.Mathematical modeling 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. .

SIMULATION OF PHYSIOLOGICAL SYSTEMS **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**

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. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear PhysiologicalSystems, Wiley-IEEE Press, 2003.
3. V.Z. Marmarelis, ―Advanced methods of physiological modeling‖ , *Springer*, 1989
4. L.Stark,‖ Neurological Control System, Plenum Press‖,1968.
5. John H Milsum , ―Biological control systems‖, McGraw Hill 1966
6. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,―Advanced Computational Methods in Life System Modeling and Simulation‖, *Springer*,2017

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	3	2	2	2	-	-	-	-	-	-	2	3	-	-	3
CO6	3	3	2	2	2	-	-	-	-	-	-	2	3	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEG	SOFT COMPUTING TECHNIQUES FOR BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the neural network architectures and learning algorithms, for different applications		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	**Utilize** the basics of artificial neural networks and their learning methods.	AP	03,09
CO2:	**Develop** fuzzy set theory, fuzzy rules, and fuzzy inference systems.	AP	09
CO3:	**Apply** genetic algorithms to solve optimization problems.	AP	03,09
CO4:	**Select** different optimization techniques like swarm intelligence and Fibonacci search.	AP	09
CO5:	**Develop** hybrid models using neural networks, fuzzy logic, and genetic algorithms.	AP	03,09
CO6:	**Build** advanced models like SVM, ELM, and Random Forest.	AP	03,09

FROM BIOLOGY TO ARTIFICIAL NEURAL NETWORKS – INTRODUCTION **9**

Biological Neural Networks, Components of Artificial Neural Networks – Connections, Propagation function and Network Inputs, Common Activation Functions, Threshold, Network Topologies, Learning - Supervised, Unsupervised, Reinforcement. Backpropagation, Radial Basis Function, Self-Organizing Maps, Counter Propagation Networks, Adaptive Resonant Theory (ART).

FUZZY SET THEORY **10**

Introduction to Fuzzy – Fuzzy Sets – Basic Definition and Terminology – Set-theoretic Operations – Member Function Formulation and Parameterization – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations – Fuzzy If-Then Rules – Fuzzy Reasoning – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Tsukamoto Fuzzy Models – Input Space Partitioning and Fuzzy Modelling.

GENETIC ALGORITHM **9**

Genetic Algorithms: Introduction to Genetic Algorithms (GA), Representation, Operators in GA, Fitness function, population, building block hypothesis and schema theorem.; Genetic algorithms operators methods of selection, crossover and mutation, simple GA (SGA), other types of GA, generation gap, steady state GA.

OPTIMIZATION USING SOFT COMPUTING **9**

Single variable optimization - Region Elimination Methods, Fibonacci Search Method, Multivariable Optimization - Cauchy's Steepest Descent Method, Newton's method, Swarm Intelligence-Particle Swarm Optimization, ANT Intelligence – ANT Colony Optimization, Artificial Bee Colony Algorithm, Jumping Frog Optimization .

HYBRID AND ADVANCED MODEL IN SOFT COMPUTING **8**

Genetic Algorithm based Back propagation Network, Fuzzy Logic Controlled Genetic Algorithms, Neuro-fuzzy hybrid systems, Support Vector Machine, Extreme Learning Machine (ELM), Extended ELM, Random Forest Algorithm

Total Periods: **45**

Text Books:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, ―Neuro-Fuzzy and Soft Computing‖, , Pearson Education

2004.
2. James A Freeman and David M.Skapra, ―Neural Networks: Algorithms, Applications, and Programming Techniques‖, Addison-Wesley, 1991, Digital Version 2007.
3. Davis E.Goldberg, ―Genetic Algorithms: Search, Optimization and MachineLearning‖, Addison Wesley, N.Y., 1989.

References:

12. LaureneFausett, ―Fundamentals of neural networks- Architectures, algorithms and applications‖, Prentice Hall, 1994.
13. Simon O. Haykins,‖Neural Networks: A Comprehensive Foundation‖, 2nd Edition, Pearson 1994
14. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	2	-	-	-	-	-	-	2	3	-	-	2
CO2	3	2	2	--	2	-	-	-	-	-	-	2	3	-	-	2
CO3	3	2	2	-	2	-	-	-	-	-	-	2	3	-	-	3
CO4	3	2	3	-	2	-	-	-	-	-	-	2	3	-	-	2
CO5	3	2	3	-	3	-	-	-	-	-	-	2	3	-	-	2
CO6	3	2	3	-	3	-	-	-	-	-	-	2	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEH	NEURAL ENGINEERING	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the various techniques to study central and peripheral nerve function.		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the nerve excitability and conduction studies in neurological disorders.	UN	03
CO2:	Outline the EMG and reflex studies for neuromuscular and autonomic evaluations	UN	03,09
CO3:	Summarize the EEG principles, techniques, and clinical applications in neurology.	UN	03,09
CO4:	Interpret the evoked potentials and their diagnostic applications	UN	03,09
CO5:	Explain the functional neuroimaging methods and their applications	UN	03,09
CO6:	Infer electrophysiological evaluation techniques for specialized clinical situations.	UN	03

NERVE EXCITABILITY AND ELECTROMYOGRAPHY — **8**

Nerve Excitability: Functional insights derived from axonal structures, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Nerve conduction studies, Microneurography and its potential clinical applications.Clinical Electromyography (EMG), Quantitative EMG,Neuromuscular Ultrasound as a compliment to the electrodiagnostic evaluation, Electrophysiologic study of Disorders of Neuromuscular Junction:, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.

ELECTROENCEPHALOGRAPHY — **10**

Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Paediatric EEG, EEG Artefacts and Benign Variants, Video EEG monitoring for epilepsy, Invasive Clinical Neurophysiology in Epilepsy and movement disorders, Topographic mapping, Frequency analysis and other quantitative techniques in EEG, Intraoperative EEG monitoring during carotid endarterectomy and cardiac surgery, Magnetoencephalography

EVOKED POTENTIALS — **9**

Evoked Potentials and Related Techniques: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology

FUNCTIONAL NEUROIMAGING AND COGNITION — **9**

Historical and physiological perspective, Functional neuroimaging methods: PET and fMRI, Network analyses, of: Functional neuroimaging Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro-psychologically impaired patients

ELECTROPHYSIOLOGICAL EVALUATION IN SPECIAL SITUATIONS — **8**

Electrophysiological evaluation of sacral function: Bladder, bowel and sexual function, Vestibular laboratory testing, Polysomnographic evaluation of sleep disorders, Electrophysiologic evaluation of: brain death, patients in the intensive care unit, patients with suspected neurotoxic disorders.

Total Periods: 45

Text Books:

1. Michael J. Aminoff, et. al., ―Aminoff‘s Electrodiagnosis in Clinical Neurology‖, Sixth Edition, Elsevier Saunders, 2012.
2. Kim E. Barrett.et. al., ―Ganong‘s review of Medical Physiology‖, 23rd Edition, McGraw Hill Medical, 2010.
3. Roberto Cabeza and Alan Kingstone, Handbook of Functional Neuroimaging of Cognition, Second Edition, MIT Press, 2006.

References:

1. Eric R. Kandelet. al., ―Principles of Neural Science‖ ,McGraw-Hill, New York, 2012.
2. R. Cooper, et. al, ―Techniques in Clinical Neurophysiology: A Practical Manual , Elsevier, Amsterdam, The Netherlands, 2005.
3. Holodny, Andrei I., et al, ―Functional neuroimaging: a clinical approach‖. Informa Health Care, 2008

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	
CO3	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	2
CO4	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	2
CO5	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	
CO6	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	--

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEI	MEDICAL ETHICS AND STANDARDS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the principles Patient safety and regulatory aspects followed in hospitals.		
SDG	03,09,12,16		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the basics of ethical principles in health care settings	UN	03,16
CO2:	Summarize the importance of ethical principles and issues in biomedical research and healthcare practices.	UN	03,09
CO3:	Interpret the concept of safety aspects in medical device	UN	03,09
CO4:	Outline the standards , regulations for medical device safety and management.	UN	03,12
CO5:	Infer the concepts of accreditation and standards in hospital	UN	03,09
CO6:	Explain the safety precautions of the patient in health care system.	UN	03,16

INTRODUCTION TO MEDICAL ETHICS	**9**
Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories --Deontology & Utilitarianism ,Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace – Autonomy, Non-Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas-Applications of Plus decision making model.	
CODE OF ETHICS FOR BIOMEDICAL ENGINEERS	**9**
Bioethics-The principle of Double effect, Code of Hammurabi, Engineering Competence, Ethical Issues in biomedical research-Cloning and stem cell research, Neuro ethics, Organ Transplantation, Hypothetico-deductive method, Research Conflict of Interest. Medical device failure- Five failure types, Bio-terrorism, Sustainable Bioethics-Life cycles and Concurrent Engineering, Environmental Health – case studies	
MEDICAL DEVICE SAFETY	**9**
Shared Responsibility for Medical device safety. WHO – International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee- its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement –ISO, Voluntary and mandatory standards, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device	
REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE	**9**
International Standards- Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards – National Health Mission , Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance – Radiation protection AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.	
HOSPITAL ACCREDITATION AND SAFETY STANDARDS	**9**

Accreditation - JCI Accreditation & its Policies.Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat.Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety – Human factors, Reliability, Evidence based Medicine, Root cause Analysis.	
Total Periods:	**45**

Text Books:

1. William Charney, "Handbook of Modern Hospital Safety'', CRC Press, 2nd Edition, 2009.
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, "Inspection of Medical Devices: For Regulatory Purposes", Springer Nature, 2018.
3. Domiel A Vallero , "Biomedical Ethics for Engineers", Elsevier Pub.1st Edition, 2007.

References:

1. Eileen E.Morrison, "Ethics in Health Administration: A Practical Approach for Decision Makers'',Jonnes and Bartletts' Publication, 2nd Edition, 2011.
2. Robert M Veatch, "Basics of Bio Ethics'', Prentice- Hall, Inc., 2nd Edition, 2003.
3. Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc., 2010.
4. Joint Commission Accreditation Standards for Hospitals ,2nd Edition, 2003

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-	3	-	3	-	-	-	2	-	-	-	-
CO2	3	-	-	-	-	3	-	3	-	-	-	2	3	-	-	-
CO3	2	-	-	-	-	3	-	3	-	-	-	2	-	-	2	-
CO4	2	-	-	-	-	3	-	3	-	-	-	2	-	-	2	-
CO5	-	-	-	-	-	3	-	3	-	-	-	2	-	-	-	-
CO6	2	-	-	-	-	3	-	3	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEJ	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	**Category:**	**PE**
Aim:	To study the orthopaedic and prosthetics in rehabilitation.		
SDG	03,04,09,10		

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Explain the different sensory assist devices, orthotics and prosthetics for rehabilitation applications	UN	03
CO2:	Outline the virtual reality tools for different aids.	UN	09
CO3:	Illustrate the legal aspects for building rehabilitation aids for the needed people.	UN	10
CO4:	Summarize the concepts for future development and applications in Rehabilitation engineering	UN	03,09
CO5:	Interpret the basic concepts of sensory augmentation.	UN	03
CO6:	Explain the rehabilitation medicine and advocacy.	UN	04,10

INTRODUCTION	**9**
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.	
ENGINEERING CONCEPTS IN SENSORY REHABILITATION ENGINEERING	**9**
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, Computerized wheel chairs.	
ORTHOPEDIC PROSTHETICS AND ORTHOTICS IN REHABILITATION	**9**
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).	
VIRTUAL REALITY IN REHABILITATION	**9**
Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation. .	
REHABILITATION MEDICINE AND ADVOCACY	**9**
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.	
Total Periods:	**45**
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. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), “An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering” CRC Press, 2006.

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	2	-	-	-	-	2	3	2	2	
CO2	3	-	-	-	2	2	2	-	-	-	-	2	3	2	2	2
CO3	3	-	-	-	-	2	2	2	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	2	2	-	-	-	-	2	3	2	2	2
CO5	3	-	-	-	-	2	2	-	-	-	-	2	3	2	2	
CO6	3	-	-	-	-	2	2	2	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEK	BODY AREA NETWORKS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Sem:	3	Category:	PE
Aim:	To study the basic hardware requirement of body area network				
SDG	03,09,11,16				

Course Outcomes: The Students will be able to

		BTL	SDG
CO1:	Illustrate the architecture of BAN.	UN	09
CO2:	Interpret the hardware components of body area network .	UN	03
CO3:	Summarize the various types of wireless communication and network.	UN	09
CO4:	Explain BAN interferences, transmission effects, and countermeasures.	UN	03,11
CO5:	Classify medical device regulations and BAN security measures.	UN	16
CO6:	Make use of the BAN applications in healthcare monitoring, and sports medicine.	UN	03

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

HARDWARE FOR BAN — **9**

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

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

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.

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**

Text Books:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability’’, Cambridge University Press, 2013.

References:

1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems’’, Springer, 2013.
2. Guang-Zhong Yang(Ed.), “Body Sensor Networks’’, Springer, 2006.

3. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	2	2		2	-	-	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3	-	-	-	-	3	-	3	-	-	-	2	-	-	3	-
CO6	3	-	-	-	-	-	-	-	-	-	-	3	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEL	PRINCIPLES OF TISSUE ENGINEERING			L-T-P	C
				3-0-0	3
Programme:	**B.E. BIOMEDICAL ENGINEERING**		**Category:**	**PE**	
Aim:	To study the cell cycle and its differentiation.				
SDG	03,09				

Course Outcomes:		
The Students will be able to	BTL	SDG
CO1: Explain the basics of tissue engineering and cell development.	UN	03
CO2: Summarize the components of tissue engineering, including cells, scaffolds, and media.	UN	**09**
CO3: Illustarate the types, properties, and functions of stem cells.	UN	**03,09**
CO4: Extend various sources of stem cells and their potential applications.	UN	**03**
CO5: Explain the biomaterials and their cell interactions in tissue engineering.	UN	**03**
CO6: List the applications of tissue engineering in medicine and industry.	UN	**03,09**

FUNDAMENTALS OF TISSUE ENGINEERING	**9**
Tissue Engineering: Introduction - Objectives of tissue engineering - Laboratory set up for tissue engineering. Tissue development and Tissue exchange - Cell cycle and differentiation - cell adhesion - cell adhesion molecules - cell migration - cell aggregation and tissue equivalent.	
COMPONENTS OF TISSUE ENGINEERING	**9**
Cell: Cell harvesting In Vitro – Medium: Synthetic and Biological media – Scaffold: Natural and Synthetic scaffold: Cell and Drug delivery systems - Transplantation – Implantation - nanotechnology in tissue engineering – Biocompatibility studies In Vitro and In Vivo.	
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.	
MATERIALS IN TISSUE ENGINEERING	**9**
Biological materials – degradable and non degradable – extra cellular matrix-decellularization - Polymers: synthetic and natural – cell interaction with polymers – applications of polymer. Ceramics and Metals.	
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 – Tissue Engineered Food. Regulation, Commercialization and Patenting.	
TOTAL PERIODS	**45**

Text Book:
1.W. Mark Saltzman, "Tissue Engineering – Engineering principles for design of replacement organs and tissue",Oxford University Press Inc New York, 2004. 2. CS Potten, "Stem cells", Elsevier, 1996.
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.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO5	3	-	-	-	-		2	-	-	-	-	2	3	-	-	-
CO6	3	-	-	-	-	2		2	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEM	ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY				L	T	P	C
					3	0	0	3
Programme:	B.E. (**ECE,BME**)	**Sem:**		**Category:**			**PE**	
Aim:	To gain the knowledge on the EMI coupling mechanism and its mitigation techniques							
SDG	03,09,11,16							

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Explain the fundamentals of EMI and EMC, including sources, types, and radiation hazards.	UN	03,09
CO2:	Analyze different coupling mechanisms in EMI, including common mode and differential mode coupling.	AP	09
CO3:	Apply various techniques for mitigating EMI, such as shielding, grounding, and filtering.	AP	09
CO4:	Outline the EMI standards and regulations from organizations like IEC, FCC, and MIL461E.	UN	16
CO5:	Choose the various test methods and instrumentation used in tissue engineering applications.	AP	09
CO6:	Describe the role of tissue engineering in organ replacement, regenerative medicine, and commercialization	UN	03,11

BASIC CONCEPTS	**7**
Definition of EMI and EMC; Intra and Inter system EMI; Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility; Transient & ESD; Case Histories; Radiation Hazards to humans	
COUPLING MECHANISM	**9**
Common made coupling; Differential mode coupling; Common impedance coupling; Ground loop coupling; Field to cable coupling; Cable to cable coupling; Power mains and Power supply coupling.	
EMI MITIGATION TECHNIQUES	**10**
Shielding – principle, choice of materials for H, E and free space fields, and thickness; EMI gaskets; Bonding; Grounding – circuits, system and cable grounding; Filtering; Transient EMI control devices and applications; PCB Zoning, Component selection, mounting, trace routing	
STANDARDS AND REGULATION	**7**
Units of EMI; National and International EMI Standardizing Organizations – IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.	
TEST METHODS AND INSTRUMENTATION	**12**
Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver. Regenerative engineering: peripheral Nerve regeneration – cardiac tissue regeneration – muscle regeneration – Tissue Engineered Food. Regulation, Commercialization and Patenting.	
Total Periods:	**45**

Text Books:

1. V.P. Kodali, “Engineering EMC Principles, Measurements and Technologies”, IEEE Press,New york, 2nd Edition, 2010

2. Henry W.Ott., “Noise Reduction Techniques in Electronic Systems”, A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 2009.

References:

1. Don R.J.White Consultant Incorporate, “Handbook of EMI/EMC”, Vol I-V, 1988
2. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Edition, Artech house, Norwood, 1987
3. C.R. Paul, “Introduction to Electromagnetic Compatibility”, John wiley& sons Inc. 2006.

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	3	2	-	-	-	-	2	3	-	-	-
CO2	3	3	-	-	-	-		-	-	-	-	2	3	-	-	-
CO3	3	3	-	-	-	-	2	-	-	-	-	2	3	-	-	-
CO4	3	-	-	-	-	-	2	3	-	-	-	2		-	-	-
CO5	3	-	-	-	-	2	-	-	-	-	-	2	3	-	2	-
CO6	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEN	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the importance of security for networks.		
SDG	09,11,16		

Course Outcomes:

The Students will be able to	BTL	SDG
CO1: Identify the number-theoretic and algebraic algorithms in network security and communication.	AP	09
CO2:Apply modern block and stream ciphers, including DES and AES, in secure communications.	AP	16
CO3:Apply mathematics behind asymmetric key encryption and apply cryptographic methods like RSA, Rabin, and elliptic curves.	AP	09
CO4: Make use of the different authentication methods.	AP	16
CO5: Outline the various key management systems in real-world scenarios.	UN	11
CO6:Apply security protocols at various layers, including application, transport, and network layers, in secure communication systems.	AP	09,16

NUMBER THEORETIC AND ALGEBRAIC ALGORITHMS	**9**
Significance of network and data security in todays communication scenario – Overall Classification - Integer Arithmetic Modular Arithmetic – matrices – Linear congruence	
MODERN SYMMETRIC KEY CIPHERS	**9**
Modern block ciphers – Modern stream ciphers – DES – AES – uses of modern block ciphers and stream cipher, Application Examples	
ASYMMETRIC KEY ENCIPHERMENT	**9**
Mathematics of cryptography – Primality Testing – Factorization – Chinese Remainder Theorem – Quadratic – Exponentiation & Logarithm – RSA, Rabin – Elliptic curve, Application Examples	
INTEGRITY AUTHENTICATI0N AND KEY MANEGEMENT	**9**
Message integrity – random oracle model – message authentication – SHA-512 – WHIRL POOL-Digital signature schemes Entity anthentication– password – challenge response – zero knowledge – Biometrics – Kerberos – symmetric key management – public key distribution – steganography, Application Examples	
NETWORK SECURITY	**9**
Security at the Application Layer: E-mail – PGP – S/MIME – Security at the transport layer: SSL and TLS – Security at the network layer: IPsec, Two Security Protocol – Security Association – Internet Key Exchange – ISAKMP, Application Examples.	
Total Periods:	**45**

Text Books:

1. Behrouz A. Ferouzan, "Cryptography & Network Security", 5th Edition, Tata McGraw Hill,.
2. W.Stallings, "Cryptography & Network Security: Principles and Practice", Prentice Hall, 4th Edition, 2003.

References:

1. Douglas R.Stlinson, "Cryptography Theory and Practice", CRC Press series on Discrete Mathematics and its application 1995.
2. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security Private Communication in a Public World", Pearson Education, 2nd Edition, 2003.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	2	-	-	-	2	2	-	-	2
CO2	3	2	-	-	-	-	-	2	-	-	-	2	2	-	-	-
CO3	3	2	-	-	-	-	-	2	-	-	-	2	2	-	-	-
CO4	3	2	-	-	-	-	-	2	-	-	-	2	2	-	-	-
CO5	3	-	-	-	-	-	-	2	-	-	-	2	2	-	-	-
CO6	3	2	-	-	-	-	-	2	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEO	MULTIMEDIA COMPRESSION AND NETWORKS	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the characteristics of text, voice, image and video data		
SDG	09,12		

Course Outcomes:

The Students will be able to

		BTL	SDG
CO1:	Explain various compression schemes for text, voice, image and video & analyse the compression schemes		
CO2:	Summarize the different communication protocols for voice over internet and multimedia networking	UN	09,12
CO3:	Illustrate the principles of compression and apply lossless and lossy techniques for text and image data.	UN	09
CO4:	Apply various encoding methods for efficient data compression.	UN	09,12
CO5:	Describe the basics of VoIP, including protocols, call management, quality of service, and CODEC methods.	UN	09
CO6:	Extend the multimedia networking, real-time applications, and quality of service mechanisms.	UN	09

MULTIMEDIA COMPONENTS — **9**

Introduction- Multimedia skills- Multimedia components and their characteristics- Text, sound, images, graphics, animation, video, hardware.

AUDIO AND VIDEO COMPRESSION — **9**

Audio compression–DPCM-Adaptive DPCM –adaptive predictive coding-linear Predictive coding code excited LPC-perpetual coding –Video compression principles-H.261, H.263, MPEG 1, 2, 4.

TEXT AND IMAGE COMPRESSION — **9**

Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding- text compression –static Huffman coding dynamic Huffman coding –arithmetic coding –Lempel Ziv-Welsh Compression-image compression

VoIP TECHNOLOGY — **9**

Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service – CODEC Methods-VOIP applicability.

MULTIMEDIA NETWORKING — **9**

Multimedia Networking- Applications-Streamed stored and audio-making – Best Effort service protocols for real time interactive Applications-distributing multimedia-beyond best effort service secluding and Policing Mechanisms-Integrated services-Differentiated Services-RSVP.

Total Periods: — **45**

Text Books:

1. Fred Halshall, "Multimedia Communication - Applications, Networks, Protocols and Standards", Pearson education, 2007.

2. Tay Vaughan, "Multideai: Making It Work", TMH, 8th Edition, 2007.

References:

1. Kurose and W. Ross, "Computer Networking A Top Down Approach", Pearson education, 3rd Edition, 2005.
2. Marcus Goncalves ―Voice over IP Networks, McGraw Hill,
3. KR. Rao,Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems: Techniques, Standards, and Networks", Pearson Education, 2007
4. R. Steimnetz, K. Nahrstedt, "Multimedia Computing, Communications and Applications", Pearson Education, 1st Edition, 1995.
5. Ranjan Parekh, "Principles of Multimedia", TMH, 2006.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	-		-	-	-	3	3	-	-	-
CO2	3	-	-	-	2	-	-	2	-	-	-	3	3	-	-	-
CO3	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO4	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO5	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO6	3	-	-	-	2	-		2	-	-	-	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEP	BIOMETRIC SYSTEMS				L	T	P	C
					3	0	0	3
Programme:	B.E. Biomedical Engineering	**Sem:**	**3**	**Category:**			**PE**	
Aim:	To study the recognize personal privacy and security implications of biometrics based identification technology.							
SDG	03,09							

Course Outcomes:

The Students will be able to		**BTL**	**SDG**
CO1:	Explain the biometric technologies, processes, and their advantages over traditional methods.	UN	09
CO2:	Describe the biometric system performance and the importance of strong authentication and privacy protection.	UN	03,09
CO3:	Illustrate the fingerprint identification, including patterns, features, and matching methods.	UN	03,09
CO4:	Interpret the face recognition technology, including detection, classification, and evaluation methods.	UN	03,09
CO5:	Summarize the voice scan technology, its features, performance, and biometric integration.	UN	03,09
CO6:	Extend the multibiometric systems, fusion techniques, and their applications in biometric authentication.	UN	03,09

INTRODUCTION TO BIOMETRICS	**9**
Introduction and back ground – biometric technologies – passive biometrics – active biometrics - Biometrics Vs traditional techniques – Benefits of biometrics - Operation of a biometric system– Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems: FAR, FRR, FTE rate, FTA rate and rate- Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications	
FINGERPRINT IDENTIFICATION TECHNOLOGY	**9**
Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint Matching: Fingerprint Classification, Matching policies	
FACE RECOGNITION	**9**
Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition	
VOICE SCAN	**9**
Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration.	
FUSION IN BIOMETRICS	**9**
Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multibiometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion. Examples – biopotential and gait based biometric systems	
Total Periods:	**45**
Text Books:	

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, ―Biometric Systems, Technology Design and Performance Evaluation‖, Springer, 2005.
2. David D. Zhang, ―Automated Biometrics: Technologies and Systems‖, Kluwer Academic Publishers, New Delhi, 2000.
3. Arun A. Ross , Karthik Nandakumar, A.K.Jain, ―Handbook of Multibiometrics‖, Springer, New Delhi, 2006.

References:

1. Paul Reid, ―Biometrics for Network Security‖, Pearson Education, 2004.
2. Nalini K Ratha, Ruud Bolle, ―Automatic fingerprint Recognition System‖, Springer, 2003
3. L C Jain, I Hayashi, S B Lee, U Halici, ―Intelligent Biometric Techniques in Fingerprint and Face Recognition‖ CRC Press, 1999.
4. John Chirillo, Scott Blaul, ―Implementing Biometric Security‖, John Wiley, 2003.
5. S.Y. Kung, S.H. Lin, M.W.Mak, ―Biometric Authentication: A Machine Learning Approach‖Prentice Hall, 2005.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	-		-	-	-	3	3	-	-	-
CO2	3	-	-	-	2	-	-	2	-	-	-	3	3	-	-	-
CO3	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO4	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO5	3	-	-	-	2	-	2	2	-	-	-	3	3	-	-	-
CO6	3	-	-	-	2	-		2	-	-	-	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMER	VIRTUAL REALITY AND AUGMENTED REALITY	L	T	P	C
		3	0	0	3

Programme:	B.E. Biomedical Engineering	Category:	PE
Aim:	To study the virtual reality, augmented reality and using them to build engineering applications.		
SDG	09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the basic concepts of virtual reality.	UN	09
CO2:	Utilize the virtual reality development process.	UN	09
CO3:	Illustrate the content creation considerations for virtual reality.	UN	09
CO4:	Interpret the augmented reality on the web.	UN	09
CO5:	Identify virtual reality on the mobile.	AP	09
CO6:	Apply virtual and augmented reality for real time applications.	AP	09

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.

VR DEVELOPMENT PROCESS **9**

Geometric modelling - kinematics modelling- physical modelling - behaviour modelling - model Management

CONTENT CREATION CONSIDERATIONS FOR VR **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

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 .

APPLICATIONS **9**

Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy

Total Periods: 45

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.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	3	-	-	2
CO5	3	-	-	-	2	-	-	-	-	-	-	2	3	-	-	2
CO6	3	3	-	-	2	-	-	-	-	-	-	2	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMES	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	PE
AIM:	To understand the optical properties of tissues and the use of photonic techniques in medical diagnostics, imaging, and therapy, with an emphasis on laser safety.		
SDG	03,09		

Course Outcomes:

At the end of the course, the students should be able to		BTL	SDG
CO1:	Interpret the fundamental optical properties of tissues	UN	03
CO2:	Illustrate the components of instrumentation in Medical Photonics and Configurations	UN	09
CO3:	Describe surgical applications of lasers.	UN	03
CO4:	Explain photonics and its diagnostic applications.	UN	03
CO5:	Outline the application of optics in diagnostic and therapeutic techniques.	UN	03
CO6:	Summarize the emerging techniques in medical optics.	UN	09

UNIT – I OPTICAL PROPERTIES OF THE TISSUES	9
Fundamental Properties of light - Refraction, Reflection, Laws (Snell's law and Fresnel law) Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology, Laser tissue Interactions – Photo chemical, Photo thermal and Photo mechanical interactions, Fluorescence, Speckles, Photo ablative processes.	
UNIT II INSTRUMENTATION IN PHOTONICS	**9**
Instrumentation for absorption, Scattering and emission measurements, Excitation light sources–high pressure arc lamps, LEDs, Lasers, Optical filters – Prism and Monochromators, Polarizers, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection methods, Optical fibers – Total Internal Reflection.	
UNIT III SURGICAL THERAPEUTIC APPLICATIONS OF LASERS	**9**
Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.	
UNIT IV NON THERMAL DIAGNOSTIC APPLICATIONS	**9**
Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle applications of lasers in biology and medicine.	
UNIT V DIAGNOSTIC AND THERAPEUTIC TECHNIQUES	**9**
Near field imaging of biological structures, In vitro clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) - Principles and mechanisms - Oncological and non-oncological applications of PDT - Bio stimulation effect – applications - Laser Safety Procedures.	
Total Periods:	
Text Books:	

1.Tuan Vo Dirh, “Biomedical Photonics – Handbook”, CRC Press, Bocaraton, 2014.
2. Paras N. Prasad, “Introduction to Biophotonics”, A. John Wiley and Sons, Inc. Publications, 2003
References:
1. MarkolfH.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007
2. G.David Baxter “Therapeutic Lasers – Theory and practice”, Churchill Livingstone publications Edition- 2001.
3. Leon Goldman, M.D., &R.James Rockwell, Jr., “Lasers in Medicine”, Gordon and Breach,Science Publishers Inc., 1975.

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMET	BIOMECHANICS	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	PE
AIM:	To explore mechanics and its application to biological systems, focusing on biomechanics, modeling, and ergonomics.		
SDG	03,08,09		

Course Outcomes:

At the end of the course, the students should be able to		BTL	SDG
CO1:	Explain the principles of mechanics.	UN	09
CO2:	Outline the principles of biofluid dynamics.	UN	03
CO3:	Infer the fundamentals of bio-solid mechanics.	UN	03
CO4:	Apply the knowledge of joint mechanics for biomechanical applications.	UN	03
CO5:	Interpret the computational mathematical modelling in biomechanics.	UN	09
CO6:	Extend ergonomics principles used for design of work enironment.	UN	08

UNIT – I INTRODUCTION TO MECHANICS **9**

Introduction – Scalars and vectors, Statics – Force types, Resolution and composition of forces, Moments of force and couple, Resultant force determination, parallel forces in space, equilibrium of coplanar forces, Dynamics, Basic principles – Linear motion, Newton's laws of motion, Impulse and Momentum, Work and Energy Kinetics – Velocity and acceleration, Kinematics – Link segment models, Force transducers, Force plates, Introduction to Constitutive equations –Constitutive equations of Nonviscous fluid, Newtonian Viscous fluid and Hookean Elastic solid93

UNIT – II BIOFLUID MECHANICS **9**

Intrinsic fluid properties – Density, Viscosity, Compressibility and Surface Tension, Viscometers –Capillary, Coaxial cylinder and cone and plate, Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube – Steady Laminar flow, Turbulent flow, Flow development, Viscous and Turbulent Sheer Stress, Effect of pulsatility, Boundary Layer Separation, Structure of blood vessels, Material properties and modelling of Blood vessels, Heart –Cardiac muscle characterisation, Native heart valves – Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics.

UNIT – III BIOSOLID MECHANICS **9**

Constitutive equation of viscoelasticity – Maxwell &Voight models, anisotropy, Hard Tissues –Structure, blood circulation, elasticity and strength, viscoelastic properties, functional adaptation, Soft Tissues – Structure, functions, material properties and modelling of Soft Tissues – Cartilage, Tendons and Ligaments Skeletal Muscle – Muscle action, Hill's models, mathematical modelling, Bone fracture mechanics, Implants for bone fractures.

UNIT – IV BIOMECHANICS OF JOINTS	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 MODELING AND ERGONOMICS	**9**
Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics –Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted vibrations.	
Total Periods:	45
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.	
References:	
1. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, "Biofluid Mechanics: The Human Circulation", Taylor and Francis, 2007. 2. Sheraz S. Malik and Shahbaz S. Malik, "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015. 3. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004. 4. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007. 5. Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005. 6. Carl J. Payton, "Biomechanical Evaluation of movement in sports and Exercise", 2008.	

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO5	3		-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO6	3	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEU	HOSPITAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	PE
AIM:	To provide knowledge on hospital waste management, hazard control, and patient safety for safe healthcare practices.		
SDG	03,12,16		

Course Outcomes:

At the end of the course, the students should be able to		BTL	SDG
CO1:	Explain various hazards, accidents and its control.	UN	03
CO2:	Describe the waste disposal procedures for different biowastes.	UN	12
CO3:	Classify different biowastes based on its properties.	UN	12
CO4:	Illstrate the various different safety facilities in hospitals.	UN	03
CO5:	Interpret various regulations and safety norms.	UN	16
CO6:	Summarize the infection and quality control strategies to reduce healthcare risks.	UN	03

UNIT – I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS **9**

Healthcare Hazard Control: Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviours, 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 labelling, 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 Blood borne 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**
Text Books:	
1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014). 2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).	
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.	

CO's- PO's & PSO's MAPPING

ourse Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-	3	-	-	-	-	-	2	2	-	-	-
CO2	2	-	-	-	-	3	-	2	-	-	-	2	2	-	-	-
CO3	2	-	-	-	-	3	-	-	-	-	-	2	2	-	-	-
CO4	2	-	-	-	-	3	-	3	-	-	-	2	2	-	-	-
CO5	2	-	-	-	-	3	-	3	-	-	-	2	2	-	-	-
CO6	2	-	-	-	-	3	-	3	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEV	ELECTRICAL SAFETY AND QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	PE
AIM:	To develop knowledge and insight into the procedures used in quality control and assurance activities as well as safety measures to be followed in hospitals.		
SDG	03,16		

Course Outcomes:

At end of the course the students will be able to		BTL	SDG
CO1:	Expalin the concept of electrical hazards.	UN	03
CO2:	Outline the knowledge of quality control and assurance activities for hospital safety.	UN	03
CO3:	Infer the electrical protection, safety, maintenance and CPR.	UN	03
CO4:	Interpret the principles of quality management.	UN	03
CO5:	Summerize the concept of the electricity act.	UN	16
CO6:	Outline the regulations and accreditation requirements in hospitals.	UN	16

UNIT – I ELECTRICAL HAZARDS	12
Review of Electrical concept, Electrostatic – Electro magnetism – Electrical Hazards – Energy leakage – Clearance and insulation– Current surges – Electrical causes of fire and explosion –Human interface with electricity – Human resistance to electricity.	
UNIT – II STANDARDS AND REQUIREMENTS	**12**
National electrical Safety code - Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate. Hazardous area classification and classification of electrical equipments for hazardous areas (IS, NFPA, API and OSHA standards).	
UNIT – III ELECTRICAL PROTECTION AND MAINTENANCE	**9**
Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance. First aid-cardio pulmonary resuscitation(CPR).	
UNIT – IV STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS	**6**
Define Quality- Need for Standardization & Quality Management, QM in Health care organization Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services –Classification of equipments.	
UNIT – V REGULATORY REQUIREMENT FOR HEALTH CARE	**6**
CE and FDA regulations, Accreditation for hospitals-JCI, NABH and NABL, Other regulatory Codes.	
Total Periods:	45

Text Books:

1. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
2. Cesar A. Cacere & Albert Zana, The Practice of Clinical Engineering. Academic press,

New York, 1977.
References:
1. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979. 2. Karen Parsley, Karen Parsley Philomena Corrigan" Quality improvement in Healthcare, 2nd edition,Nelson Thrones Pub, 2002 3. Sharon Myers "Patient Safety & Hospital Accreditation - A Model for Ensuring Success" Springer Publishers 2012 4. Joseph F Dyro "Clinical Engineering Handbook" Elsevier Publishers, 2004

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	3	2	-	-	-	-	2	-	-	-	-
CO2	3	-	-	-	-	3	2	2	-	-	-	2	2	-	-	-
CO3	3	-	-	-	-	3	2	2	-	-	-	2	2	-	-	-
CO4	3	-	-	-	-	3	-	2	-	-	-	2	2	-	-	-
CO5	3	-	-	-	-	3	-	3	-	-	-	2	-	-	-	-
CO6	3	-	-	-	-	3	2	3	-	-	-	2	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEW	ERGONOMICS	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	PE
AIM:	To understand and apply ergonomic principles for designing safe, efficient, and comfortable workplaces and biomedical devices that suit human capabilities and limitations.		
SDG	03		

Course Outcomes:

At the end of the course, the student should be able to		BTL	SDG
CO1:	Explain the principles of ergonomics in visual, auditory system.	UN	03
CO2:	Describe muscle physiology for human posture sign biomedical devices.	UN	03
CO3:	Explain the arrangement, design of displays and controls.	UN	03
CO4:	Outline the ergonomic principles to the creation of safe, healthy, and efficient workplace.	UN	03
CO5:	Illustrate anthropometrics design principle for an individual work space .	UN	03
CO6:	Summarize the ergonomics concept in the biomedical applications.	UN	03

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.

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 physical arrangement 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 –work space envelope- factors in design of work space surfaces- principles of seat design –principles of control panel. 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 Equipments.

Total Periods: **45**

Text Books:

1. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
2. Robert.N. Bailey, Human Performance Engineering, Third Edition, 1996
3. Martin Helander, Guide to Human Factors and Ergonomics, Second Edition, CRC Press, 2005.

References:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.
2. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO2	2	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO3	2	-	-	-	-	2	-	-	-	-	-	2	3	-	-	-
CO4	2	-	-	-	-	3	3	-	-	-	-	2	3	-	-	-
CO5	2	-	-	-	-	2	3	-	-	-	-	2	3	-	-	-
CO6	2	3	-	-	-	2	3	-	-	-	-	2	3	2	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191BMEX	MEDICAL IMAGING TECHNIQUES	L	T	P	C
		3	0	0	3

Programme:	B.E. (**BME**)	Category:	PE
Aim:	To study about the various medical imaging techniques radiography, fluoroscopy, computed tomography, magnetic resonance imaging, spectroscopy, radio isotopic imaging, infrared imaging , ultra sound and neuromagnetic imaging.		
SDG	03,09,12		

Course Outcomes:			
The Students will be able to		BTL	SDG
CO1:	Explain the working of radiography fluoroscopy	UN	03,09
CO2:	Infer the function of computed tomography and image reconstruction method.	UN	03,09
CO3:	Illustrate the function of magnetic resonance imaging & spectroscopy	UN	03,09
CO4:	Discuss the working of radio isotopic imaging & infrared imaging	UN	03,12
CO5:	Outline the function of ultra sound imaging.	UN	03,09
CO6:	Interpret the working of neuromagnetic imaging.	UN	03,09

UNIT I. RADIOGRAPHY AND FLUOROSCOPY	**9**
Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment – X-Ray Tube, the collimator, Bucky Grid, Digital Radiography- discrete digital detectors, storage phosphor and film scanning, – Fluoroscopy – X-ray Image Intensifier -Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.	
UNTI II. COMPUTED TOMOGRAPHY	**9**
Principles of sectional imaging, Principles of computed Tomographic Imaging - Scan motions, X-ray sources. Influences of Images quality: Unsharpness- contrast - Image Noise-2-D image reconstruction techniques-Back projection and iterative.	
UNIT III. MAGNETIC RESONANCE IMAGING AND SPECTROSCOPY	**9**
Fundamentals of magnetic resonance- overview - Relaxation processes T1 and T2. Block Diagram approach of MRI system- system Magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, contrast agents- tissue contrast in MRI- MRangiography, MR spectroscopy, fMRI	
UNIT IV. RADIO ISOTOPIC IMAGING AND INFRARED IMAGING	**9**
Units of EMI; National and International EMI Standardizing Organizations – IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.	
UNIT V. ULTRASOUND, NEUROMAGNETIC IMAGING	
Ultrasound: Wave propagation and interaction in Biological tissues -Transducers and imaging systems- Imaging modes- Time required to obtain Images- System components, signal processing - dynamic Range- Ultrasound Image Artifacts- Quality control, Origin of Doppler shift- Limitations of Doppler systems. Neuromagnetic Imaging: Background.	
Total Periods:	**45**
Text Books:	
1. Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia,1988. 2. Jerry L.Prince and Jnathan M.Links," Medical Imaging Signals and Systems"- Pearson	

Education Inc. 2006

References:

1. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics: A John Wiley & sons, Inc., Publication, Fourth Edition 2002.
2. Z.H. Cho., J-oie, P. Jones and Manbir Singh,Foundations of Medical Imaging: John Wiley and sons Inc.
3. Avinash C. Kak, Malcolm Shaney, "Principles of Computerized Tomographic Imaging", IEEE Press, Newyork-1998.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	2	-	-	-	-	-	2	3	2	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	2	3	2	-	2
CO3	3	-	-	-	-	2	-	-	-	-	-	2	3	2	-	-
CO4	3	-	-	-	-	2	-	-	-	-	-	2	3	2	-	-
CO5	3	-	-	-	-	2	-	-	-	-	-	2	3	2	-	-
CO6	3	-	-	-	-	2	-	-	-	-	-	3	3	2	-	-

191BAEE	PROFESSIONAL ETHICS IN ENGINEERING	L	T	P	C
		3	0	0	3

Programme:	B.E. / B.Tech	Category:	PE

Aim:	To enable the students to create an awareness on Engineering Ethics and Human Values.
SDG	04.06,08.09.16

Course Outcomes:

The students will be able to		BTL	SDG
CO1:	Infer human values in professional society.	UN	04,06
CO2:	Identify the core values that shape the ethical behavior of an engineer.	AP	04,08
CO3:	Illustrate codes of conduct and responsibilities of engineers in professional society.	UN	08,16
CO4:	Explain the awareness about ethical concerns and conflicts.	UN	16
CO5:	Interpret the safety and risk analysis.	UN	08,09
CO6:	Identify the global issues in ethics.	AP	09,16

HUMAN VALUES **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

ENGINEERING ETHICS **9**

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – a balanced outlook on Law.

SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

GLOBAL ISSUES **9**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

Total Periods: **45**

Text Books:

1. Mike Martin and Roland Schinzinger, 'Ethics in Engineering', McGraw Hill, New York, 2012.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, 'Engineering Ethics – Concepts and Cases', 6th Edition, Ray James, Elian Englehardt Wadsworth publishing co, 2013.

References:

1. Charles D Fleddermann, 'Engineering Ethics', Prentice Hall, New Mexico, 2012.

2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, 2013.
3. Edmund G Seebauer and Robert L Barry, ‘Fundamentals of Ethics for Scientists and Engineers’, Oxford University Press, 2013.
4. David Erman & Michele Shauf, ‘Computers, Ethics and Society, Oxford University Press, 2012.

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	3	-	3	-	-	-	2	-	-	-	-
CO2	-	-	-	-	-	3	-	3	-	-	-	2	-	-	-	-
CO3	-	-	-	-	-	2	-	3	-	-	-	2	-	-	-	-
CO4	-	-	-	-	-	2	-	3	-	-	-	2	-	-	-	-
CO5	-	-	-	-	-	2	-	3	-	-	-	2	-	-	-	-
CO6	-	-	-	-	-	2	-	3	-	-	-	2	-	-	-	-

Enter correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191OE8A	TELE HEALTH TECHNOLOGY	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. (Common to all Branches except BME)	Category:	OE
Aim:	To study the principles of Telemedicine and its standards.		
SDG	03,09,16		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Summarize the principles of healthcare in telemedicine.	UN	03
CO2:	Outline the encryption techniques for secure data transmission.	UN	09
CO3:	Describe the legal aspects of telemedicine.	UN	16
CO4:	Explain different data storage and communication standards used in telehealth.	UN	03,09
CO5:	Identify various applications of telemedicine.	AP	03,09
CO6:	Illustrate recent advancements in telehealth technology.	UN	03,09

FUNDAMENTALS OF TELEMEDICINE	**9**
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.	
TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE	**9**
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.	
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, intellectual property rights.	
PICTURE ARCHIVING AND COMMUNICATION SYSTEM	**9**
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.	
APPLICATIONS OF TELEMEDICINE	**9**
Tele radiology, tele pathology, tele cardiology, tele oncology, tele dermatology, tele surgery, e Health and Cyber Medicine.	
Total Periods:	**45**

Text Books:

6. Norris A C, ―Essentials of Telemedicine and Telecare‖, John Wiley, New York, 2002.
7. H K Huang, ―PACS and Imaging Informatics: Basic Principles and Applications‖ Wiley, New Jersey, 2010.

References:

1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, ―Handbook of Telemedicine‖, IOS Press, Netherland, 2002.
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. Khandpur R S, ―TELEMEDICINE – Technology and Applications‖, PHI Learning Pvt Ltd., New Delhi, 2017

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO3	3	-	-	-	-	2	-	3	-	-	-	2	2	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191OE8B	SPEECH PROCESSING	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. Biomedical Engineering	Category:	OE
AIM:	To understand speech processing techniques for analysis, modeling, recognition, and synthesis to develop speech-based applications.		
SDG	04,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the fundamental techniques used in speech recognition and synthesis.	UN	04
CO2:	Outline the speech feature extraction techniques and distortion measurement methods.	UN	09
CO3:	Summarize the pattern comparison techniques for speech time alignment and normalization.	UN	09
CO4:	Compare the different speech modelling techniques.	UN	09
CO5:	Interpret the large vocabulary continuous speech recognition systems using acoustic and language models.	UN	09
CO6:	Outline the text-to-speech synthesis systems using concatenative and waveform synthesis methods.	UN	09

UNIT – I BASIC CONCEPTS	9
Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.	
UNIT – II SPEECH ANALYSIS	**9**
Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization –Dynamic Time Warping, Multiple Time – Alignment Paths.	
UNIT – III SPEECH MODELING	**9**
Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.	
UNIT – IV SPEECH RECOGNITION	**9**
Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent subword units; Applications and present status.	
UNIT – V SPEECH SYNTHESIS	**9**
Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.	
Total Periods:	**45**

Text Books:

1. Lawrence Rabinerand Biing-Hwang Juang, "Fundamentals of Speech Recognition", Pearson Education, 2003.
2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction toNatural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 3rd Edition, 2018.

References:

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-
CO6	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191OE8C	INTERNET OF THINGS IN MEDICINE	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. (Common to all Branches except BME)	Category:	OE
Aim:	Build simple IoT Systems using Arduino and Raspberry Pi.		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the concept of internet of things.	UN	09
CO2:	Illustrate the IoT infrastructure for popular applications	UN	09
CO3:	Compare the various IoT protocols.	UN	09
CO4:	Design an IoT system using Rasperry Pi/Arduino.	AP	09
CO5:	Outline the data analytics and supported services related to IoT.	UN	09
CO6:	Interpret the applications of IoT in medicine.	UN	03,09

FUNDAMENTALS OF IoT **9**

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects

IoT PROTOCOLS **9**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT

DESIGN AND DEVELOPMENT **9**

Design Methodology – Embedded computing logic – Microcontroller, System on Chips – IoT system building blocks – Arduino – Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming

DATA ANALYTICS AND SUPPORTING SERVICES **9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

APPLICATIONS OF IOT IN MEDICINE **9**

NSUM Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An IoT Model for Neuro sensors, AdaBoost with feature selection using IoT for somatic mutations evaluation in Cancer, A Fuzzy-Based expert System to diagnose Alzheimer's Disease, Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments, Approach to predict Diabetic Retinopathy through data analytics, Diagnosis of chest diseases using artificial neural networks.

Total Periods: **45**

Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT

Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, "Internet of Things and Personalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.

References:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.
3. Jan Ho¨ ller, 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.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects", O'Reilly Media, 2nd Edition.

CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (Pos)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO4	3	2	2	2	-	-	-	-	-	-	-	2	-	-	-	-
CO5	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
CO6	3	-	-	-	-	2	-	-	-	-	-	3	3	-	-	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191OE8D	BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

Programme:	B.E./B.Tech. (Common to all Branches except BME)	Category:	OE
Aim:	To Study the various signal acquisition methods of BCI.		
SDG	03,09		

Course Outcomes:

The Students will be able to		BTL	SDG
CO1:	Explain the concept of Brain computer interface.	UN	03,09
CO2:	Outline the significance of brain activation	UN	03,09
CO3:	Select appropriate feature extraction methods	AP	03,09
CO4:	Choose machine learning algorithms for translation	AP	03,09
CO5:	List different Invasive BCIs	UN	03,09
CO6:	Examine different Non-invasive BCIs .	AP	03,09

INTRODUCTION TO BCI — **9**

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

BRAIN ACTIVATION — **9**

Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks

FEATURE EXTRACTION METHODS — **9**

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis

MACHINE LEARNING METHODS FOR BCI — **9**

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF‘s, Perceptron‘s, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis

APPLICATIONS OF BCI — **9**

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Non-invasive BCIs:P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

Total Periods: 45

Text Books:

1. Rajesh.P.N.Rao, ―Brain-Computer Interfacing: An Introduction‖, Cambridge University Press, First edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, ―Brain Computer Interfaces: Principles and practice‖, Oxford University Press, USA, Edition 1, January 2012.

References:

5. Ella Hassianien, A &Azar.A.T (Editors), ―Brain-Computer Interfaces Current Trends and Applications‖, Springer, 2015.
6. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
7. Ali Bashashati, MehrdadFatourechi, Rabab K Ward, Gary E Birch,‖ A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals‖ Journal of Neural Engineering, Vol.4, 2007, PP.32-57
8. Arnon Kohen, ―Biomedical Signal Processing‖, Vol I and II, CRC Press Inc, Boca Rato, Florida.
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CO's- PO's & PSO's MAPPING

Course Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	-	2	-	-	-	-	-	-	-	-	2	3	-	-	-
CO4	3	-	2	-	-	-	-	-	-	-	-	2	3	-	-	3
CO5	3	-	2	-	-	-	-	-	-	-	-	2	3	-	3	-
CO6	3	-	2	-	-	-	-	-	-	-	-	2	3	-	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC01	DESIGN THINKING	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To impart knowledge on design thinking process for understanding complex designs and to provide design skills to analyze design thinking issues and apply the tools and techniques of design.
SDG	03,04,09,12

Course Outcomes:

Students will be able to		BTL	SDG
CO1:	Demonstrate knowledge of design thinking process	UN	04
CO2:	Recall design thinking techniques to design relevant products/services	UN	09
CO3:	Apply human centered design (HCD) methodology for product or service design.	AP	03,09
CO4:	Use ideation techniques for developing innovative products or services	AP	12
CO5:	Analyse the causes for the problems in the design of products or services	AN	12
CO6:	Perform the steps to gain practical knowledge of prototyping, testing and validation.	AN	09

UNIT-I	OVERVIEW OF DESIGN THINKING PROCESS	6

Introduction to design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, Understanding design thinking and its process model, Design thinking tools. Human-Centered Design (HCD) process - Empathize, Define, Ideate, Prototype and Test and Iterate or Empathize, Analyze, Solve and Test.

UNIT-II	EMPATHIZE	6

Design thinking phases, How to emphatize, Role of empathy in design thinking, purpose of empathy maps, Things to be done prior to empathy mapping, creation of user personas, customer journey mapping, How might we questions

UNIT-III	SOLVE / IDEATE	6

Silent brainstorming, metaphors for ideation, CREATE and What-If tool for ideation, introduction to TRIZ, Inventive principles and their applications

UNIT-IV	ANALYZE / DEFINE	6

Root cause analysis, conflict of interest, perspective analysis, big picture thinking through system operator, big picture thinking through function modeling.

UNIT-V	TEST (PROTOTYPING AND VALIDATION)	6

Prototyping, Assumptions during the design thinking process, Validation in the market, best practices of presentation.

	Total Periods	30

References

5. Dr. Bala Ramadurai, "Karmic Design Thinking", First EditionTRIZ Innovation India, 2020.
6. Karl T. Ulrich, “Design Creation of Artifacts in Society”, Trustees of the University of Pennsylvania Publisher, USA, 2011

7. Alma R. Hoffmann, “Sketching as Design Thinking”, Taylor & Francis, UK, 2019
8. Michael Lewrick, Patrick Link and Larry Leifer, “The Design Thinking Playbook”, Wiley, USA, 2018.

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	3	3	3	-	-	-	-	-	-	-	3	-	-	3	3
CO2	-	3	3	3	-	-	-	-	-	-	-	3	-	-	3	3
CO3	-	3	3	3	-	-	-	-	-	-	-	3	-	-	3	3
CO4	-	2	2	2	-	-	-	-	-	-	-	2	-	-	2	2
CO5	-	2	2	2	-	-	-	-	-	-	-	2	-	-	2	2
CO6	-	2	2	2	-	-	-	-	-	-	-	2	-	-	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC02	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
SDG	02,03,04,08,09,15

Course Outcomes:

Students will be able to		BTL	SDG
CO1.	Identify the concept of Traditional knowledge and its importance	AP	04
CO2.	Explain the need and importance of protecting traditional knowledge.	UN	09
CO3.	Illustrate the various enactments related to the protection of traditional knowledge.	UN	09
CO4.	Interpret the concepts of Intellectual property to protect the traditional knowledge.	UN	08
CO5.	Identify the importance of conservation and sustainable development of environment	AP	15
CO6.	Explain the importance of Traditional knowledge in Agriculture and Medicine.	UN	02,03

UNIT-I	INTRODUCTION TO TRADITIONAL KNOWLEDGE	6

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge

UNIT-II	PROTECTION OF TRADITIONAL KNOWLEDGE	6

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

UNIT-III	LEGAL FRAME WORK AND TRADITIONAL KNOWLEDGE	6

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act);

The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016. Geographical indicators act 2003.

UNIT-IV	TRADITIONAL KNOWLEDGE AND INTELLECTUAL PROPERTY	6

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.

UNIT-V	TRADITIONAL KNOWLEDGE IN DIFFERENT SECTORS	6

Traditional knowledge and engineering, Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.

Total Periods	**30**

References

1. Amit Jha, “Traditional Knowledge System in India”, 2009.
2. Basanta Kumar Mohanta, Vipin Kumar Singh, “Traditional Knowledge System and Technology in India”, Pratibha Prakashan 2012.
3. Amit Jha, “Traditional Knowledge System in India”, Atlantic publishers, 2002
4. Kapil Kapoor, Michel Danino, "Knowledge Traditions and Practices of India"

E-Resources:

1. https://www.youtube.com/watch?v=LZP1StpYEPM
2. http://nptel.ac.in/courses/121106003/

CO’s- PO’s & PSO’s MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	1	-	-	-	-	2	-	2	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	2	-	3	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	2
CO4	-	-	-	-	2	-	-		-	-	-	-	-	-	2	-
CO5	-	-	-	-	-	-	3		-	-	-	-	1	-	-	-
CO6	-	-	-	-	-	3		2	-	-	-	-	-	3	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC03	INDIAN CONSTITUTION	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To understand the importance of Indian constitution, Administration, Concept and Development of Human Rights, election commission.
SDG	10,11,16

Course Outcomes:

Students will be able to		BTL	SDG
CO1.	Know the sources, features and principles of Indian Constitution.	UN	16
CO2.	Learn about Union Government and its administration.	UN	16
CO3.	Learn about State government and its administration.	UN	16
CO4.	Get acquainted with Local administration and Panchayat Raj	UN	11
CO5.	Be aware of basic concepts and developments of Human Rights.	UN	10
CO6.	Gain knowledge on roles and functioning of Election Commission.	UN	16

UNIT-I	INTRODUCTION TO INDIAN CONSTITUTION	6

Constitution' meaning of the term, Indian Constitution- Sources and constitutional history, Features- Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II	UNION GOVERNMENT AND STATE GOVERNMENT	6

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

State Government and its Administration

Governor: Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions

UNIT-III	LOCAL ADMINISTRATION AND PACHAYAT RAJ	6

Local Administration District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation,

Panchayat raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-IV	CONCEPT AND DEVELOPMENT OF HUMAN RIGHTS	6

Meaning Scope and Development of Human Rights, United Nations and Human Rights – UNHCR, UDHR 1948, ICCPR 1996 and ICESCR 1966, Human Rights in India: Protection of Human Rights Act, 1993 - (NHRC and SHRC), First, Second and Third Generation Human Rights, Judicial Activism and Human Rights.

UNIT-V	ELECTION COMMISSION	6
Election Commission- Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women		
	Total Periods	**30**

References

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4E, 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government and Politics Hans
7. J. Raj Indian Government and Politics
8. M.V. Pylee, Indian Constitution
9. Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd. New Delhi
10. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-Resources:

1. nptel.ac.in/courses/109104074/8

2. nptel.ac.in/courses/109104045/

3. nptel.ac.in/courses/101104065/

4. www.hss.iitb.ac.in/en/lecture-details

5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	3	-	3	-	-	3	-	-	-	-	-
CO2	-	-	-	-	-	3	-	3	-	-	3	-	-	-	-	-
CO3	-	-	-	-	-	3	-	3	-	-	3	-	-	-	-	-
CO4	-	-	-	-	-	2	-	2	-	-	2	-	-	-	-	-
CO5	-	-	-	-	-	2	-	2	-	-	2	-	-	-	-	-
CO6	-	-	-	-	-	2	-	2	-	-	2	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High

191MC04	UNIVERSAL HUMAN VALUES	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To facilitate the competence to understand the harmony in nature/existence and participation of human being in the nature/existence.
SDG	02,03,04,11

Course Outcomes:

Students will be able to		BTL	SDG
CO1.	Ensure the clarity about human aspirations, goal, activities and purpose of life.	UN	04
CO2.	Developthe understanding of human tradition and its various components.	AP	11
CO3.	Criticallyevaluate their preconditioning and present beliefs.	AP	11
CO4.	Beginwith, and then to continue within the student leading to continuous self-evolution.	AP	03
CO5.	Verifythe truth or reality in their own right, based on their Natural Acceptance and subsequent Experiential Validation.	AP	04
CO6.	Setdo's and don'ts related to values.	UN	12

UNIT-I	INTRODUCTION	6

The basic human aspirations and their fulfillment through Right understanding and Resolution; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution.

UNIT-II	UNDERSTANDING HUMAN BEING AND ITS EXPANSION	6

The domain of right understanding starts from understanding the human being (the knower, the experience and the doer); and extends up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).

UNIT-III	ACTIVITIES OF THE SELF	6

Understanding the human being comprehensively is the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Reasons for harmony/contradiction in the self.

UNIT-IV	UNDERSTANDING CO-EXISTENCE WITH OTHER ORDERS	6

The need and the process of inner evolution (through self-exploration, self-awareness and self-evaluation)- particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).

UNIT-V	EXPANSION OF HARMONY FROM SELF TO ENTIRE EXISTENCE	6

Understanding different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All-encompassing Resolution covering all four dimensions of human endeavour viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from self to Nature and entire Existence.

Total Periods	**30**

References

1. A Foundation Course in Human Values and Profession Ethics (Text Book and Teachers' Manual), R. R. Gaur, R. Sangal, G. P. Bagaria (2010), Excel Books, New Delhi [ISBN 978-8- 174-46781-2]
2. Avartansheel Arthshastra, A. Nagraj, Divya Path Sansthan, Amarkantak, India
3. Economy of Permanence – (a quest for social order based on non-violence), J. C. Kumarappa (2010), Sarva-Seva-Sangh-Prakashan, Varansi, India
4. Energy and Equity, Ivan Illich (1974), The Trinity Press, Worcester & Harper Collins, USA
5. Ishandi Nau Upnishad, Shankaracharya, Geeta press, Gorakhpur,
6. Manav Vyavahar Darshan, A. Nagraj, Divya Path Sansthan, Amarkantak, India
7. Manaviya Sanvidhan, A. Nagraj, Divya Path Sansthan, Amarkantak, India

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-	-
CO4	-	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-
CO5	-	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-
CO6	-	-	-	-	-	2	-	2	2	-	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

191MC05	YOGA	L	T	P	C
		2	0	0	0

Programme:	B.E., / B. Tech			Category:	MC

Aim:	To promote positive health, prevention of stress related health problems and rehabilitation through Yoga.
SDG	03

Course Outcomes:

Students will be able to

CO1:	Know about the history and evolution of Yoga**.**	UN	03
CO2:	Practice skills in Yoga for health.	AP	03
CO3:	Find out the habits to ensure mental and emotional balance.	AP	03
CO4:	Demonstrate basic skills associated with yogaactivities including strength and flexibility, balance and coordination.	AP	03
CO5:	Demonstrate the ability to perform yogamovements in various combination and forms.	AP	03
CO6:	Demonstrate the ability to create and present various yoga sequences.	AP	03

UNIT-I	FOUNDATIONS OF YOGA	5

Origin of Yoga, History and Development of Yoga; Etymology and Definitions, Misconceptions, Aim and Objectives of Yoga, True Nature and Principles of Yoga.

UNIT-II	YOUTH AND YOGA	5

Youth and yoga- yoga as a tool for healthy lifestyle, Yoga as a preventive, promotive and curative method. Pranayama and Different Yoga traditions and their impacts.

UNIT-III	ROLE OF YOGA IN PREVENTIVE HEALTH CARE	5

Role of Yoga in preventive health care – Yoga as a way of life, Heyam dukham anagatam; Potential causes of Ill-health: Tapatrayas and Kleshas, Physical and Physiological manifestation of Disease: Vyadhi, Alasya, Angamejayatva and Ssvasa-prashvasa.

UNIT-IV	METHODS OF TEACHING YOGA	5

Teaching and Learning: Concepts and Relationship between the two; Principles of Teaching: Levels and Phases of Teaching, Quality of perfect Yoga Guru; Yogic levels of learning, Vidyarthi, Shishya, Mumukshu; Meaning and scope of Teaching methods, and factors influencing them; Sources of Teaching methods;

UNIT-V	ASAN AND PRANAYAM	10

Asan and Pranayam:

- Various yog poses and their benefits for mind & body
- Regularization of breathing techniques and its effects
- Different Phases in Pranayama Pracice:
  - Puraka (Inhalation), Kumbhaka (Retension) and Recaka (Exhalation)

- Breathing Ratio in Pranayama Practice
- Application of Bandhas in Pranayama

Total Periods	**30**

References

1. Yogic Asanas for Group Tarining-Part-I", Janardan Swami Yogabhyasi Mandal, Nagpur.
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature" AdvaitaAshrama Publication, Kolkata.
3. Silva Mehta, Mira Mehta and Shyam Mehta, "Yoga: The Iyengar Way", Knopp publication, 1990.
4. Vishnu-Devananda, "The Complete Illustrated Book of Yoga", 1995.
5. Timothy McCall, "Yoga as Medicine: The Yogic Prescription for Health and Healing", Harmony, 2007.
6. Hathayoga Pradipika of Swatmarama - Kaivalyadhama, Lonavala
7. The Science of Yoga - Taimini - Theosophical Publishing House, Adyar, Madras

CO's- PO's & PSO's MAPPING

Course Outcomes	Programme Outcomes (POs)												Programme Specific Outcomes (PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	-	-	-	-	-	3	3	3	3	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	3	3	3	-	-	-	-	-	-	-
CO3	-	-	-	-	-	3	3	3	3	-	-	-	-	-	-	-
CO4	-	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-
CO5	-	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-
CO6	-	-	-	-	-	2	2	-	2	-	-	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)