Four-Year Undergraduate Programme

Bachelor of Technology

Biomedical Engineering

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

1. Vision of the Department

The Department of Biomedical Engineering aspires to integrate innovative engineering principles into the domains of biology, physiology, and medicine, with a focus on addressing health and societal needs. This vision underscores a commitment to advancing the fundamentals of biomedical engineering, thereby contributing to the assessment of fitness-related issues for human health and societal well-being.

2. Mission of the Department

M1 To excel in biomedical engineering education, we integrate engineering with medical sciences, fostering academic excellence, research, and innovation.
M2 To usher in a new era in healthcare, we aim to impart comprehensive knowledge in Human Anatomy and Physiology intertwined with essential engineering principles.
M3 To meet the evolving demands of the healthcare sector, we offer essential training programs to cultivate the skills and knowledge required for future biomedical engineers.
M4 To address the dynamic demands of the healthcare sector, we provide essential programs aimed at cultivating the skills and knowledge necessary for aspiring biomedical engineers.
M5 To Train the students with good Practical skills.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the B.Tech. Biomedical Engineering curriculum enables graduates to attain.

PEO 1	Pursue successful career that encompasses the proficient analysis, design, and solution of real-time engineering problems, reflecting a commitment to excellence and contributing to innovative solutions in the dynamic landscape of the engineering profession.
PEO 2	Striving to excel in professional career, committed to pursuing lifelong learning, including higher education and research, for the continuous enhancement of skills.
PEO 3	Demonstrate interpersonal skills, leadership ability and team building to achieve organization goals and serve society with professional ethics and integrity.

4. Program Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of Study.

PLO 1	**Engineering knowledge:**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PLO 2	**Problem analysis:**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using the first principles of mathematics, natural sciences, and engineering sciences.
PLO 3	**Design/development of solutions:**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

PLO 4	**Conduct investigations of complex problems:**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PLO 5	**Modern tool usage:**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PLO 6	**The engineer and society:**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PLO 7	**Environment and sustainability:**	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PLO 8	**Ethics:**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PLO 9	**Individual and team work:**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PLO 10	**Communication:**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PLO 11	**Project management and finance:**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PLO 12	**Life-long learning:**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

5. Program Specific Learning Outcomes

PSO 1	Exhibit proficiency in conducting measurements and interpreting data from living systems, while effectively addressing challenges associated with the interaction between living and non-living materials and systems.
PSO 2	Graduates will be familiar with latest biomedical engineering software tools and equipment to analyse clinical problems.

6. Credit Framework

Semester wise Credit distribution of the programme	
Semester-1	22
Semester-2	18
Semester-3	24
Semester-4	22
Semester-5	22
Semester-6	17
Semester-7	29
Semester-8	13
Total Credits:	**167**

Category wise Credit distribution of the programme	
Category	**Credit**
Major Core	83
Minor Stream	32
Multidisciplinary	18
Ability Enhancement Course	9
Skill Enhancement Courses	5
Value added Courses	2
Summer Internship	4
Research Project/Dissertation	14
Total Credits:	**167**

7. Program Curriculum

Semester 1						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303105102	Programming for Problem Solving	4	3	2	0
2	303106101	Basic Electrical Engineering	4	3	2	0
3	303107153	Electronic Workshop	1	0	2	0
4	303109102	Elements of Mechanical Engineering	4	3	2	0
5	303111101	Biology	3	3	0	0
6	303191101	Mathematics-I	4	4	-	-
7	303193103	Communication Skills	2	-	-	2
Total			**22**	**16**	**8**	**2**
Semester 2						

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
8	303104105	Environmental Science	Audit Course	1	0	0
9	303107151	Basic Electronics	4	3	2	0
10	303109101	Engineering Graphics	4	2	4	0
11	303191151	Mathematics-II	4	4	-	-
12	303192102	Engineering Physics-II	4	3	2	0
13	303193152	Advanced Communication & Technical Writing	2	-	-	2
Total			**18**	**13**	**8**	**2**
Semester 3						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
14	303111201	Human Anatomy and Physiology	3	3	0	0
15	303111202	Human Anatomy and Physiology Lab	1	0	2	0
16	303111203	Control Theory	3	3	-	-
17	303111204	Control Theory Lab	1	-	2	-
18	303111208	Product Realization	1	-	2	-
19	303113201	Analog and Digital Electronics	4	4	-	-
20	303113202	Analog and Digital Electronics Lab	1	-	2	-
21	303122201	Network Analysis and Synthesis	3	3	-	-
22	303122202	Network Analysis and Synthesis Lab	1	-	2	-
23	303191201	Complex Variables and PDE	4	4	-	-
24	303193203	Professional Communication Skills	2	-	-	2
Total			**24**	**17**	**10**	**2**
Semester 4						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
25	303111251	Biomaterial and Implants	3	3	-	-
26	303111252	Biomaterial and Implants Lab	1	-	2	-
27	303111253	Biosensor and Transducers	3	3	-	-
28	303111254	Biosensor and Transducers Lab	1	-	2	-

29	303111255	Electronic Devices & Circuits	3	3	-	-
30	303111256	Electronic Devices & Circuits Lab	1	-	2	-
31	303111257	Signals and Systems for Biomedical	3	3	-	-
32	303111258	Signals and Systems for Biomedical Lab	1	-	2	-
33	303111260	Industrial/Hospital training	1	-	2	-
34	303113257	Microcontrollers and Interfacing	3	3	-	-
35	303113258	Microcontrollers and Interfacing Lab	1	-	2	-
36	303193252	Professional Grooming and Personality Development	1	-	-	1
Total			**22**	**15**	**12**	**1**

Semester 5

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
37	303111301	Biological Modelling and Simulation	3	3	-	-
38	303111302	Biological Modelling and Simulation Lab	1	-	2	-
39	303111303	Intellectual Property Rights and Bioethics	2	2	-	-
40	303111305	Medical Instrumentation and Surgical Procedures	3	3	-	-
41	303111306	Medical Instrumentation and Surgical Procedures Lab	1	-	2	-
42	303111307	Hospital Management Systems	3	3	-	-
43	303111310	Summer Internship-I	2	-	-	-
44	303193304	Professionalism & Corporate Ethics	1	-	-	1
45		Open Elective 01 (Compulsory Subjects :1)	2	2	-	-
46		Open Elective 01 (Compulsory Subjects :1)	2	2	0	0
47		PEC 01-LAB (Compulsory Subjects :1)	1	-	2	-
48		PEC 01 (Compulsory Subjects :1)	3	3	-	-
Total			**24**	**18**	**6**	**1**

PEC 01

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	303111331	Basics of programming for healthcare	3	3	-	-
2	303111333	Ophthalmic Instrumentation	3	3	-	-

3	303111335	Telemedicine	3	3	-	-
PEC 01-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303111332	Basics of Programming for Healthcare Lab	1	-	2	-
2	303111334	Ophthalmic Instrumentation Lab	1	-	2	-
3	303111336	Telemedicine Lab	1	-	2	-
Open Elective 01						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303101331	Basic Aircraft Science	2	2	-	-
2	303104311	Disaster Preparedness and Planning	2	2	0	0
3	303105304	Cyber Security	2	2	0	0
4	303105305	Internet of Things	2	2	0	0
5	303107346	Fundamentals of Communication Engineering	2	2	0	0
6	303109346	Renewable Energy Sources	2	2	0	0
Semester 6						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
49	303111351	Diagnostic Techniques and Instrumentation	3	3	-	-
50	303111352	Diagnostic Techniques and Instrumentation Lab	1	-	2	-
51	303111353	Biomedical Signal Processing	4	4	-	-
52	303111354	Biomedical Signal Processing Lab	1	-	2	-
53	303111356	Minor Project	1	-	2	-
54	303193353	Employability Skills	1	-	-	1
55		Open Elective 02 (Compulsory Subjects :1)	2	2	-	-
56		PEC 02 (Compulsory Subjects :1)	3	3	-	-
57		PEC 02-LAB (Compulsory Subjects :1)	1	-	2	-
Total			**17**	**12**	**8**	**1**
PEC 02						

Sr. No.	Subject Code	Subject Name	Credit	Lect	Lab	Tut
1	303111381	Bioinformatics	3	3	-	-
2	303111383	Biomechanics & Rehabilitation Engineering	3	3	-	-
3	303111385	Embedded System	3	3	-	-
PEC 02-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303111382	Bioinformatics Lab	1	-	2	-
2	303111384	Biomechanics & Rehabilitation Engineering Lab	1	-	2	-
3	303111386	Embedded System Lab	1	-	2	-
Open Elective 02						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303100351	Programme Management and Entrepreneurship	2	2	0	0
2	303100352	Life Sciences	2	2	0	0
3	303100353	Fundamentals of Management	2	2	0	0
4	303100354	Constitution of India	2	2	0	0
Semester 7						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
58	303111401	Medical Imaging Technology	3	3	-	-
59	303111402	Medical Imaging Technology Lab	1	-	2	-
60	303111403	Therapeutic Equipment's	3	3	-	-
61	303111404	Therapeutic Equipment's Lab	1	-	2	-
62	303111405	Analytical Techniques & Instrumentation	3	3	-	-
63	303111406	Analytical Techniques & Instrumentation Lab	1	-	2	-
64	303111407	Hospital Information System & Regulatory Standards	3	3	-	-
65	303111410	Virtual Biomedical Instrumentation	2	-	4	-
66	303111412	Project-I	6	-	12	-

67	303111414	Summer Internship-II	2	-	-	-
68		PEC 03 (Compulsory Subjects :1)	3	3	-	-
69		PEC 03-LAB (Compulsory Subjects :1)	1	-	2	-
Total			**29**	**15**	**24**	
PEC 03						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303111431	Nanotechnology for Medical Applications	3	3	-	-
2	303111433	Internet of Things	3	3	0	0
3	303111435	Artificial Organ & Rehabilitation Devices	3	3	-	-
PEC 03-LAB						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303111432	Nanotechnology for Medical Applications Lab	1	-	2	-
2	303111434	Internet of Things Lab	1	-	2	-
3	303111436	Artificial Organ & Rehabilitation Devices Lab	1	-	2	-
Semester 8						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
64	303111451	Digital image processing for Biomedical	3	3	-	-
65	303111452	Digital image processing for Biomedical Lab	1	-	2	-
66	303111454	Project-II	6	-	12	-
67		PEC 04 (Compulsory Subjects :1)	3	3	-	-
Total			**13**	**6**	**14**	
PEC 04						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	303111481	Tissue Engineering	3	3	-	-
2	303111483	Radiotherapy	3	3	-	-
3	303111485	Biomedical microsystems	3	3	-	-
Total			**167**			

SEMESTER 1

a. **Course Name:** Mathematics-I
b. **Course Code:** 303191101
c. **Prerequisite:** Knowledge of Mathematics up to 12th science level
d. **Rationale:** The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and matrix algebra, preparing students for engineering challenges with optimized problem-solving skills

e. **Course Learning Objective:**

CLOBJ 1	Develop a comprehensive understanding of definite and improper integrals, including the application of integration techniques to find areas and volumes in both Cartesian and Polar coordinates.
CLOBJ 2	Utilize differential equations to model and solve practical scenarios, demonstrating proficiency in various solution techniques.
CLOBJ 3	Analyse the convergence and divergence of sequences and series, employing tests such as the Alternating Series Test and Ratio Test
CLOBJ 4	Analyse matrix operations and determinants, exploring their properties and applications in solving systems of linear equations.
CLOBJ 5	Apply Fourier series for representing periodic functions, verifying Dirichlet's conditions.
CLOBJ 6	Solve optimization problems using multivariable calculus concepts, such as Lagrange's multiplier.

f. **Course Learning Outcomes:**

CLO 1	Develop understanding of fundamental mathematical concepts
CLO 2	Formulate and solve mathematical models for real-world engineering problems,
CLO 3	Integrate knowledge from different mathematical topics to analyse and solve complex engineering problems
CLO 4	Critically analyse mathematical results, interpret their engineering significance, and make informed decisions based on mathematical outcomes, fostering a deeper understanding of the subject.
CLO 5	Clearly and effectively communicate mathematical ideas, solutions, and reasoning, both in written and oral formats, demonstrating effective communication skills.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		Total
L	T	P	C	MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L-Lectures**; T-** Tutorial**; P-**Practical**; C-** Credit**; MSE-** Mid-Semester Evaluation**,**
CE- Continues Evaluation**, ESE-** End Semester Examination

h. Course Content:

Sr. NO.	Topics	Weightage (%)	Teaching Hours
1	**UNIT 1** Improper Integral & Application of Definite Integral: Evaluation of definite and improper integrals, Beta and Gamma functions and their properties Area bounded by curves in Cartesian and Polar form, Area of a region bounded by function, Area of a region bounded by curves in Parametric form, Volume by slicing, Volume of solid by revolution.	8%	5
2	**UNIT 2** First order Ordinary Differential equation: Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type, Applications	15%	9
3	**UNIT 3** Matrices: Matrices & Determinants with Properties, Linear Independence, Rank of Matrix, System of Linear Equations, Consistency of System, Solution of system of Linear Equations by Gauss Jordan and Gauss-Elimination Method, Eigen values, Eigenvectors, Symmetric, Skew-symmetric, and orthogonal Matrices, Eigen bases, Diagonalization, Cayley Hamilton Theorem and its Applications, Diagonalization, Orthogonal Transformation, Quadratic form.	25%	15
4	**UNIT 4** Sequences and Series: Basic of Sequences, Bounded and Monotonic Sequences, Series, Convergence of sequence and series, Geometric series, P- series, Cauchy's Integral Test, Comparison Test, Alternating Series, Absolute and Conditional convergence, Ratio test, Cauchy's Root Test, Power series, Taylor's and Maclaurin's series.	17%	10

5	**UNIT 5** Fourier Series: Fourier Series of 2 periodic functions, Dirichlet's conditions for representation by a Fourier series, Fourier Series of a function of period 2, Fourier Series of even and odd functions, Half range series.	10%	6

6	**UNIT 6** Multivariable Calculus (Differentiation): Functions of Several Variables, Limit, Continuity, Partial Derivatives, Homogeneous function, Euler's Theorem for homogeneous function, Modified Euler's Theorem, Chain Rule, Implicit function, Jacobian, Tangent plane and Normal line, Maximum and Minimum Values, Lagrange's Multiplier, Taylor's and Maclaurin's Series for functions of two variables.	25%	15
	Total:	100%	60

i. Text Book and Reference Book:

1. Calculus and Analytic Geometry (TextBook), By G.B. Thomas and R.L. Finney | Addison Wesley
2. Calculus with early transcendental functions, By James Stewart | Cengage Learning
3. Higher Engineering Mathematics, By B. S. Grewal | Khanna Publications
4. Elementary Linear Algebra (TextBook), By Howard Anton, Chris Rorres | Willy India Edition | 9th Edition
5. Advanced Engineering Mathematics (TextBook), By Erwin Kreyszig | Willey India Education
6. A textbook of Engineering Mathematics, By N.P. Bali and Manish Goyal | Laxmi Publications

a. **Course Name:** Biology
b. **Course Code:** 303111101
c. **Prerequisite:** Knowledge of General Biology up to 10th or 12th class.
d. **Rationale**: To provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers.

e. **Course Learning Objective:**

CLOBJ 1	Understand and explain the structure and chemical/physical properties of monosaccharides, disaccharides, and polysaccharides.
CLOBJ 2	Investigate the function of enzymes and their role in biochemical reactions.
CLOBJ 3	Gain the understanding of the interphase nucleus including the nuclear membrane, nucleolus, and nucleosome model.
CLOBJ 4	Analyze formation of peptides and differentiate between different peptide bonds.

f. **Course Learning Outcomes:**

CLO 1	Identify the structure and chemical/physical properties of monosaccharides, disaccharides, and polysaccharides.
CLO 2	Understand the function of enzymes and their role in biochemical reactions.
CLO 3	Analyze the structure of the interphase nucleus including the nuclear membrane, nucleolus, and nucleosome model.
CLO 4	Describe the formation of peptides and differentiate between different peptide bonds.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
3	**-**	**0**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- lectures**; T-** Tutorial**; P-**Practical**; C-** Credit**; MSE-** Mid-Semester Evaluation**, CE-** Continues Evaluation**, ESE-** End Semester Examination

h. Course Content:

Sr. No.	Topics	Weightage (%)	Teaching hours
1	**Biological Molecules:** **Proteins:** Amino acids – classification, peptides, protein structure, globular proteins (Hemoglobin) & fibrous protein (Keratin), structure of proteins, types of bonds contributing to protein structure, Enzymes. **Carbohydrates**: Structure, chemical & physical properties of monosaccharides, disaccharides (maltose, sucrose, lactose), polysaccharides (starch, glycogen & cellulose). **Lipids**: Classification of lipids (simple, derived & complex with one example each) **Nucleic acids**: Nomenclature of nucleotides & nucleosides, structure of nucleic acids, the structure of DNA itself to its function as hereditary molecule **Vitamins, Hormones, Electrolyte**: Important diseases related to macromolecules.	30%	12
2	**The Cell:** **Cell Membrane:** Membrane models Membrane junctions – Tight, gap, septate, desmosomes. Membrane Transport – Diffusion, osmosis, passive & active transport. Endocytosis & Exocytosis. **Cytoplasm**: Ribosomes, Endoplasmic Reticulum– Structure and role in protein synthesis. Golgi apparatus: Structure, origin & relationship to endoplasmic reticulum. Lysosomes, Mitochondria: Structure of inner, outer membranes & the matrix. Cytoskeletal elements: Microfilaments: Structure & function in striated muscle fibers, Microtubules: Structure as in cilia/flagella, mechanism in movement **Nucleus**: Structure of Inter phase nucleus – nuclear membrane, nucleolus, nucleosome model. Genetic material: DNA and RNA their structure function and type. Cell cycle & cell division, Cell cycle. Mitosis, meiosis & their significance.	35%	14
3	**The Tissue** Introduction**,** Types of Tissues, Epithelial Tissue: Types, Structure and Functions of Epithelial Tissue. Connective Tissue: Types, Cells and Functions of Connective Tissue. Muscle Tissue: Types, Function. Nervous Tissue: Types, cell, Structure, Functions	25%	10
4	**The Blood:** Introduction, Importance, Composition of Blood- Blood cells and their functions. Haemostasis, Blood group System, Blood transfusion, RH Blood Group**.**	10%	9
	Total:	100%	45

i. Reference Books:

1. The Cell:A Molecular Approach By Cooper GM
2. Anatomy and physiology in Health and Illness (TextBook) By ROSS AND WILSON | Churchill Livingstone (Elsevier)
3. Text book of Medical Physiology (TextBook) By Guyton and Hall
4. Lehninger Principles of Biochemistry, By David L. Nelson, Michael M. Cox, |

Publisher: W. H. Freeman | Fourth Edition

5. Cell and Molecular Biology By De Robertis, E.D.P | Lippincott Williams and Williams(eighth Edition)

a. **Course Name:** Communication Skills
b. **Course Code:** 303193103
c. **Prerequisite:** Knowledge of English Language studied till 12th standard.
d. **Rationale:** Basic Communication Skills are essential for all Engineers.

e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to communicate ideas clearly and effectively.
CLOBJ 2	Develop strategies for building positive interpersonal relationships, fostering effective collaboration and teamwork.
CLOBJ 3	Develop active reading skills, including the ability to comprehend, interpret, and respond appropriately to written messages.
CLOBJ 4	Exhibit proficiency in written communication, crafting clear, concise, and well-organized messages across various formats (Ex: Book review, Picture Description, Picture Connectors).
CLOBJ 5	Deliver professional presentations, incorporating effective visual aids, engaging content, and confident delivery.
CLOBJ 6	Understand and analyze the common grammatical errors.

f. **Course Learning Outcomes:**

CLO 1	Understand the importance of creative and critical thinking.
CLO 2	Expand vocabulary with proper pronunciation.
CLO 3	Comprehend the basics of English grammar.
CLO 4	Read & write effectively for a variety of contexts.
CLO 5	Develop confidence in public speaking skills.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				T	**CE**	**P**	**Theory**	**P**	
0	**2**	**0**	**2**	**-**	**100**	**-**	**-**	**-**	**100**

L: Lectures**; T-** Tutorial**; P-**Practical**; C-** Credit**; MSE-** Mid-Semester Evaluation**, CE-** Continues Evaluation**, ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Crazy Scientist** The students will be taught the importance of invention and innovation using some examples that changed the world the way it worked.	**5%**	**2**
2	**Phonetics** IPA Introduction (listening tracks) Phonic Sounds Pronunciation Practice including transcription	**10%**	**4**
3	**Vocabulary Building & Word Formation Process** Compounding, clipping, blending, derivation, creative respelling, coining and borrowing Prefixes & suffixes, synonyms & antonyms, standard abbreviations (related activities will be provided)	**10%**	**2**
4	**Speaking Activity : Role play on Critical Thinking (Life boat)** This activity topic gears towards making students do role play based on various scenarios. It involves giving them a scenario and asking them to further develop the idea in a very interesting manner, then going on to enact it. It aims to improve students' convincing skills.	**10%**	**4**
5	**Picture Description & Picture Connector** Enable students to use vocabulary and useful expression to describe the picture. In this class the students will be trained to form logical connections between a set of pictures which will be shared with them. This geared towards building creativity and presentation skills.	**15%**	**4**
6	**Mine Activity:** Usage of Preposition Students will learn to use proper propositions by active participation in the activity.	**8%**	**2**
7	**Worksheets on Identifying Common Errors in Writing** Sentence structure Punctuations Subject-Verb Agreement Noun-Pronoun Agreement	**12%**	**2**
8	**Reading Skills** The art of effective reading and its various strategies to be taught to the learners and practice exercises be given on reading comprehension.	**10%**	**2**

9	**Speech and spoken Exchanges; Extempore** Students will learn the correct usage of spoken language as different from the written form. It will help the students in extempore speech. This will be done by making the students give a variety of impromptu speeches in front of the class: 1 minute talk on simple topics. To change the average speakers in the class to some of the best Orator.	**10%**	**4**
10	**Book Review** The learners will identify the central idea of the book, author's style and approach towards the book.This will enable the learners to express their point of view and hone their creativity and writing skills	**10%**	**4**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Understanding and Using English Grammar By Betty Azar & Stacy Hagen | Pearson Education.
2. Business Correspondence and Report Writing By SHARMA, R. AND MOHAN, K.
3. Communication Skills By Kumar S and Lata P | New Delhi Oxford University Press.
4. Technical Communication: Principles and Practice By Sangeetha Sharma, Meenakshi Raman | Oxford University Press.
5. Practical English Usage By MICHAEL SWAN.
6. A Remedial English Grammar for Foreign Student by F.T. WOOD.
7. Oxford Practice Grammar, By John Eastwood | Oxford University Press

a. **Course Name:** Programming for Problem Solving
b. **Course Code:** 303105102
c. **Prerequisite:** Requires Basic Knowledge of Computer
d. Rationale: This course is design to provide basic ideas of computer programming. This course also makes help to understand programming language. It will help to develop their logical abilities.

e. **Course Learning Objective:**

CLOBJ 1	Recognize and recall fundamental principles and organizations of computers, demonstrating a foundational understanding of computer architecture and design.
CLOBJ 2	Comprehend the concepts of computer programming languages, illustrating a grasp of syntax, semantics, and the essential components of programming languages.
CLOBJ 3	Develop algorithms for solving basic engineering problems, demonstrating the ability to apply theoretical knowledge to practical problem-solving scenarios.
CLOBJ 4	Demonstrate proficiency in the practical application of C programming by writing, compiling, and debugging programs, showcasing the ability to implement and troubleshoot code effectively.
CLOBJ 5	Evaluate and analyse complex computational programs written in C, demonstrating the capacity to assess and understand intricate solutions to computational challenges.
CLOBJ 6	Develop simple projects using the C programming language, showcasing creativity and application of learned principles to produce functional and practical software solutions.

f. **Course Learning Outcomes:**

CLO 1	Recognize the computer's basic principles and organizations.
CLO 2	Understand Concepts of Computer Programming Language.
CLO 3	Develop the algorithm for solving basic Engineering Problems.
CLO 4	Write, Compile and debug program with C Programming.
CLO 5	Analyse the Solved, Complex Computational Program written in C.
CLO 6	Develop simple projects using C Language.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**2**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No	Topics	Weightage (%)	Teaching Hours
1	**Number System:** Introduction and type of Number system, Conversion between number system, Arithmetic operations on number system, Signed and unsigned number system Software, Computer Languages and Computer Program	2%	1
2	**Introduction to 'C' Programming:** Features of C language, structure of C Program, Flow Charts and Algorithms Types of errors, debugging, tracing/stepwise execution of program, watching variables values in memory.	3%	1
3	**Constants, Variables and data Types:** Character Set, C tokens, Keywords and Identifiers, Constants, Variables, Data types, Declaration of Variables, assigning values to variables, type def, and defining symbolic constants.	5%	2
4	**Operators and Expression:** Introduction to Operators and its types, Evaluation of expressions, Precedence of arithmetic operators, Type conversions in expressions, Operator precedence and associatively.	10%	5
5	**Management Input and Output Operators:** Introduction, reading a character, writing a character, formatted input, formatted output.	5%	2
6	**Control structure in C:** Decision Making & branching: Decision making with If &I.. Else statements, If.. Else statements (Nested …. Ladder), The Switch & goto statements, The turnery (? :) Operator Looping: The while statement, The break statement & The Do... While loop, The FOR loop, Jump within loops – Programs	15%	7
7	**Array:** Introduction, One-dimensional arrays, Two-dimensional arrays, arrays, Concept of Multidimensional arrays.	10%	4
8	**String:** string, string storage, Built-in-string functions	10%	4
9	**User-Defined Functions:** Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing.	10%	5
10	**Structure and Unions:** Introduction, Structure definition, declaring and initializing Structure variables, Accessing Structure members, Copying & Comparison of structures, Arrays of structures, Arrays within structures, Structures within Structures, Structures and functions, Unions	10%	5

11	**Pointers:** Basics of pointers, pointer to pointer, pointer and array, Pointer to array, array of pointers, functions returning a pointer	**10%**	**5**
12	**Dynamic memory allocation:** Introduction to Dynamic memory allocation, malloc (), calloc (), free (), reallot ()	**5%**	**2**
13	**File Management in C:** Introduction to file management and its functions	**5%**	**2**
	Total:	**100 %**	**45**

i. Reference Book:

1. "Programming in ANSI C", (Textbook), By E. Balaguruswamy, Tata McGraw Hill
2. "C Programming: Test Your Skills", By Ashok Kamthane
3. "Computer Fundamentals", By P.K.Sinha and Priti Sinha, BPB Publications, 4th Edition
4. "Star C Programming", STAR Certification, C Certification Exam
5. "Programming with C", By Byron Gottfried, Tata McGraw Hill Education.
6. "C the Complete Reference", By Herbert Schildt
7. "Let Us C", By Yeshavant Kanetkar | BPB Publications

j. List of Experiments:

Sr. NO.	Experiment List
1	Write a program to print HELLO FRIENDS!
2	Write a program that reads two nos. from key board and gives their addition, subtraction, multiplication, division and modulo.
3	Write a program to calculate area of circle, use Ω as symbolic constants.
4	Write a program to convert days into months and days.
5	Write a program which calculates the summation of three digits from the given 3-digit number.
6	Write a program to demonstrate enumerates data type.
7	Write a program to compute Fahrenheit from centigrade.
8	Write a program to calculate simple interest. Read the price of item in decimal form e.g. 12.50 and separate Rs and Paise from the given value e.g. 12 rupees and 50 paise.
9	Write a program to find the largest of the three nos. using Nested-If-Else statement.
10	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
11	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.
12	Write a C program to enter a character and to check whether it is a small letter or it is a capital letter or it is a digit or it is a special symbol.

13	Write a program to read marks from keyboard and your program should display equivalent grade according to following table. Marks Grade 100-80 Dist 60-79 First Class 35-59 Second Class
14	Write a program to read marks of a student from keyboard whether the student id pass (if).
15	Write a program to find the sum of first N odd numbers.
16	Write a program using while loop construct which finds the factorial of a given integer number.
17	Write a C program using do«while and for loop constructs to reverse the digits of the number.
18	Write a program to demonstrate use of Switch- Break Statement.
19	Write a program to find out all the numbers divisible by 5 and 7 between 1 to 100.
20	Check for Armstrong number. A number is Armstrong if sum of cube of every digit is same as the original number. E.g. 153=13+53+33=153
21	Write a program to print the output of bellow series. 1!+2!+3!+4!+ …… n!
22	Write a program to print the following outputs using for Loop. 1 * 12 ** 123 ***
23	Write a program to print the following outputs using for Loop. (a) 1 (b) 321 21 21 321 1
24	Write a program which sorts 10 numbers into ascending order.
25	Write a program to find maximum element from 1-D array.
26	Write a program to find number of odd and even elements from the 1-D array.
27	Write a program add two 2x2 matrices.
28	Write a program to count number of positive, negative and zero elements from 3x3 matrix.
29	Write a function for the following operations on string: Copy one string to another

	Comparing two strings Adding a string to the end of another.
30	Write a program to count vowels from a entered String.
31	Write a program which finds whether a string is a palindrome or not.
32	Write a program to find factorial of a number using recursion.
33	Write a program that used user defined function Swap ( ) and interchange the value of two variable.
34	Write a function to return 1 if the number is prime otherwise return 0.
35	Define a structure type, personal that would contain person name, date of joining and salary.
36	Define a structure called cricket that will describe the following information: Player name Team name Batting average
37	Write a program to add two numbers using pointers.
38	Write a program to swap two numbers using pointer
39	Write a program to illustrate reading files contents.
40	Write a program to illustrate the use of fgets( )

a. **Course Name:** Basic Electrical Engineering
b. **Course Code:** 303106101
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
d. **Rationale:** Basic Electrical Engineering knowledge is fundamental as it provides a strong foundation for various engineering disciplines, promotes problem-solving skills, supports innovation, and opens doors to diverse career opportunities.

e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to Alternating current, alternating voltage, etc., Demonstrate a clear understanding of Pure R, L C circuit and combination of RLC, Series and Parallel combination of R, L and C, etc.
CLOBJ 3	Acquire knowledge of the resistor, capacitor, and inductor and their performance characteristics for series and parallel connections.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the basic concepts, working principles and applications of transformer, DC machines and AC machines.
CLOBJ 6	Study the use of LT Switch Gear, Fuse, MCB, ELCB etc.

f. **Course Learning Outcomes:**

CLO 1	Understand electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLO 2	Solve basic electrical circuit problems using various laws and theorems
CLO 3	Understand the role of resistor, capacitor and inductor and their performance characteristics for series and parallel connections.
CLO 4	Discuss three phase-balanced circuits.
CLO 5	Understanding the basic concepts and working principles of transformers, DC machines and AC machines.
CLO 6	Acquire knowledge about electrical installations

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L-Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**DC Circuits** Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff current and voltage laws, Mesh and Node analysis, Simplifications of networks using series and parallel combinations and star-delta conversions. Superposition, Thevenin and Norton Theorems.	22%	10
2	**AC Circuits** Sinusoidal voltages and currents, their mathematical and graphical representation, Concept of instantaneous, peak (maximum), average and R.M.S. values, frequency, cycle, period, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasors, examples based on theory. Study of A.C. circuits consisting of pure resistance, pure inductance, pure capacitance and corresponding voltage current phasor diagrams and waveforms. Development of the concept of reactance, the study of series R-L, R-C, R-L C circuit and resonance, study of parallel R-L, R-C and R-L C circuit, concept of impedance, admittance, conductance and susceptance in case of above combinations and relevant voltage-current phasor diagrams, the concept of active, reactive and apparent power and power factor, examples based on theory. Concept of three-phase supply and phase sequence. Voltages, currents and power relations three-phase have balanced star-connected loads and delta-	33%	15

	connected loads along with phasor diagrams, Power and power factor measurement in balanced three-phase circuits (one, two and three wattmeter methods), examples based on theory.		
3	**Transformers** Magnetic effect of an electric current, right-hand thumb rule, Concept of m.m.f., flux, flux density, reluctance, permeability and field strength, their units and relationships, comparison between electrical and magnetic parameters. Fleming's left-hand rule. Self and mutual inductance, Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency.	**20%**	**9**
4	**Electrical Machines** Construction, working and application of DC Motor and Generator. Generation of 3 phase rotating magnetic fields, Construction and working of a three-phase and Single phase induction motor and its types. Construction and working of Synchronous generator.	**15%**	**7**
5	**Electrical Installations** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries.	**10%**	**4**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Electrical Engineering Fundamentals, By V. D. Toro, Prentice Hall India, Pub. Year 1989
2. Basic Electrical Engineering, By D. C. Kulshreshtha, McGraw Hill
3. Fundamentals of Electrical Engineering, By Leonard S. Bobrow, Oxford University Press, Pub. Year 1996
4. Electrical and Electronics Technology, By E. Hughes Pearson, Pub. Year 2010 5. Basic Electrical Engineering, By D. P. Kothari and I. J. Nagrath, Tata McGraw Hill, Pub. Year, 2010
5. A textbook of Electrical Technology Volume 1&2, By B. L. Theraja, S. Chand Publication

j. List of Experiments

S.No.	Name of experiments
1	To Study about Various Electrical and Electronics Symbols and demonstrate various measuring instruments used in Basic electrical Engineering laboratory.
2	To Perform and Solve Electrical Networks with Series and Parallel Combinations of Resistors Using Kirchhoff's Laws.
3	To Obtain Inductance, Power and Power Factor of the Series RL Circuit With AC Supply Using Phasor Diagram
4	To Obtain Capacitance, Power and Power Factor of the Series RC Circuit With AC Supply Using Phasor Diagram.
5	To Obtain Inductance, Capacitance, Power and Power Factor of the Series

	R-L-C Circuit With AC Supply Using Phasor Diagram
6	Verification of superposition theorem with dc source.
7	Verification of Thevenin's theorem with dc source..
8	Verification of Norton's theorems in dc circuits.
9	Verification of Current and Voltage Relations in Three Phase Balanced Star and Delta Connected Loads.
10	To study the cut-section of a dc machine, single phase induction machine and three phase induction machine.
11	Find out the Efficiency and Voltage Regulation of Single Phase Transformer by Direct Load Test.

a. **Course Name:** Elements of Mechanical Engineering
b. **Course Code:** 303109102
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12th science level
d. **Rationale:** Elements of Mechanical Engineering Course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.

e. **Course Learning Objective:**

CLOBJ 1	Identify and basic mechanical components such as gears, bearings, Pumps, Compressor, boiler, I.C Engines.
CLOBJ 2	Understand various laws and behaviour of fluid at different conditions.
CLOBJ 3	Illustrate the operational mechanisms through diagrams, models, or practical demonstrations.
CLOBJ 4	Demonstrate construction and working principles of diverse mechanical devices, such as engines, pumps, and compressors.
CLOBJ 5	Evaluate basic problems related to I.C engine, pumps, compressors and Fluids.
CLOBJ 6	Analyse and discuss the interactions and relationships between various mechanical elements within a system.

f. **Course Learning Outcomes:**

CLO 1	Identify basic mechanical components and their functions.
CLO 2	Understand basic Properties and behaviour of various fluids.
CLO 3	Understand Construction and working of various mechanical devices
CLO 4	Apply fundamental principles to solve basic mechanical engineering problems

g. **Teaching Examination scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**2**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE** Continuous Evaluation , **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage(%)	Teaching Hours
1	**Basics of Thermodynamics** Prime Movers - Meaning and Classification; Concept of Force, Pressure, Energy, Work, Power, System, Heat, Temperature, Specific heat capacity, Internal Energy, Enthalpy, Specific Volume; Thermodynamics – Definition: Change of State, Path, Process, Cycle, Thermodynamic systems, Statement of Zeroth Law, First Law and Second Law of Thermodynamics and its Applications.	10%	5
2	**Properties of Gases** Gas Laws, Boyle's law, Charles law, Combined gas law; Gas Constant, Relation between Cp and Cv Constant Volume Process; Constant Pressure Process; Isothermal Process; Adiabatic Process; Poly-tropic Process. Examples based on above topics.	15%	7
3	**Properties of Steam** Types of Steam and Steam formation; Specific Enthalpy; Specific Volume; Dryness Fraction of Steam; Measurement of Dryness Fraction; Steam Table. Examples based on above topics.	15%	7
4	**Heat Engines** Definition of Heat Engine; Classification of Heat Engine; Carnot Cycle, Rankine Cycle, Otto Cycle and Diesel Cycle. Internal Combustion Engines: Two Stroke Petrol and Diesel Engine; Four Stroke Petrol and Diesel Engine; Measurement of Indicated Power and Brake Power: Numerical on calculation of Mechanical, Thermal and Volumetric Efficiency. Examples based on above topics.	20%	9
5	**Energy Conversion Devices** Steam Generators: Definition and Classification; Cochran, Lancashire, Locomotive, Babcock and Wilcox Boiler: Construction and Working; Boiler Mounting and Accessories. Refrigeration and Air Conditioning: Meaning of Refrigeration; Vapour Compression Refrigeration Cycle; Vapour Absorption Refrigeration Cycle; Air conditioning; Window Air Conditioning and Split Air Conditioning.	20%	9
6	**Pumps And Air Compressors** Pumps Definition, Classification and Application of Pumps; Types and Operation of Rotary pump, Reciprocating Pump, Centrifugal Pump. Air Compressors Definition, Classification and Application of Compressors; Types and Operation of Rotary and Reciprocating Air Compressor.	10%	4

7	**Motion And Power Transmission Devices** **Shaft and Axle;** Belt Drive; Chain Drive; Friction Drive; Gear Drive; Clutch, Coupling and Brake.	**5%**	**2**
8	**Conventional And Non-Conventional Energy Sources** Introduction and Classification of Energy Sources; Conventional Energy Sources E.g. Solid, Liquid, Gaseous and Nuclear fuels; Calorific Value of Fuels; Non-Conventional Energy Sources E.g. Solar Energy, Wind Energy, Hydro Power, Biomass and Biomass Energy; Comparison of Conventional & Non-Conventional Energy Sources.	**5%**	**2**
	Total:	**100 %**	**45**

i. List of Experiments:

Sr. NO.	**Experiment List**
1	Demonstration and study of construction and working of Petrol Engine Model.
2	Demonstration and study of construction and working of Diesel Engine Model.
3	Determination of brake thermal efficiency of an I. C. Engine.
4	Demonstration and study of construction and working of various types of boiler Models.
5	Study of construction and working of different boiler mountings and accessories.
6	Demonstration on construction and working of different types of pumps.
7	Demonstration on construction and working of different types of air compressors.
8	Demonstration on vapour compression refrigeration cycle and vapour absorption refrigeration cycle.
9	Demonstration on construction, working and applications of different types of coupling, clutch and brake.
10	Demonstration on construction, working and applications of motion and power transmission devices.

a. **Course Name:** Electronic Workshop
b. **Course Code:** 303107153
c. **Prerequisite:** Zeal to learn the subject.
d. **Rationale:** The use of workshop practices in day to day industrial as well domestic life helps to solve the problems. Further, it also deals with basic introduction of system components of electrical and electronic systems, and provides hands on practice in assembling, interconnecting, testing, and repairing such system by making use of various tools used in electrical and electronic workshop. Electronic systems are built on printed circuit board (PCB) and breadboard. One need to use source instruments (power sources and signal sources), and appropriate measuring instruments to study behaviour of a system.

e. Course Learning Objective:

CLOBJ 1	students should be able to identify and understand the function of basic electronic components such as resistors, capacitors, diodes, transistors, and integrated circuits.
CLOBJ 2	Students will develop strategies for building positive interpersonal relationships, fostering effective collaboration and teamwork.
CLOBJ 3	Students gain practical skills in soldering, breadboarding, and prototyping electronic circuits. Students should be able to assemble and troubleshoot circuits using common electronic components and tools.
CLOBJ 4	Student will learn how to use electronic test equipment such as multimeters, oscilloscopes, and function generators to measure voltage, current, frequency, and other parameters in electronic circuits.

f. Course Learning Outcomes:

CLO 1	Gain ability to understand eh working of Active and Passive Components
CLO 2	Ability to understand the operating of various testing and measurement instrumentation.
CLO 3	Ability to learn electrical wiring.
CLO 4	Ability to design electronic circuit for the specific applications

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**-**	**2**	**1**	**-**	**-**	**50**	**-**	**50**	**100 %**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1.	Electrical Component: Types of switches, relays, fuses, MCB, ELCB. Types of wires and Gauges, Sockets and Earthings, lamp Load.	**14%**	**4**
2.	Basic Passive Components: Types of passive elements and identification: Resistors, capacitors, Inductors and their power ratings, Value identification through color Coding	**14%**	**4**
3.	Power Supply and Multimeter: Operating principle of Power supply, Operating principle of Multimeter measuring various parameters like voltage, current, continuity, resistance, capacitance etc.	**14%**	**4**
4.	Active components: Types of active components and symbolic representations, Interpreting data sheet of various active components like PN junction diode, Zener diode, BJT, Power Transistor, Fixed voltage IC Regulators etc., Identification and measurement.	**16%**	**4**
5.	Function Generator and CRO: Basics of Function Generator, Specifications of Function Generator and operating ranges of various parameters of available functions, operating principle of CRO, Specifications of CRO and Operating ranges of various parameters	**16%**	**5**
6.	Basic Electrical & Electronics parameter: Measurement of voltage, current, frequency, phase, and Power	**10%**	**4**
7.	Electrical Wiring: Introduction to electrical wiring, types of wiring, Staircase wiring, Double Staircase wiring, GO Down Wiring, Demonstration of Fuse, MCB along its operation and study of ELCB, Demonstration of different types of cables, wires, probes, connectors	**16%**	**5**
	Total:	**100%**	**30**

i. Text Book and Reference Book:

1. Electronic Principles by Albert Paul Malvino | TMH
2. Electronic Devices by Thomas L. Floyd | Pearson, Prentice Hall "Linear Systems and Signals" by B.P. Lathi.
3. Electronic Devices and Circuits by David A. Bell | Oxford Publication
4. Electronic Devices and Circuits by Jacob Millman and Halkias | Tata McGraw Hill Publication New Delhi.
5. Shop Theory by Anderson James & Earl E. Tatro | Macmillan/McGraw-Hill School.
6. Workshop Technology by Bava H. S. | Tata McGraw Hill Publishing Co. Ltd.

7. Elements of Workshop Technology Vol. I By Hajra Chaudhary S.K. | Asia Publishing House.
8. Workshop Technology by Chapman, W.A.J. ELBS Low Price Text | Edward Donald Pub. Ltd.
9. Basic Machine Shop Practice Vol. I & II By Tejwani, V.K. | Tata McGraw Hill Pub. Co.
10. Workshop Technology Vol. I & II By Arora, B.D. | Satya Prakashan, New Delhi" Signals and Systems" by Simon Haykin and Barry Van Veen.

SEMESTER 2

a. **Course Name:** Environmental Science
b. **Course Code:** 303104105
c. **Prerequisite:** Knowledge of Physics, Chemistry and Mathematics up to 12th science level and Biology up to 10th science level
d. **Rationale:** Basic knowledge of the environment is essential for all human beings for a good life and sustainable existence

e. **Course Learning Objective:**

CLOBJ 1	Apply systems thinking to analyse the city as a system, demonstrating application
CLOBJ 2	Evaluate the role of smart citizens and approaches for citizen engagement
CLOBJ 3	Identify sources and stressors of water resources, demonstrating understanding
CLOBJ 4	Analyse the causes, effects, and control measures of population explosion

f. **Course Learning Outcomes:**

CLO 1	Understand the interrelation and interdependency of organisms and their interactions with the environment
CLO 2	Identify eco-friendly measures in engineering projects
CLO 3	Understand preventive steps for environmental protection.
CLO 4	Act as a responsible individual who is aware of efficient usage of resources and securing sustainable development

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
1	**0**	**0**	**Audit Course**	**-**	**50**	**-**	**-**	**-**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE** Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**
1	**ENVIRONMENTAL HEALTH, ECOLOGY AND QUALITY OF LIFE** Environmental education: Objective and scope,	**25%**	**7**

	Impact of technology on the environment, Environmental disasters: Case studies, Global environmental awareness to mitigate stress on the environment, Structure and function of an ecosystem, Ecological pyramids, Pyramid of number, Pyramid of energy and pyramid of biomass.		
2	**POLLUTION PREVENTION** Air & Noise pollution -Sources & their Effects, Case studies of Major Catastrophes, Structure and composition of the atmosphere, Water, Soil, Marine, Thermal & Marine Pollution: The story of fluoride contamination, Eutrophication of lakes, control measures, Measuring water quality: Water quality index, Waste water treatment (general) primary, secondary and tertiary stages, Municipal Solid waste management: Sources and effects of municipal waste, Biomedical waste, Hazardous waste	**20%**	**6**
3	**POPULATION GROWTH, GLOBAL ENVIRONMENTAL CHALLENGES & LATEST DEVELOPMENTS** Population Explosion - Causes, Effects and Control, an International initiative in population-related issues, Urbanization, Growth of the world's large cities, Water resources: Sources of water, Stress on water resources, Climate Change, Global Warming and Green House Effect, Acid Rain, Depletion of Ozone layer, Variation in concentrations of GHG gases in ambient air during last millennium, Role of Environmental Information System (ENVIS) in India and similar programs run by EPA(USA), Role of soft tools like Quantum GIS, Autodesk Building Information Modelling (BIM) and City Finance Approach to Climate-Stabilizing Targets (C- FACT), Life Cycle Assessment, Bioinformatics and Optimization tools for sustainable development.	**25%**	**7**
4	**SMART CITIES** **Introduction to smart cities -** about smart cities, what is a smart city, world urbanization, case studies of Songdo, Rio De Janeiro, what makes cities smart. **City as a system of systems –** Introduction, systems thinking, Milton Keynes Future Challenges, Rich picture as city challenges, Wicked problems, Development of **smart city approach –** core elements, open data, sustainability, privacy and ethics, development processes. **Smart Citizens –** their role, engaging citizens, IES Cities,	**30%**	**10**

	Energy systems, Approaches for Citizen Engagement, co creating smart cities, cities unlocked, living labs, city problems, crowdsourcing ideas, redesigning cities for citizens, all age-friendly cities, mobility on demand, motion maps. **Infrastructure, Technology and Data –** urban infrastructure and its technology, future of lighting, IoT, connected objects, sensing the city, NOx eating paints and air quality sensors, safest, smart citizen kit, sensing your city, Sensored City, Cyber security for data power, open, shared and closed data, satellite data, open data revolution, Smart City Project Data **Innovation –** smart innovations, smart city ecosystem, data-driven innovations for smart cities **Standards and Capacity Building –** the role of Standard, BSI smart city Standards, Hyper Cat, ITU Smart Sustainable cities, Smart City Readiness, Lessons Learnt from Amsterdam **Smart Measurements -** metrics and indicators, city indicators, WCCD data portal, value proposition, integrated reporting, smart city learning and education, urban data school.		
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Environmental Studies For Undergraduate Courses",(TextBook),By Dr Erach Bharucha | Orient BlackSwan | Second Edition, Pub. Year 2013.
2. "Basics of Environmental Studies", By U K Khare, Tata McGraw Hill
3. "Environmental Studies" By Anindita Basak, Drling Kindersley (India) Pvt. Ltd Pearson
4. "Environmental Sciences", By Daniel B Botkin & Edward A Keller, John Wiley & Sons
5. "Air Pollution", By M N Rao, H. V N Rao, McGraw Hill Publishing Company Limited, New Delhi

a. **Course Name:** Mathematics-II
b. **Course Code:** 303191151
c. **Prerequisite:** Knowledge of Mathematics up to 12th science level
d. **Rationale**: The Mathematics I syllabus integrates fundamental calculus concepts, advanced mathematical techniques, and vector calculus, preparing students for engineering challenges with optimized problem-solving skills.

e. **Course Learning Objective:**

CLOBJ 1	Define and identify ordinary differential equations of higher order. Classify ODEs based on homogeneity and linearity. Solve homogeneous linear ODEs of higher order with constant coefficients, and variable coefficients.
CLOBJ 2	Solve homogeneous linear ODEs of higher order with constant coefficients, variable coefficients
CLOBJ 3	Apply the Method of Undetermined Coefficients to solve nonhomogeneous ODEs. Utilize the Solution by Variation of Parameters for solving nonhomogeneous ODEs. Explore applications of ODEs in real-world scenarios.
CLOBJ 4	Understand power series solutions for ordinary points and regular Singular points. Explore properties and applications of Legendre polynomials and Bessel functions.
CLOBJ 5	Define Laplace transform and its inverse. Understand the linearity property of Laplace transforms. Solve ordinary differential equations using Laplace transforms.
CLOBJ 6	Define Fourier Integral and its applications. Explore Fourier Cosine and Sine Integrals.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate the ability to translate physical or engineering problems into mathematical equations and solve them.
CLO 2	Develop analytical and critical thinking skills through the process of solving complex mathematical problems.
CLO 3	Understand and interpret mathematical solutions in the context of the given problems.
CLO 4	Communicate mathematical concepts and solutions clearly and effectively, both in written and verbal forms.
CLO 5	Present mathematical arguments and solutions in a logical and organized manner.

CLO 6	Lay a solid foundation for more advanced courses in mathematics and related disciplines.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	**Topics**	**Weightage (%)**	**T**
1	UNIT 1 Higher order ordinary differential equations: Ordinary differential equations of higher orders, Homogeneous Linear ODEs of Higher Order, Homogeneous Linear ODEs with Constant Coefficients, Euler–Cauchy equations, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters, Applications	8%	5
2	UNIT 2 Power Series: Power series solutions at ordinary point and regular singular point; Legendre polynomials, Bessel functions of the first kind and their property	15%	9
3	UNIT 3 Laplace Transform: Laplace Transform and inverse Laplace transform, Linearity, First Shifting Theorem (s-Shifting), Transforms of Derivatives and Integrals, ODEs, UNIT Step Function (Heaviside Function), Second Shifting Theorem (t-Shifting), Laplace transform of periodic functions, Short Impulses, Dirac's Delta Function, Convolution, Integral Equations, Differentiation and Integration of Transforms, Solution of ordinary differential equation by Laplace transform	25%	15
4	UNIT 4 Fourier Integral: Fourier Integral, Fourier Cosine Integral and Fourier Sine Integral	17%	10
5	UNIT 5 Vector Calculus: Gradient of scalar field, Directional Derivative, Divergence and curl of Vector field, Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.	10%	6
6	UNIT 6 Multivariable Calculus (Integration): Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Triple integrals (Cartesian)	25%	15
	Total:	**100%**	**60**

i. Text Book and Reference Book:

1. Calculus and Analytic Geometry (TextBook) By G.B. Thomas and R.L. Finney | Addison Wesley
2. Calculus with early transcendental functions By James Stewart | Cengage Learning
3. Higher Engineering Mathematics By B. S. Grewal | Khanna Publications
4. Elementary Linear Algebra (TextBook) By Howard Anton, Chris Rorres | Willy India Edition | 9th Edition
5. Advanced Engineering Mathematics (TextBook) By Erwin Kreyszig | Willey India Education
6. A text book of Engineering Mathematics By N.P. Bali and Manish Goyal | Laxmi Publications

a. **Course Name:** Basic Electronics
b. **Course Code:** 303107151
c. **Prerequisite:** Knowledge of Physics and Mathematics up to12th sciencelevel
d. **Rationale:** The course provides introductory treatment of the field of Basic Electronics to the students of various branches of engineering.
e. **Course Learning Objective:**

CLOBJ1	Explain the fundamental concepts of electronic devices, such assemiconductor physics, diode and transistor operation, and semiconductor materials.
CLOBJ2	Analyze and describe the characteristics and behavior of variouselectronic devices, including diodes, transistors, and amplifiers.
CLOBJ3	Apply circuit analysis techniques to understand and design basicelectronic circuits involving devices like diodes and transistors.
CLOBJ4	Understand the principles of signal amplification and processing using electronic devices, including amplifier configurations and feedback systems.
CLOBJ5	Comprehend the principles of digital electronics, including logicgates, flip-flops, and digital circuit design.
CLOBJ6	Analyze and design circuits using operational amplifiers, includingapplications in amplification, filtering, and signal conditioning.

f. **Course Learning Outcomes:**

CLO 1	Understand the concept of intrinsic and extrinsic semiconductor.
CLO 2	Understand construction, characteristics of semiconductor devices like diodeand bipolar junction transistor.
CLO 3	Understand and design circuits using components like diode, BJT,resistors, capacitors, inductors etc.
CLO 4	Identify and analyze different type biasing circuit.
CLO 5	Analyze and Design Transistor Amplifier Circuit.
CLO 6	Design DC Regulated Power Supply.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**		
				Internal Evaluation	**ESE**	

L	T	P	C	MSE	CE	P	Theory	P	Total
3	0	2	4	20	20	20	60	30	150

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	Diode Theory and Its Applications Introduction to Ideal Diode, Effect of temperature Ideal diodes, unbiased diode and Forward and reverse bias of Diode. PIV, surge current, Diode as Uncontrolled switch. Rectifiers: Half wave, Full wave and bridge wave. IDC, VDC and Irms Measurements. Ripple factor, PIV rating. Choke and Capacitor input filter rectifiers, Clipper and Clamper circuits, Voltage multiplier: Half wave voltage doubler and full wave voltage doubler	15 %	10
2	Special Purpose Diodes Construction of Zener diode, Characteristics of Zener diode, Application of Zener Diode as Voltage Regulator, load line, Optoelectronic devices (LED and Photo Diode), Seven Segment Display, Schottky diode and its Application, Varactor Diode and its Application, Understanding Datasheets.	15%	7
3	Transistor Fundamentals and its Biasing techniques Construction of BJT, working principle of BJT, Characteristics & specifications of BJT (PNP & NPN transistors), Biased and unbiased BJT, Configuration of transistor, concept of gain & BW, Operation of BJT in cut-off, saturation & active regions (DC analysis), BJT as switch, Transistor as an amplifier, Voltage divider bias and analysis, VDB load line and Q point.	30%	15
4	DC Regulated Power Supply Voltage Regulator-Basic series and shunt regulator, Types of voltage regulator IC: Fixed and adjustable positive and negative linear voltage regulator, IC linear fixed voltage regulator (78XX, 79XX, LM340 Series), Linear Adjustable Regulator (IC LM317, LM337, and IC 723 IC regulator), DC Regulated Power supply, Switched mode power supply (SMPS).	20 %	7
5	Introduction to Sensors and Transducers: Introduction to sensors and Transducers, Comparison between sensors and Transducers, Applications of Sensors and Transducers, Types of Electronic sensors, Types of Transducers.	20 %	6
	Total:	100 %	45

i. Text Book and Reference Book:

1. Electronic Principles (TextBook) By A. P. Malvino | TataMcGraw Hill Publication New Delhi.|
2. Electronic Devices and Circuits by Jacob Millman and Halkias Tata McGraw Hill PublicationNew Delhi.
3. Electronic Devices and Circuits by Robert L. Boylestad andLouis Nashelesky | Pearson, Prentice Hall.
4. Electronic Devices By Thomas L. Floyd | Pearson, PrenticeHall
5. Linear Electronic Circuits and Devices by James Cox, Delmar Publication.
6. Electronic Devices and Circuits by David A. Bell | Oxford

j. Experiment List:

Sr.No.	Experiment List
1	To Plot V-I characteristics Diodes. (a) PN junction diode Characteristic. (b) ZenerDiode characteristics.
2	To Observe Rectifier Circuit (a) Half wave Rectifier without filter (b) Full wave rectifier without filter. (c) Half wave Rectifier with (L, C) filter (d) Full wave Rectifier with (L, C) filter and measure DC voltage regulation and ripple factor for various load currents in case of filtered output.
3	Designing of power supply using IC regulator circuit. (a) Designing of +5 Volt DC Power Supply using 7805. (b) Designing of -5 Volt DC Power Supply using 7905. (c) Designing of +12 Volt DC Power Supply using 7812. (d) Designing of -12 Volt DC Power Supply using 7912.
4	To Observe Response of Clipping and Clamping circuits using diodes. (a) Diode Positive Clipper without and with Biased clipper (b) Diode Negative Clipper without and with Biased clipper. (c) Biased Positive – Negative Clipper (Combinational Clipper) (d) Positive Clamper, Negative Clamper.
5	(a) To Plot and Study input- output characteristics of common Base (CB) configuration of Transistor
6	To study Voltage divider bias circuit: (a) To observe the effect of change in base current on Q- operating point (b) To set Q point for operation of transistor amplifier in linear region.
7	Optoelectronic devices: (a)To plot characteristics of LED (b)To plot Characteristic of Photo Diode (c) To observe isolated control of optocoupler.
8	To plot characteristics of Schottky and Varactor diode.
9	Designing of Linear Adjustable Regulator using IC LM317
10	Introduction to Sensors and Transducers.

a. **Course Name:** Engineering Graphics
b. **Course Code:** 303109101
c. **Prerequisite:** Knowledge of Physics and Mathematics up to 12^{th} science level
d. **Rationale:** "Engineering Graphics" course Provide students with a comprehensive foundation in the fundamental principles and concepts that form the backbone of mechanical engineering for various Engineering disciplines.
e. **Course Learning Objective:**

CLOBJ 1	Identify and name common drafting tools and their uses.
CLOBJ 2	Interpret engineering drawings and symbols.
CLOBJ 3	Demonstrate the ability to create accurate engineering drawings using industry-standard software.
CLOBJ 4	Solve engineering design problems by applying geometric and spatial concepts.
CLOBJ 5	Generate accurate and professional engineering drawings independently.
CLOBJ 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

f. **Course Learning Outcomes:**

CLO 1	Identify and recall common drafting tools and their uses.
CLO 2	Interpret and explain engineering drawings and symbols.
CLO 3	Demonstrate the application of industry-standard software to create accurate engineering drawings.
CLO 4	Solve engineering design problems by applying geometric and spatial concepts.
CLO 5	Generate accurate and professional engineering drawings independently.
CLO 6	Design and create 3D models of engineering components using computer-aided design (CAD) tools.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**4**	**4**	**20**	**20**	**20**	**60**	**30**	**150**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**INTRODUCTION TO ENGINEERING GRAPHICS** Scope of Engineering Drawing in all Branches of Engineering, Uses of Drawing Instruments and Accessories, Introduction to Drawing Standards BIS-SP- 46, Representative Fraction, Types of Scales (Plain and Diagonal Scale), Dimensioning Terms and Notations,Types of Arrowheads, Lines, Lettering, Numbering and Dimensioning	5%	0
2	**ENGINEERING CURVES:** Classification of Engineering Curves, Application of Engineering Curves, Constructions of Engineering Curves - Conics, Spirals, Involutes and Cycloids with Tangents and Normal	10%	5
3	**PRINCIPLES OF PROJECTIONS:** Types of Projections - Oblique, Perspective, Orthographic and Isometric Projections; Introduction to Principal Planes of Projections, Projections of Points located in all four Quadrants; Projections of lines inclined to one of the Reference Plane and inclined to two Reference Planes.	10%	4
4	**PROJECTIONS OF PLANES:** Projections of various planes – Polygonal, Circular and Elliptical shape inclined to one of the Reference Plane and inclined to two Reference Planes; Concept of Auxiliary Plane of Projections.	10%	4
5	**PROJECTIONS OF SOLIDS AND SECTIONS OF SOLIDS:** Classifications of basic Solids, Projections of Solids - Right Regular Prism, Pyramid, Cone, Cylinder, Tetrahedron and Cube inclined to one of the Reference Plane and inclined totwo Reference Planes; Frustum of Prism, Pyramid and Cone inclined to one of the Reference Plane; Types ofCutting Planes - Auxiliary Inclined Plane, Auxiliary VerticalPlane, Horizontal Cutting Plane, Profile Cutting Plane; Sections of Solids resting on H.P/V.P and Inclined to only one of the Reference Planes; Sectional Views, True Shape of the Sections	20%	10
6	**DEVELOPMENT OF SURFACES:** Methods of Development of Lateral Surfaces of Right Regular Solids, Parallel Line Development and Radial Line Development, Applications of Development of Surfaces.	10%	5
7	**ORTHOGRAPHIC PROJECTIONS:** Projections on Principal Planes from Front, Top and Sidesof the Pictorial view of an Object, First Angle Projection and Third Angle Projection method; Full Sectional Orthographic Views – Side and Front, Offset Cutting views	15%	0
8	**ISOMETRIC VIEW/DRAWING AND ISOMETRIC PROJECTIONS:** Conversion of Orthographic Views into Isometric Projection, View or Drawing; Isometric Scale.	15%	0

9	**OVERVIEW OF COMPUTER AIDED DRAFTING TOOL:** Introduction to Computer Aided Drafting Software; Preparation of Orthographic Projections and IsometricViews Using Drafting Software	5%	0
	Total:	**100 %**	**28**

i. Text Book and Reference Book:

1. Engineering Drawing N.D. Bhatt & V.M. Panchal; Charotar Publishing House
2. ENGINEERING GRAPHICS P. J. Shah; S. Chand & Co., New Delhi Publications.
3. Graphic Science and Design French, T.E. Vierck, C.J & Foster; Tata McGraw HillPublications.
4. Fundamentals of Engineering Drawing Luzadder; W. J & Duff Prentice Hall Publications.
5. Engineering Drawing and Graphics Venugopal k; New Age International PrivateLimited Publishers.

j. Experiment List:

Sr. NO.	Experiment List
1	Introduction to Engineering Graphics: Types of lines, Letterings, Drawing Symbols, Numberings, Dimensioning Terms and Notations, Title Block, Geometric Constructions etc.
2	Drawing Sheet on Engineering Curves.
3	Drawing Sheet on Projections of Points and Lines.
4	Drawing Sheet on Projections of Planes.
5	Drawing Sheet on Projections of Solids and Sections of Solids.
6	Drawing Sheet on Development of Surfaces.
7	Drawing Sheet on Orthographic Projections.
8	Drawing Sheet on Isometric Projection/View or Drawing.
9	Prepare 2D Drawings using AutoCAD.
10	Prepare Isometric Views using AutoCAD.

a. **Course Name:** Engineering Physics-II
b. **Course Code:** 303192102
c. **Prerequisite:** Knowledge of Physics and some basic concepts in Mathematics like differentiation, integration, limit, differential equation, vector calculus up to 12thscience level.
d. **Rationale:** Knowledge of physics is essential for all Engineering branch because physics is the foundation subject of all the branches of engineering and it develops scientific temperament and analytical capability of engineering students. Comprehension of basic physics concepts enables the students to solve engineering problem logically and develop scientific approach

e. **Course Learning Objective:**

CLOBJ 1	Understand the basics of quantum mechanics, including Schrodinger'sequations and the physical significance of wave functions.
CLOBJ 2	Apply the Schrodinger equation to analyze particles in one-dimensional potential boxes, emphasizing practical implications and tunneling effects.
CLOBJ 3	Master concepts of energy bands, semiconductor classification, E-k diagrams,and semiconductor device analysis including P-N junction diodes.
CLOBJ 4	Comprehensively understand material classification, focusing on magnetic materials, nanomaterials, and analyzing physical, thermal, electrical, optical, and magnetic properties.
CLOBJ 5	Gain expertise in laser principles, types, and applications, as well as fiber opticsprinciples and applications. Understand optoelectronic devices, their functionalities, and practical applications.

f. **Course Learning Outcomes:**

CLO 1	Formulate and conceptualize various theoretical aspects and the physicalphenomena at atomic level
CLO 2	Analyse the optical transition processes in semiconductors and identify thematerials useful in optoelectronic devices.
CLO 3	Understand the fabrication and applications of low dimensional semiconductordevices.
CLO 4	Acquire proficiency in experimental techniques used for studying nanoscalesystems, including microscopy and spectroscopy.
CLO 5	Master the principles of quantum mechanics and their application to nanoscalesystems.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	2	4	20	20	20	60	30	150

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**-Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr.	Topics	Weightage (%)	Teaching Hours
1	UNIT-I: Modern Physics Introduction about quantum Mechanics, Schrodinger's equations, Time dependent and Time Independent Wave Equation, Physical Significance of the wave Function, Application of Schrodinger equation in particle in One Dimensional Potential Box and Tunneling effects.	**20 %**	**9**
2	UNIT-II: Band theory& Semiconductors Energy bands in solids, Classification of Materials into, Semiconductors& Insulators, Density of state, E-k diagram, Kronig-Penny model (to introduce origin of band gap), Effective mass. Direct and indirect band gap. Carrier Concentration in semiconductors, Fermi Level in Intrinsicand Extrinsic Semiconductors, P-N junction diode, Ohmic and Schottky Junction.	**20 %**	**9**
3	UNIT-III: Materials Classification of materials: Magnetic materials, Nanomaterials based on semiconductors and metal oxides, Basic characteristic properties of nanomaterials, Novel Materials. Physical, Thermal, Electrical, Optical and Magnetic properties of materials.	**20 %**	**9**
4	UNIT-IV: Laser and Fiber Optics Lasers: Interaction of radiation with Matter, Absorption, Spontaneous and Stimulated emission, Characteristics of Lasers, Types of Lasers: Ruby Laser, Helium-Neon Laser, Semiconductor Diode Laser,Applications of Lasers. Fiber Optics: Principle and Structure of Optical Fiber, Numerical Aperture of fiber, Types of Optical Fibers, Attenuation in Optical Fibers, Applications of Optical Fibers.	**20 %**	**9**
5	UNIT-V: Devices Optoelectronic Devices: Photoconductive cell, photovoltaic cell,Photodiode, Phototransistor, LED, IR emitters, Opto coupler, X-ray diffractometer, Quantum devices and their applications.	**20 %**	**9**
	Total:	**100 %**	**45**

i. Text books:

1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc., (2007).
3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. Engineering Physics — HK Malek and A. K. Singh- Mc Graw Hill Publication.
5. Semiconductor Optoelectronic Devices- P. Bhattacharya-Prentice Hall of India.
6. Fundamentals of Physics- Halliday, Resnick and Walker.

j. List of experiments

S.No	Name Of experiments
1	I-V characteristics of light emitting diode in forward bias.
2	I-V characteristics of Zener diode in reverse bias.
3	Determination of Velocity of ultrasonic waves in water.
4	Determination of Dielectric constants of Dielectric samples
5	Measurement of Band gap of semiconductor material.
6	Measurement of Hall coefficient RH and carrier concentration in a semiconductor
7	Measurement of Planck's constant using LED
8	Measurement of wavelength of laser light using diffraction grating.
9	Measurement of Numerical aperture of an optical Fiber.
10	Moment of Inertia of a flywheel.
11	Measurement of power loss in an optical fibre
12	B-H Curve tracing.
13	Determination of Young's modulus.
14	Determination of thermal conductivity. (Searle's method or Lee's method)
15	To Determine acceleration due to gravity using compound pendulum.

a. **Course Name:** Advanced Communication & Technical Writing
b. **Course Code:** 303193152
c. **Prerequisite:** Knowledge of English Language studied till 12th standard
d. **Rationale:** Communication confidence laced with knowledge of English grammar isessential for all engineers.

e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to adapt writing style to different audiences and purposes.
CLOBJ 2	Create comprehensive technical documents such as reports, manuals, and proposals.
CLOBJ 3	Deliver professional presentations, incorporating effective visual aids, engaging content and confident delivery.
CLOBJ 4	Apply technical communication through various mediums (video, web content, multimedia)
CLOBJ 5	Incorporate advanced document design principles for clarity and readability.
CLOBJ 6	Deliver different types of speeches.

f. **Course Learning Outcomes:**

CLO 1	Develop four basic communication skills.
CLO 2	Construct grammatically correct sentences.
CLO 3	Develop and deliver professional presentation skills
CLO 4	Develop the skills of critical thinking.
CLO 5	Compare different types of written communication.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
0	**2**	**0**	**2**	-	**100**	**-**	-	-	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**-Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Developing Effective Listening Skills**: To help students understand the meaning and importance of good listening skills, learning the traits of being a good listener through activity andlistening audio tracks.	**10%**	**2**
2	**Error analysis**: To provide insights into the complicated processes of language development as well as asystematic way for identifying, describing andexplaining errors. (Tenses, Voices, Reported speech)	**10%**	**4**
3	**Delivering different types of speeches:** Students will understand and use the different patterns for structuring speeches: Welcome / Introductory speech, Vote of Thanks speeches, Farwell speeches	**10%**	**2**
4	**Professional Presentations:** Students will learn ▪ Combating stage fright ▪ Preparing power point presentation ▪ Delivering PPT	**10%**	**5**
5	**Essay writing**: Students will overcome the common pitfalls in the taskof essay writing by understanding • Basics of Paragraph development and paragraph jumble • Types of essays • Characteristic features of essays • Guiding Principles	**10%**	**4**
6	**Reading Comprehension**: • Employing Different Reading Skills • Activity • Practice	**10%**	**2**
7	**Project Proposal**: • To equip students with the various elements required to prepare a winning proposal.	**5%**	**2**
8	**Misplaced Modifiers**: • Students will understand how to place the improperly separated word, phrase or clause from the word it describes.	**5%**	**1**

9	**Movie Review**: • A movie show followed by writing a review. • To provide an exposure to students how to express their opinions about some film or documentary with unbiased and objective approach.	**10%**	**2**
10	**Narrative Writing**: • Narrative writing helps them explore different characters and settings. • To help students clarify their thinking, and teach them to express that in writing in an organized way.	**5%**	**2**
11	**Writing Reports**: • Process of writing • Order of writing • Final draft & checklist for reports • Sample reports: • Memorandum • Letter report	**10%**	**2**
12	**Critical Thinking**: • Need, relevance and Significance of Critical Thinking • Logic in problem solving and decision making(activities) Moral Reasoning (Case Studies)	**5%**	**2**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. "Understanding and Using English Grammar", Betty Azar & Stacy Hagen; Pearson Education.
2. "Business Correspondence and Report Writing ", SHARMA, R. AND MOHAN, K.
3. "Communication Skills", Kumar S and Lata P; New Delhi Oxford University Press
4. "Technical Communication: Principles and Practice" Sangeetha Sharma, Meenakshi Raman; Oxford University Press. "Practical English Usage MICHAE

SEMESTER 3

a. **Course Name:** Human Anatomy and Physiology
b. **Course Code:** 303111201
c. **Prerequisite:** Basic knowledge of Biology and chemistry up to 12th Level.
d. **Rationale:** The students need to learn fundamentals of anatomical structures and physiology of body organs. This knowledge is helpful to design any instrument. Students get to know about body composition, organs and systems.

e. **Course Learning Objective:**

CLOBJ 1	Explain the structures of different body parts.
CLOBJ 2	Describe the physiology of body organs.
CLOBJ 3	Demonstrate the ability to interpret how the nervous system controls various body parts.
CLOBJ 4	Apply their knowledge to point out and explain the processes of exchange and transportation of gases in the body
CLOBJ 5	Locate and identify anatomical structures through recalling their knowledge.
CLOBJ 6	Study the use of Anatomy in biomedical field

f. **Course Learning Outcomes:**

CLO 1	Explain the structures of different body parts.
CLO 2	Describe the physiology of body organs.
CLO 3	Able to interpret how the nervous system controls the body parts.
CLO 4	Able to point out the exchange and transportation of gases.
CLO 5	Locate and identify anatomical structures
CLO 6	Able to point out the exchange and transportation of gases.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Human Anatomy and Physiology** Definition of anatomy and physiology, Terms related to anatomy and physiology, Anatomical planes and positions, Organs and systems. Structural Organization, Cavities of the body, Outline of the following systems: Cardiovascular System, Respiratory System, Alimentary System, Nervous System, Reproductive System, Urinary System, Skeletal System, Muscular System, Lymphatic System, Endocrine System, Integumentary system (Skin Study).	5%	3
2	**Cardiovascular and Respiratory System** **Cardiovascular System**: Anatomy of the heart, Heart-position and function, Properties of Cardiac muscle, Origin of the heart beat and electrical activity of the heart. Anatomy and Physiology of Arteries, capillaries and veins. Cardiac cycle, Types of Circulation, Blood pressure, heart rate and their regulation, Cardiac output, Pulse Pressure, Heart sound, ECG. **Respiratory System** Structure and function of respiratory system, mechanism of respiration, regulation of respiration, principle of gas exchange/transport between the lungs and tissues, pulmonary volumes and capacities, pulmonary function test, Spiro meter, artificial respiration	20%	10
3	**Digestive and Urinary System** **Digestive System** Digestive system-Introduction. Various parts of digestive system, their structure and functions. Accessory digestive organs, Mechanisms of Digestion **Urinary System**: Various parts of excretory/Urinary system, their structure and functions: Kidneys, Ureters, Urinary Bladder, Urethra; Structure of Nephron, Physiology of urine formation And physiology of micturition.	20%	9

4	**Nervous System and Special Senses** **Nervous System**: Introduction, Functions of Nervous System, Central Nervous System: Neuron, Anatomy, Communication, Cerebrospinal Fluid, Functions of CSF, Brain-Parts, Anatomy and Physiology, Spinal Cord, Peripheral nervous system, Reflex Action and Reflex Arc, Parasympathetic & Sympathetic nervous system, Problems of the Nervous System. **Special Senses**: Structure, function and physiology of vision, hearing, taste & smell. Mechanism of vision, color vision, mechanism of hearing, tests of hearing	**20%**	**8**
5	**Integumentary, Skeletal and Muscular System** **Integumentary System**: Introduction, The Skin: Structure and Functions of Skin, Regulation of Body temperature, Skin Disorders, Wound Healing **Skeletal System**: Introduction, Components and Functions of Skeletal system, Divisions of Skeletal system, Classification of Bone based of Shape, Axial Skeleton: Skull, Vertebral column (spinal column), Thoracic cage, Sternum. Appendicular skeleton: Pectoral Girdle, upper limbs, Pelvic Girdle, Lowe Limbs. **Muscular System**: Introduction, types of Muscular tissue, Anatomical terms of movement, Physiology of muscle contraction	**15%**	**7**
6	**Endocrine and Reproductive System** **Endocrine System**: Introduction, Hormones, Classification of Hormones, Principal Endocrine glands and their functions, Other glands and their functions, Mixed Glands, Secretions of all glands **Reproductive System**: Introduction, Asexual and Sexual Reproduction, Organs, Location and Functions of Female Reproductive System: Cyclical development of ovarian follicle, ovum and corpus luteum, Menstrual Cycle v/s Ovarian Cycle, Mechanism of Labor and Parturition, Stages of Labor, Organs, Location and Functions of Male Reproductive System: Composition of semen, Sperm Count and the factors involved in male fertility, Hormonal control of mammary gland development and lactation	**20%**	**8**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Anatomy and physiology in Health and Illness, By ROSS AND WILSON; Churchill Livingstone (Elsevier).
2. Textbook of Medical Physiology, By A.C.Guyton; Saunders
3. Human Anatomy, By B.D Chaurasia.
4. Human anatomy and Physiology with Health Education, By Padma B Sanghani; McGrawHill.
5. Atlas of Human Anatomy by Frank H. Netter.

a. **Course Name:** Human Anatomy and Physiology Lab
b. **Course Code:** 303111202
c. **Prerequisite:** Basic knowledge of Biology and chemistry up to 12th Level.
d. **Rationale:** The students need to learn fundamentals of anatomical structures and physiology of body organs. This knowledge is helpful to design any instrument. Students get to know about body composition, organs and systems
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with biological systems.
CLOBJ 2	Solve problems related to the various tissues and organs of different systems of human body
CLOBJ 3	Acquire knowledge of the gross morphology, structure and functions of various organs of the human body.
CLOBJ 4	Understand different anatomical structures

f. **Course Learning Outcomes:**

CLO 1	Locate and identify anatomical structures
CLO 2	Identify the various tissues and organs of different systems of human body
CLO 3	Able to interpret the gross morphology, structure and functions of various organs of the human body.
CLO 4	Illustrate the knowledge of biological systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
0	**-**	**2**	**1**	**-**	**-**	**20**		**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	To study the Skeletal system
2	To identify different joints in the human body
3	To study the digestive system
4	To study the structure and function of different components of eyes
5	To study the structure and function of different components of ears
6	To determine normal bleeding time
7	To study the Endocrine system
8	To study the Nervous system
9	To study the excretory system
10	To study the respiratory system
11	To study the human male reproductive system
12	To study the human female reproductive system
13	To study the integumentary system
14	To study the working of heart
15	To study the muscular system

a. **Course Name:** Control Theory
b. **Course Code:** 303111203
c. **Prerequisite:** Knowledge of Linear differential equations, Different equations and its solution and Laplace transform.
d. **Rationale:** The course explores the fundamentals of control systems, understanding and predicting system behaviour and design and analysis of closed loop control systems.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with systems theory to complex real world problems in order to obtain models that are expressed using differential equations, transfer functions, and state space equations.
CLOBJ 2	Solve problems system behavior based on the mathematical model of that system.
CLOBJ 3	Acquire knowledge of the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist plots.
CLOBJ 4	Understand different single phase and three phase circuits.
CLOBJ 5	Demonstrate a clear understanding of the models of dynamic systems in transfer function and state space forms.

f. **Course Learning Outcomes:**

CLO 1	Apply systems theory to complex real world problems in order to obtain models that are expressed using differential equations, transfer functions, and state space equations.
CLO 2	Predict system behavior based on the mathematical model of that system where the model may be expressed in time or frequency domain.
CLO 3	Analyze the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist plot.
CLO 4	Obtain models of dynamic systems in transfer function and state space forms.
CLO 5	Design of PID Controllers with Frequency-Response Approach.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Control Systems** Introduction, Examples of Control Systems, Closed-Loop Control versus n-Loop Control, Digital Computer Control, The Control Problem.	5%	3
2	**Mathematical Modeling of Control Systems** Introduction, Transfer Function and Impulse-Response Function, Automatic Control Systems, Transformation of Mathematical Models with MATLAB. Mathematical Modeling of Mechanical Systems, Mathematical Modeling of Electrical Systems, and Block diagram Model, Signal flow graph.	15%	6
3	**State Variable Models** Concept of State Variable, State equation, State-Space Representations of Transfer-Function Systems, Transformation of System Models with MATLAB, Solving the Time-Invariant State Equation, Some Useful Results in Vector-Matrix Analysis.	15%	6
4	**Feedback Characteristics of Control System** Feedback and non-feedback Systems, Reduction of parameters variations by use of feedback, Control over System dynamics by use of feedback, Control of the effects of disturbance signal by use of feedback, Linearizing effect of feedback, Regenerative feedback.	5%	3
5	**Time response analysis** Design Specifications and Performance Indices: Standard Test signal, Time response of first order systems, Time response of second order systems, Steady-state errors and errors constants, Effect of adding zero to a system, Design specifications of second order systems, Design consideration of higher order systems, Performance Indices.	10%	5

6	**Concept of Stability and algebraic Criteria** The Concept of Stability, Necessary condition of stability, Hurwitz stability criterion, Routh stability criterion, Relative stability analysis.	**5%**	**3**
7	**Control Systems Analysis and Design by the Root-Locus Method** Introduction, Root-Locus Plots, Plotting Root Loci with MATLAB, Root- Locus Plots of Positive Feedback Systems, Root-Locus Approach to Control-Systems Design.	**10%**	**5**
8	**Control Systems Analysis and Design by the Frequency- Response Method** Introduction, Correlation between time and frequency response, Polar plots, Bode plots, All pass and minimum phase systems, Log magnitude versus Phase plots.	**15%**	**6**
9	**Stability in frequency domain** Introduction, Mathematical Preliminaries, Nyquist stability criterion, assessment of relative stability using Nyquist criterion.	**10%**	**4**
10	**PID Controllers and Modified PID Controllers** Introduction, Ziegler'Nichols Rules for Tuning PID Controllers, Design of PID Controllers with Frequency-Response Approach, Modifications of PID Control Schemes, Two-Degrees-of-Freedom Control.	**10%**	**4**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Modern Control System, By Richarc C. Drof and Robert H. Bishop).
2. Modern Control Engineering, By Katsuhiko Ogata; Prentice Hall of India
3. Control Systems Engineering, By Nagrath and Gopal; New Age Publication.
4. Automatic Control Systems, By Benjamin C.Kuo; John Wiley & Sons.
5. Feedback and Control Systems, By Joseph J Distefano.

a. **Course Name:** Control Theory Lab
b. **Course Code:** 303111204
c. **Prerequisite:** Knowledge of Linear differential equations, Different equations and its solution and Laplace transform.
d. **Rationale:** The course explores the fundamentals of control systems, understanding and predicting system behaviour and design and analysis of closed loop control systems
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the closed and open loop systems.
CLOBJ 2	Solve problems related to the stability of the closed and open loop system.
CLOBJ 3	Acquire knowledge of the stability of the closed and open loop system.
CLOBJ 4	Understand system behaviour based on the mathematical model of that system using MATLAB
CLOBJ 5	Demonstrate a clear understanding of the Analysis effect of PID controller on system

f. **Course Learning Outcomes:**

CLO 1	Understand and interpret the response of the closed and open loop systems.
CLO 2	Solve basic stability of the closed and open loop system.
CLO 3	Understand the stability of the closed and open loop system.
CLO 4	Discuss system behaviour based on the mathematical model of that system using MATLAB
CLO 5	Understanding the Analysis effect of PID controller on system.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	Introduction to MATLAB for Control System.
2	Introduction to Simulink and various block sets.
3	Analysis different input signals to control system
4	Analysis of linear time-invariant systems and representation
5	Write a MATLAB program for reduction of block diagrams.
6	Plotting response of first order circuit and second order circuits with the help of MATLAB programming.
7	Obtain the root locus plot for the system using MATLAB
8	Obtain the bode plot for the system using MATLAB
9	Obtain the Nyquist plot for the system using MATLAB
10	Basic concept of state space and its conversion using MATLAB
11	Simulation of control system represented in state space form.
12	Analysis effect of P, PD, PI, PID controller on system.

a. **Course Name:** Analog and Digital Electronics
b. **Course Code:** 303113201
c. **Prerequisite:** Knowledge of Basic Electronics.
d. **Rationale:** The course provides introduction to Simulation and Designing software's for electronic circuit design. Using simulation software the students can design and analyse various analogy and digital circuits. The students can design PCB layout for the desired circuits using PCB design tools. Using simulation software like MATLAB/SCILAB various electronics and mathematical concept can be implemented.
e. **Course Learning Objective:**

CLOBJ 1	Define and explain fundamental control system concepts, including open-loop and closed-loop systems, feedback, and control objectives.
CLOBJ 2	Develop the ability to create mathematical models of dynamic systems using differential equations, transfer functions, and block diagrams.
CLOBJ 3	Analyse the stability of linear time-invariant systems using stability criteria such as the Routh-Hurwitz criterion and the Nyquist criterion.
CLOBJ 4	Understand and analyse the transient and steady-state responses of systems to different inputs.
CLOBJ 5	Apply frequency domain analysis techniques, such as Bode plots and Nyquist diagrams, to understand system behaviour in the frequency domain.

f. **Course Learning Outcomes:**

CLO 1	Describe the functioning and selection of OP-AMP as per application.
CLO 2	Design and testing of OP-AMP based circuits.
CLO 3	Design and implement Combinational and Sequential logic circuits.
CLO 4	Describe the process of Analog to Digital conversion and Digital to Analog conversion
CLO 5	Describe the functioning and selection of OP-AMP as per application.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Differential, Multi-stage and Operational Amplifiers:** Differential amplifier; power amplifier; direct coupled multi- stage amplifier; internal structure of an operational amplifier, ideal op-amp, non-idealities in an op-amp (Output offset voltage, input bias current, input offset current, slew rate, gain bandwidth product).	13%	8
2	**Linear applications of Op-Amp:** Idealized analysis of op-amp circuits. Inverting and non- inverting amplifier, differential amplifier, instrumentation amplifier, integrator, active filter, P, PI and PID controllers and lead/lag compensator using an op-amp, voltage regulator, oscillators (Wein bridge and phase shift). Analog to Digital Conversion.	17%	10
3	**Nonlinear applications of Op-Amp:** Hysteretic Comparator, Zero Crossing Detector, Square-wave and triangular-wave generators. Precision rectifier, peak detector	10%	6
4	**Fundamentals of Digital Systems and logic families** Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, number systems-binary, signed binary, octal hexadecimal number, binary arithmetic, ones and twos complements arithmetic, characteristics of digital lCs, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-statelogic.	15%	9
5	**Combinational Digital Circuits:** Standard representation for logic functions, K-map representation, and simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital	15%	9

	comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Q-M method of function realization.		
6	**Sequential Circuits and Systems:** A 1-bit memory, the circuit properties of Bi-stable latch, the clocked SR flip flop, J- K-T and D types flip-flops, applications of flip-flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using	**15%**	**9**
7	**A/D and D/A Converters:** Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter lCs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs	**15%**	**9**
	Total:	**100 %**	**60**

i. Text Book and Reference Book:

1. OPAMP & Linear Integrated Circuits (TextBook), By Ramakant Gaiekwad; PHI
2. Fundamentals of Digital Electronics (TextBook), By A. Anandkumar; PHI Publication
3. Modern Digital Electronics, By R. P. Jain; Tata McGraw-Hill Education.
4. Design with Operational Amplifiers & Analog Integrated Circuits, By Sergio Franco; McGraw Hill.
5. Operational Amplifiers and Linear IC's, By David A. Bell; Oxford University Press; 3rd edition.

a. **Course Name:** Analog and Digital Electronics Lab
b. **Course Code:** 303113202
c. **Prerequisite:** Knowledge of Basic Electronics.
d. **Rationale:** :The main objective of this subject is to inculcate basic concepts of Op-Amps & Digital circuits and system, which leads to design of complex digital system such as microprocessors. The course aims to familiarize students with combinational and sequential circuits using digital logic fundamentals.
e. **Course Learning Objective:**

CLOBJ 1	Outline and elucidate essential principles of control systems, encompassing open-loop and closed-loop setups, feedback mechanisms, and the objectives of control.
CLOBJ 2	Acquire proficiency in formulating mathematical representations of dynamic systems utilizing tools like differential equations, transfer functions, and block diagrams.
CLOBJ 3	Analyse the stability of linear time-invariant systems using stability criteria such as the Routh-Hurwitz criterion and the Nyquist criterion.
CLOBJ 4	Understand and analyse the transient and steady-state responses of systems to different inputs.
CLOBJ 5	Apply frequency domain analysis techniques, such as Bode plots and Nyquist diagrams, to understand system behaviour in the frequency domain.

f. **Course Learning Outcomes:**

CLO 1	Explain the operation and choice of operational amplifiers (OP-AMPs) based on their intended use.
CLO 2	Design and testing of OP-AMP based circuits.
CLO 3	Design and implement Combinational and Sequential logic circuits.
CLO 4	Describe the process of Analog to Digital conversion and Digital to Analog conversion.
CLO 5	Describe the functioning and selection of OP-AMP as per application.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	List of Experiments
1	Study the different parameter of op-amp
2	Frequency response of inverting amplifier and non-inverting amplifier.
3	Study of op-amp as inverting amplifier and non-inverting amplifier.
4	OPAMP circuits –integrator, differentiator, and comparator
5	Phase shift and Wein's Bridge oscillator with amplitude stabilization using OPAMPs
6	Waveform generation – Square, triangular and saw tooth wave form generation using OPAMPs.
7	Application of op-amp as low pass filter, high pass filter and band-pass filter
8	Verification of function of Half/Full adder circuits.
9	Verification of function of Binary to Grey code conversion
10	Verification of function of Latch and flip-flop.
11	Verification of counter circuit like binary up/down counter, decimal counter, ring counter, Johnson counter etc.
12	Verification of Specification and Performance indices of D/A and A/D converters

a. **Course Name:** Network Analysis and Synthesis
b. **Course Code:** 303122201
c. **Prerequisite:** Fundamental knowledge of calculus (Integration, differentiation, etc.) and Linear Algebra (Determinant, Matrices) etc.
d. **Rationale:** The Students of EC Engineering are expected to be able to analyse and synthesize circuits using various laws and theorems. This is one of the foundation courses offering understanding of concepts and developing of skills required to analyse and synthesize real word problems circuits in the field of Electronics.
e. **Course Learning Objective:**

CLOBJ 1	Define network synthesis and its role in electronic circuit design. Understand the importance of systematic approaches to network design.
CLOBJ 2	Introduce impedance and admittance parameters in the context of network synthesis. Understand the relationships between these parameters and the characteristics of passive components.
CLOBJ 3	Define image impedance and its role in simplifying network analysis. Understand how transfer functions are used to represent network behavior
CLOBJ 4	Explore various network theorems and techniques used in synthesis, including reciprocity, duality, and insertion loss. Apply these theorems to simplify and analyze network configurations
CLOBJ 5	Introduce elementary synthesis procedures for the design of passive networks. Understand how to create networks with desired impedance characteristics.

f. **Course Learning Outcomes:**

CLO 1	Understand basics electrical circuits with nodal and mesh analysis
CLO 2	Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc.
CLO 3	Apply Laplace Transform for steady state and transient analysis.
CLO 4	Determine different network functions.
CLO 5	Appreciate the frequency domain techniques.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Basic Concepts :** Node and mesh analysis, matrix approach of network containing voltage and current sources, and reactance, source transformation and duality, coupled Circuit Analysis: dot convention.	15%	7
2	**Graph Theory :** Graph of a network, definitions, tree, Co-tree, link, basic loop and basic cut set, Incidence matrix, Cut set matrix, Tie set matrix, Duality, Loop and Nodal methods of analyses.	10%	4
3	**Network Theorems** Network theorems: Superposition, reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.	15%	7
4	**Laplace Transform and network analysis :** Laplace transforms and properties: Partial fractions, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions.	15%	7
5	**The Frequency domain Fourier analysis :** Trigonometric and exponential Fourier series: Discrete spectra and symmetry of waveform, steady state response of a network to non-sinusoidal periodic inputs, power factor, effective values, Fourier transform and continuous spectra, three phase unbalanced circuit and power calculation.	15%	7
6	**Network Function Synthesis and Two port Networks :** Transient behavior, concept of complex frequency, Driving points and transfer functions poles and zeros of immittance function, their properties, sinusoidal	20%	9

	response from pole-zero locations, convolution theorem, Characterization of LTI two port networks; Z, Y, ABCD, g and h parameters, Reciprocity and symmetry, Inter-relationships between the parameters, Interconnections of two port networks.		
7	**Filters:** Behaviors of series and parallel resonant circuits, Introduction to band pass, low pass, high pass and band reject filters.	**10%**	**4**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Network Analysis, By M. E. Van Valkenburg; PHI Learning.
2. Circuit Theory, By Chakrabarti; DhanpatRai& Co.
3. Networks and Systems, By D. Roy Choudhary; Wiley Eastern Ltd.
4. Engineering Circuit Analysis, By W H Hayt, S M Durbin; Tata McGraw-Hill Education.
5. Engineering circuit analysis with PSPICE and probe, By Roger.

a. Course Name: Network Analysis and Synthesis Lab

b. Course Code: 303122202

c. Prerequisite: Knowledge of Basic Electronics.

d. Rationale: The Students of EC Engineering are expected to be able to analyze and synthesize circuits using various laws and theorems. This is one of the foundation courses offering an understanding of concepts and developing of skills required to analyze and synthesize real word problems circuits in the field of Electronics.

e. Course Learning Objective:

CLOBJ 1	Outline and elucidate basics electrical circuits with nodal and mesh analysis
CLOBJ 2	Acquire proficiency in network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc.
CLOBJ 3	Analyse the Laplace Transform for steady state and transient analysis.
CLOBJ 4	Understand and analyse the different network functions.
CLOBJ 5	Apply the frequency domain techniques

j. Course Learning Outcomes:

CLO 1	Understand basics electrical circuits with nodal and mesh analysis
CLO 2	Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, Millman's Theorem, etc.
CLO 3	Apply Laplace Transform for steady state and transient analysis.
CLO 4	Determine different network functions.
CLO 5	Appreciate the frequency domain techniques

k. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

l. List of Experiments:

Sr. NO.	List of Experiments
1	To Verify Loop Analysis and Nodal Analysis using KVL and KCL
2	To verify superposition theorem
3	To verify Thevenin's theorem
4	To verify maximum power transfer theorem
5	To verify reciprocity theorem
6	To measure and calculate RC and RL time constant for a given RC circuit
7	To measure and analyze step response of for a given series RLC circuit
8	To measure and calculate Z-parameters for a given two-port system
9	To measure and calculate Y-parameters for a given two-port system
10	To Design Passive Low Pass filter and verify the Frequency Response.
11	To Design Passive High Pass filter and verify the Frequency Response.
12	To Design Passive Band Pass filter and verify the Frequency Response.

a. **Course Name:** Complex Variables and PDE
b. **Course Code:** 303191201
c. **Prerequisite:** Geometry, Trigonometry, Calculus and ODE.
d. **Rationale:** This subject is a powerful tool for solving a wide array of applied problems.
e. **Course Learning Objective:**

CLOBJ 1	Understand complex numbers in polar form, powers, and roots. Apply complex variable differentiation principles, including Cauchy-Riemann equations.
CLOBJ 2	Master contour integrals and apply the Cauchy-Goursat theorem. Utilize Cauchy Integral formula, Liouville's theorem, and Maximum-Modulus theorem.
CLOBJ 3	Express functions through power series, including Taylor and Maclaurin Series. Analyze zeros, singularities, and residues using the Cauchy Residue theorem.
CLOBJ 4	Solve first-order linear and nonlinear PDEs using Charpit's Method.
CLOBJ 5	Solve linear partial differential equations using complementary function and particular integral method.
CLOBJ 6	Apply separation of variables to solve problems, classify second-order linear equations, and model solutions for Heat, Wave, and Laplace equations.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate proficient problem-solving skills, translating real-world problems into mathematical formulations and applying appropriate techniques for solutions.
CLO 2	Develop integrated analytical and critical thinking skills by engaging with a wide range of mathematical structures, proofs, and problem-solving techniques presented throughout the entire syllabus.
CLO 3	Understand and interpret mathematical solutions within the context of specific problems, recognizing the practical applications of discrete mathematics in diverse fields covered in all units.
CLO 4	Communicate mathematical concepts and solutions clearly and effectively, both in written and verbal forms, adapting communication styles to the diverse topics covered in each unit.
CLO 5	Present mathematical arguments and solutions in a unified, logical, and organized manner, emphasizing clarity, coherence, and precision across all units.
CLO 6	Lay a solid foundation for more advanced courses in mathematics and related disciplines.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
4	-	-	4	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content		Teaching Hours
1	**UNIT 1** **Complex Numbers**: Polar Form of Complex Numbers, Powers and Roots **Complex Variable – Differentiation**: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**26%**	**15**
2	**UNIT 2** **Complex Variable - Integration**: Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof) .	**18%**	**11**
3	**UNIT 3** Functions Given by Power Series: Taylor and Maclaurin Series, Laurent's series; Zeros of analytic functions, singularities, Residues, Cauchy Residue theorem (without proof), Residue Integration Method.	**16%**	**10**
4	**UNIT 4** **First Order Partial Differential Equations**: First order partial differential equations, solutions of first order linear and nonlinear PDEs, Charpit's Method .	**16%**	**10**

5	**UNIT 5** **Second and Higher Order Partial Differential Equations**: Solution to homogeneous and nonhomogeneous linear partial differential equations second and higher order by complementary function and particular integral method. Separation of variables method to simple problems in Cartesian coordinates, second-order linear equations and their classification, Initial and boundary conditions, Modeling and solution of the Heat, Wave and Laplace equations.	**24%**	**14**
	Total:	**100 %**	**60**

i. Text Book and Reference Book:

1. Elementary Applied Partial Differential equations with Fourier Series and Boundary Value Problem, By R. Haberman; Prentice Hall; 4th
2. Complex Variables and Applications (TextBook), By Churchil, R.V., Brown, J. and Verle, R.; McGraw-Hill Publ. Co., 1974.
3. Advanced Engineering Mathematics (TextBook), By Erwin Kreyszig; Willey India Education.
4. A First Course in Complex Analysis with Applications, By D. G. Zill, P. D. Shanahan; Jones and Bartlett Publishers.
5. Advanced Engineering Mathematics, By P. O'Neill; Cengage; 7th.
6. Elements of Partial Differential Equations, By I. Sneddon; McGraw Hill.

a. **Course Name:** Professional Communication Skills
b. **Course Code:** 303193203
c. **Prerequisite:** Knowledge of English language in practical life.
d. **Rationale:** Knowledge and application of English, Aptitude and Management Skills are crucial for better employability as well as professionalism
e. **Course Learning Objective:**

CLOBJ 1	Demonstrate the ability to communicate clearly and persuasively in oral presentations.
CLOBJ 2	Practice active listening techniques to enhance understanding in professional interactions.
CLOBJ 3	Write professional emails, memos, and reports with clarity and conciseness.
CLOBJ 4	Understand and practice time management strategies effectively.
CLOBJ 5	Demonstrate skills in resolving conflicts and negotiating effectively.
CLOBJ 6	Use digital communication tools and platforms effectively.

f. **Course Learning Outcomes:**

CLO 1	To develop advanced communication skills
CLO 2	To become more proficient in formal writing
CLO 3	To apply interpersonal communication skills to be more productive at the workplace
CLO 4	To identity, set and achieve the goals with the help of time management
CLO 5	To use with range of vocabulary to communicate effectively

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**2**	**-**	**2**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content		Teaching Hours
1	**Technical Writing: Email etiquette & Email writing Letter Writing (Types of Letters & Layout):** • Trains students on detailed email and letter writing • Students will be able to write formal letters following certain stipulated formats. They will learn different types of letters for different official purposes.	**10%**	**4**
2	**Interpersonal Communication at Workplace: Dynamics of communication** • To develop the confidence to handle a wide range of demanding situation more effectively at the workplace • To enable the students to analyse their own interpersonal communication style.	**10%**	**2**
3	**Debate: The three minute debate planner** • To enable the students to generate effective critical thinking into primary issues in the given topic. • Students will be able to resolve controversies and recognize strengths and weaknesses of arguments.	**10%**	**4**
4	**Goal setting & Tracking** To enable the students to define strategies or implementation steps to attain the identified goals and make progress every day.	**10%**	**2**
5	**Time Management & Task Planning (Case –study)** • To enable the students to identify their own time wasters and adopt strategies to reduce them. • To enable students to clarify and priorities their objective and goals by creating more planning time	**5%**	**2**
6	**Reading Comprehension: Intermediate level** To enable the students develop the knowledge, skills, and strategies they must possess to become proficient and independent readers	**10%**	**2**
7	**Listening Skills: Small everyday conversation & comprehension**	**10%**	**2**

	• Provides practice on understanding accents and day to day • Listening to English conversations in different contexts.		
8	**Information design and writing for print and online media: Blog Writing** To enable students to design information that is targeted to specific audiences in specific situations to meet defined objectives. • To create blogs and share their own knowledge and experience to the world.	**5%**	**2**
9	**Advanced vocabulary Building** • The students will expand their vocabulary so as to enhance their proficiency in reading and listening to academic texts, writing, and • The students will attain vocabulary to comprehend academic and social reading and listening • The students will develop adequate speaking skills to communicate effectively.	**10%**	**4**
10	**Picture Perception** To prepare the students for a test for basic intelligence and IQ, generally done on the first day of SSB (Sa shastra Seema Bal is one of India's Central Armed Police Forces)	**5%**	**2**
11	**Appreciation, Apology and Acknowledgement letters** • To enable the students to maintain productive business relationships through different types of letters. • To enable the students to express their feelings without speaking out loud.	**10%**	**2**
12	**The Art of Negotiation** • To enable the students to reach an agreement for mutual benefits through negotiation. • To enable the students to learn a process by which compromise or agreement is reached while avoiding argument and dispute	**5%**	**2**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Business Correspondence and Report Writing, By SHARMA, R. AND MOHAN, K.
2. Communication Skills 2011, By Kumar S and Lata P; Oxford University Press
3. Practical English Usage, By MICHAEL SWAN.
4. A Remedial English Grammar for Foreign Student, By F.T. WOOD.
5. On Writing Well, By William Zinsser; Harper Paperbacks,2006; 30th anniversary edition.

SEMESTER 4

a. **Course Name:** Biomaterial and Implants
b. **Course Code:** 303111251
c. **Prerequisite:** Basic knowledge of human anatomy and physiology is must.
d. **Rationale:** To understand the basic types of materials used in human body, to understand the importance of material selection in the implants the course contents will enable the students to study the effects of implants on human body required for Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Understand the bio-materials and its mechanical properties.
CLOBJ 2	Compare and classify the various metallic and ceramic material used for manufacturing of the implants
CLOBJ 3	Analyze the method for testing and evaluating its biocompatibility.
CLOBJ 4	Discuss three phase-balanced circuits.
CLOBJ 5	Understands the basic properties of different biomaterials used and biological substitutes.
CLOBJ 6	Acquire knowledge about electrical device installations

f. **Course Learning Outcomes:**

CLO 1	Give Classification of bio-materials and its mechanical properties.
CLO 2	Compare and classify the various metallic and ceramic material used for manufacturing of the implants
CLO 3	Understand the role for testing and evaluating biocompatibility.
CLO 4	Examine the properties of different biomaterials.
CLO 5	Understanding the basic properties of different biomaterials used and biological substitutes.
CLO 6	Acquire knowledge about electrical device installations

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	

3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction Of Biomaterial And Types** Definition and Classification of Bio-materials, Mechanical Properties, Viscoelasticity, Wound Healing Process, Body response to Implants, Types of Biomaterials: Metals, Ceramics and Polymers, Introduction of composite material.	**15%**	**7**
2	**Metals And Ceramics** Stainless steel, Cobalt-chromium based alloys, Titanium and titanium alloys, Nitinol: Shape memory effect. Dental Metals: Gold, Nickel. Corrosion of metals. Ceramics-types of ceramics: (i) Alumni as a Bioinert ceramics (ii) Bioglass as a Bioactive Ceramics and (iii) Calcium Phosphate as a Bioresorbable ceramics. Carbons: Different types of carbons.	**20%**	**9**
3	**Polymers** Polymerization: Types of Polymerization process, polymer chain, Polymers in biomedical use, types of polymer: Polyethylene, polypropylene, Per-fluorinated polymers, Acrylic polymers, Polyamides and Poly Methyl Methacrylate (PMMA), Silicon rubber, Prosthodontic polymers.	**10%**	**4**
4	**Cardiac And Ophthalmic Implants:** Vascular grafts, heart valves, cardiac assisting devices, stent, implantable pacemaker, Contact lens: soft and hard lenses, Disposable lenses, Intraocular lenses (IOLs), Viscoelastic solutions, Vitreous Implants, Eye shields, Drainage tubes in Glaucoma, Manufacturing process of cardiac and ophthalmic implant.	**15%**	**7**
5	**Orthopaedic And Dental Implants** Temporary fixation devices, Fracture healing, Repair of the ligaments, Joint Replacements; Total Hip replacement, Total Knee replacement Dental Implant	**25%**	**11**

	modalities: Dentures, types of Dental Implants End osseous, Subperiosteal, Trans osseous Implants. Filling materials, Restoration and Impression materials used in Dental Implants, Manufacturing process of orthopaedic and dental implant.		
6	**Biocompatibility And Sterilization** Methods for testing and evaluating biocompatibility: In Vivo and In Vitro testing, Hemocompatibility, Osteocompatibility, Tissue response to external materials, Biodegradable materials and their applications. Sterilization Process: ETO, Gamma radiation, autoclave. Effects of sterilization.	**15%**	**7**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Biomaterials Second Edition, Narosa Publishing House, 2005., By Sujata V. Bhatt
2. Biomaterials - Principles and Applications – CRC Press, 2003, By JoonB.Park Joseph D. Bronzino
3. Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, and Jack E. Lemons.
4. "Fundamentals of Biomaterials: An Introduction" by Qizhi Chen.
5. "Implantable Neural Prostheses 1: Devices and Applications" edited by David Zhou.

a. **Course Name:** Biomaterial and Implants Lab
b. **Course Code:** 303111252
c. **Prerequisite:** Basic knowledge of human anatomy and physiology is must.
d. **Rationale:** To understand the basic types of materials used in human body, to understand the importance of material selection in the implants the course contents will enable the students to study the effects of implants on human body required for Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the different Biomaterials.
CLOBJ 2	Solve problems related to various metallic and ceramic material used for manufacturing of the implants.
CLOBJ 3	Acquire knowledge of the Methods for testing and evaluating biocompatibility.
CLOBJ 4	Understand different properties of different biomaterials used and biological substitutes.

f. **Course Learning Outcomes:**

CLO 1	Identify the different Biomaterials.
CLO 2	Interpreting of various metallic and ceramic material used for manufacturing of the implants.
CLO 3	Illustrate the Methods for testing and evaluating biocompatibility.
CLO 4	Awareness of properties of different biomaterials used and biological substitutes.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Name of Experiments
1	To Study about Introduction of Biomaterials.
2	Identify various metals and alloys used in biomedical field.
3	Identify various ceramics used in biomedical field.
4	Identify various polymers used in biomedical field.
5	To Study about different dental implants.
6	To Study about cardiac valve implants.
7	To Study about cardiac pacemaker implantation
8	To Study about different Intra ocular implants.
9	To study about Total Hip Replacement.
10	To study about Total Knee Replacement.

a. **Course Name:** Microcontrollers and Interfacing
b. **Course Code:** 303113257
c. **Prerequisite:** Basic knowledge of Digital Electronics.
d. **Rationale:** The purpose of this course is to teach students the fundamentals of microcontroller because microcontrollers are being excessively used in the field of automation in every field. The students studying the subject are supposed to learn the architecture and programming of typical microcontroller. Students will be taught the basic use of an assembly as well as embedded C programming environment to control peripheral devices. Students will also understand the interfacing of various peripheral elements with microcontroller to design an automated system.
e. **Course Learning Objective:**

CLOBJ 1	Understand the architecture and functioning of microcontrollers, including their memory, I/O ports, and instruction set.
CLOBJ 2	Acquire proficiency in programming microcontrollers using assembly language and high-level languages for embedded systems.
CLOBJ 3	Design and implement interfaces between microcontrollers and external devices, sensors, and actuators for practical applications
CLOBJ 4	Apply microcontroller programming skills to develop real-time control systems for monitoring and regulating external processes.
CLOBJ 5	Investigate and apply communication protocols, such as UART and SPI, for data exchange between microcontrollers and external devices.
CLOBJ 6	Develop skills to troubleshoot and debug microcontroller-based systems, ensuring efficient and reliable operation in various applications.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of microcontroller architecture and proficiently program in assembly language and high-level languages for embedded systems.
CLO 2	Design and implement effective interfaces between microcontrollers and external devices, sensors, and actuators for diverse applications.
CLO 3	Apply microcontroller programming skills to develop real-time control systems, showcasing the ability to monitor and regulate external processes.
CLO 4	Investigate, select, and apply communication protocols, such as UART and SPI, for efficient data exchange between microcontrollers and external devices.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
3	-	-	3	20	20	-	60	-	100

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to 8051 Microcontroller:** Microprocessor Vs. Microcontroller, 8051 Architecture Registers, Microcontrollers and embedded processors, Overview of 8051 family Architecture of 8051, 8051 Memory organization, Registers, Special Function Registers (SFRs), Program Status Word (PSW), Program counter & ROM space in 8051.	10%	5
2	**8051 Instruction Set:** Addressing Modes, Data Transfer Instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.	15%	7
3	**8051 Stack, I/O Port Interfacing and Programming:** 8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.	20%	7
4	**8051 Timers and Serial Port:** 8051 Timers and Counters-Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication Basics of Serial Data Communication, RS232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.	15%	10

5	**8051 Interrupts and Interfacing Applications:** 8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C Programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing with 8051- LCD system – 4x4 keyboard – ADC and DAC – Stepper motor – DC motor – Water Level Indicator – Temperature control and their 8051 Assembly language interfacing programming.	**40%**	**16**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. "8051 Microcontroller & Embedded system using assembly & C" by Muhmmad Mazidi.
2. "8051 microcontroller & Embedded system using assembly & C" by K J Ayala.
3. "Programming and Customizing the 8051 Microcontroller" by Myke Predko."The 8051 Microcontrollers, Architecture and programming and Applications" by K.Uma Rao, Andhe Pallavi.

a. **Course Name:** Microcontrollers and Interfacing Lab
b. **Course Code:** 303113258
c. **Prerequisite:** Basic knowledge of Digital Electronics.
d. **Rationale:** The purpose of this course is to teach students the fundamentals of microcontroller because microcontrollers are being excessively used in the field of automation in every field. The students studying the subject are supposed to learn the architecture and programming of typical microcontroller. Students will be taught the basic use of an assembly as well as embedded C programming environment to control peripheral devices. Students will also understand the interfacing of various peripheral elements with microcontroller to design an automated system.
e. **Course Learning Objective:**

CLOBJ 1	Understand the architecture and functioning of microcontrollers, including their memory, I/O ports, and instruction set.
CLOBJ 2	Acquire proficiency in programming microcontrollers using assembly language and high-level languages for embedded systems.
CLOBJ 3	Design and implement interfaces between microcontrollers and external devices, sensors, and actuators for practical applications
CLOBJ 4	Apply microcontroller programming skills to develop real-time control systems for monitoring and regulating external processes.
CLOBJ 5	Investigate and apply communication protocols, such as UART and SPI, for data exchange between microcontrollers and external devices.
CLOBJ 6	Develop skills to troubleshoot and debug microcontroller-based systems, ensuring efficient and reliable operation in various applications.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of microcontroller architecture and proficiently program in assembly language and high-level languages for embedded systems.
CLO 2	Design and implement effective interfaces between microcontrollers and external devices, sensors, and actuators for diverse applications.
CLO 3	Apply microcontroller programming skills to develop real-time control systems, showcasing the ability to monitor and regulate external processes.
CLO 4	Investigate, select, and apply communication protocols, such as UART and SPI, for efficient data exchange between microcontrollers and external devices.

g. **Teaching & Examination Scheme:**

Teaching Scheme				Evaluation Scheme					
L	T	P	C	Internal Evaluation			ESE		Total
				MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. List of Experiments:

Sr. NO.	Experiment List
1	Programming 8051 Micro controller using ASM and C, and implementation in flash 8051 microcontroller.
2	Programming with Arithmetic logic instructions [Assembly].
3	Program using constructs (Sorting an array) [Assembly].
4	Programming using Ports [Assembly and C].
5	Delay generation using Timer [Assembly and C].
6	Programming Interrupts [Assembly and C].
7	Implementation of standard UART communication (using hyper terminal) [Assembly and C].
8	Interfacing LCD Display. [Assembly and C].
9	Interfacing with Keypad [Assembly and C].
10	Programming ADC/DAC [Assembly and C].
11	Interfacing with stepper motor. [Assembly and C].
12	Pulse Width Modulation. [Assembly and C] Programming ARM Micro controller using ASM and C using simulator
13	Programming with Arithmetic logic instructions [Assembly].

a. **Course Name:** Biosensor and Transducers
b. **Course Code:** 303111253
c. **Prerequisite:** Basics Principles of Physics, Human Anatomy & Physiology, Bio-Potentials.
d. **Rationale:** Due to growing need in the area of Health care sector and Biomedical instruments Study of Bio Transducers as well as sensors will give insight to the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with importance of the sensors and transducers for medical applications.
CLOBJ 2	Solve problems related to the importance of the sensors and transducers for medical applications.
CLOBJ 3	Acquire knowledge of the importance of the sensors and transducers for medical applications.
CLOBJ 4	Understand measuring temperature, pressure, force, flow and other important parameters in determining the circulation-, breathing- and excretory functions.
CLOBJ 5	Demonstrate engineering approach to develop biomedical measurement systems.

f. **Course Learning Outcomes:**

CLO 1	Interpret the importance of the sensors and transducers for medical applications.
CLO 2	Interpret the importance of the sensors and transducers for medical applications.
CLO 3	Present different methods for measuring temperature, pressure, force, flow and other important parameters in determining the circulation-, breathing- and excretory functions.
CLO 4	Describe how different measurement techniques are used to determine the vital parameters of diagnostic importance.
CLO 5	Provide an engineering approach to develop biomedical measurement systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	

3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Basics of measurement physiological parameters** Introduction, Basic Instrumentation System, Measurement, Measurand and Transducer, Accuracy, Precision and errors, Signal and Noise with its Ratio, Transducers Classification, Transducer Constituent Parts, Electrical Design Characteristics, Transduction Principles, Performance Characteristics.	**15%**	**7**
2	**Piezo-Electric Force and Ultrasonic Transducers** Introduction, Piezo-electric Phenomena and Materials, Expression of Piezoelectric Voltage, Piezoelectric Pressure Transducer, Advantage, Piezoelectric Ultrasonic Transducers: Introduction, Construction and design	**10%**	**5**
3	**Temperature Transducers** Introduction, basic Concepts, Construction and working principle of RTD, Thermistor and Thermocouple, Non-contact Temperature measurement, Principle of Infrared Radiation Thermometer, Non-contact Infrared Tympanic Thermometer Probe.	**15%**	**7**
4	**Displacement Transducers** Introduction, Displacement and Force Transducers, Theory of Resistance Strain Gauge, Types and Construction of Strain Gauge, Construction and working principle of LVDT, Basic Principle of RVDT, Potentiometric Displacement Transducer.	**10%**	**5**
5	**Biological Pressure and Flow Transducers: Pressure Transducers** **Pressure Transducers**: Introduction, Physiological Pressures, Blood Pressure measurement methods, Measurement of Vacuum. **Flow Transducers**: Introduction, Electromagnetic Blood flow probe, Ultrasonic Blood flow Transducers,	**20%**	**8**

	Respiratory Gas Flow Transducers, Breathing Analyzer.		
6	**Chemical and Enzyme Based Biosensors** Introduction, Blood Gas Sensors, Blood pH-sensor, pCO2 Sensor, Microbial Biosensors, Enzyme based Biosensor	**10%**	**5**
7	**Bio-potential Electrodes** Introduction, Electrode Theory, Polarizable and Nonpolarizable electrode, Types of Biopotential Electrodes, ECG Electrode, EMG Electrode, EEG Electrode, Glucose strip, Pregnancy Strip.	**15%**	**6**
8	**Basics of SMART and MEMS Sensors**	**5%**	**2**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Biomedical Transducers (TextBook), By H.T.Kasipara.
2. Transducers for Biomedical measurements, By Richard S.C. Cobbold.
3. Biomedical Sensors- Fundamentals and applications, By Harry.N. Norton.
4. Biomedical Instrumentation and Measurements (TextBook), By Leslie Cromwell.
5. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiya Tamora, and P. Ake Oberg.

a. **Course Name:** Biosensor and Transducers Lab
b. **Course Code:** 303111254
c. **Prerequisite:** Basics Principles of Physics, Human Anatomy & Physiology, Bio-Potentials.
d. **Rationale:** Due to growing need in the area of Health care sector and Biomedical instruments Study of Bio Transducers as well as sensors will give insight to the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Electronics concepts for a range of problems in medical applications.
CLOBJ 2	Solve problems related to applications of various sensors and transducers available for physiological and cellular measurements.
CLOBJ 3	Acquire knowledge of the critically reviewing the literature in the application area and apply knowledge gained from the course to analyse simple bio-sensing and transduction problems.
CLOBJ 4	Understand biomedical instrumentation systems.

f. **Course Learning Outcomes:**

CLO 1	Apply Electronics concepts for a range of problems in medical applications.
CLO 2	Interpret the applications of various sensors and transducers available for physiological and cellular measurements.
CLO 3	Capable of critically reviewing the literature in the application area and apply knowledge gained from the course to analyse simple bio-sensing and transduction problems.
CLO 4	Design biomedical instrumentation systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Sr. NO.	Experiment List
1	To study and perform resistive transducers.
2	To study and perform capacitive and inductive transducers.
3	To study and perform displacement transducers.
4	To study and understand the working of proximity transducers.
5	To study and perform resistance strain gauge
6	To study and understand the industrial weighing system.
7	To study and perform hall effect sensors.
8	To study and understand the tachometer.
9	To study and perform ph measurement.
10	To study and understand working of viscosity measurement
11	To study and understand working of turbidity measurement
12	To study and understand chromatography.
13	To study and understand infrared analysers.
14	To study and understand acceleration measurement.
15	To study and perform conductivity measurement.

a. **Course Name:** Electronic Devices & Circuits
b. **Course Code:** 303111255
c. **Prerequisite:** Basic knowledge of electronic components and laws such as KCL, KVL, etc.
d. **Rationale:** This course provides a platform for students to understand working of active devices such as Diode, BJT, and MOSFET, JFET and circuits and systems like amplifier, oscillator and feedback circuits. Students are also taught to analyse and design circuits using these active devices. This is one of the foundation courses which are required for students to understand working of complex electronic circuits and systems.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with implement the principles of semiconductors devices.
CLOBJ 2	Solve problems related to reproduce basic principle of diode and understand its second and third approximation.
CLOBJ 3	Acquire knowledge of the study and understand the bipolar junction transistor.
CLOBJ 4	Understand Demonstrate the knowledge the various biasing methods for transistor.

f. **Course Learning Outcomes:**

CLO 1	Implement the principles of semiconductors devices.
CLO 2	Reproduce basic principle of diode and understand its second and third approximation.
CLO 3	Study and understand the bipolar junction transistor.
CLO 4	Demonstrate the knowledge the various biasing methods for transistor.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Special Purpose Diode** Zener Diode, The Loaded Zener Regulator, Second Approximation of a Zener Diode, Zener Drop Out Point, Reading a Data Sheet, Load Lines, Optoelectronics Devices, The Schottky Diode, The Varactor Diode.	9%	4
2	**Bipolar Junction Transistor** The Unbiased Transistor, The Biased Transistor, Transistor Currents, The CE Connection, The base Curve, Collector Curves, Transistor Approximations, Reading Data Sheets.	10%	5
3	**Transistor Fundamentals** Variation in Current gain, The Load Line, The Operating Point, Recognizing saturation, The Transistor Switch, Emitter Bias, LED Drivers, The effect of small Changes.	10%	4
4	**Transistor Biasing** Voltage Divider Bias, Accurate Voltage Divider Bias (VDB) Analysis, VDB Load line and Q-Point, Two Supply Emitter Bias, Other Types of Bias, PNP Transistors.	12%	6
5	**AC Models** Base-Biased Amplifier, Emitter-Biased Amplifier, Small Signal operation, AC Beta, AC Resistance of the Emitter Diode, Two Transistor models, Analyzing an Amplifier, AC Quantities on the data sheet.	9%	4
6	**Voltage amplifier** Voltage amplifier: Voltage gain, The loading effect of input impedance, multistage amplifiers, cascade amplifier, two-stage feedback, Frequency Effects: Frequency Response of an Amplifier, Decibel Power gain, Decibel voltage gain, Impedance matching, The Miller Effect.	12%	5
7	**CC and CB Amplifier**	9%	4

	CC Amplifier, Output Impedance, Cascading CE and CC, Darlington Connections, Voltage Regulation, The Common Base Amplifier.		
8	**Power Amplifiers** Amplifier Terms, Two Load Lines, Class-A Operation, Class-B Operation, Class-B Push Pull Emitter Follower, Biasing Class B/AB Amplifiers, Class B/AB Driver, Class-C Operation.	**10%**	**4**
9	**JFETs AND MOSFETs** Basic Ideas, Drain Curves, Trans-conductance Curves, Biasing in Ohmic Region, Biasing in Active Region, Transconductance, JFET Amplifiers, JFET Analog Switch, Other JFET Applications, The Depletion Mode MOSFET,DMOSFET Curves, Depletion Mode MOSFET Amplifier, The Enhancement Mode MOSFET.	**10%**	**5**
10	**Introduction to feedback** The Basic concepts of Feedback, Effect Of Negative Feedback, Types Of Negative Feedback Connections, Method Of Identifying Feedback Topology and Feedback Factor , Stability Of Feedback Amplifier.	**9%**	**4**
	Total:	**100 %**	**45**

h. Text Book and Reference Book:

1. Electronic Principles, By Albert Paul Malvino; TMH
2. Electronics Device and circuits, By S Salivahanan and N Suresh Kumar; McGraw Hill Publication; Second
3. Electronics Device and Circuits, By Jacob Milman, Christos C. Halkias, Chetan D. Parikh; Tata Mcgraw Hill Publication
4. Basic Electronics devices and Circuits, By Mahesh B Patil; PHI Learning PVT. Ltd..
5. Electronic Devices & Circuit Theory, By Boylestad; PHI.

a. **Course Name:** Electronic Devices & Circuits Lab
b. **Course Code:** 303111256
c. **Prerequisite:** Basic knowledge of electronic components and laws such as KCL, KVL, etc.
d. **Rationale:** : This course provides a platform for students to understand working of active devices such as Diode, BJT, and MOSFET, JFET and circuits and systems like amplifier, oscillator and feedback circuits. Students are also taught to analyze and design circuits using these active devices. This is one of the foundation courses which are required for students to understand working of complex electronic circuits and systems
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the principles of semiconductors devices.
CLOBJ 2	Solve problems related to basic principle of diode and interpret its second and third approximation.
CLOBJ 3	Acquire knowledge of the rectifier circuits, clippers and clamper circuits using diodes.
CLOBJ 4	Understand the various special purpose diodes such as zener diode, schottky diode, varactor diode and photo diode.
CLOBJ 5	Demonstrate an Interpret the various biasing methods for transistor.

f. **Course Learning Outcomes:**

CLO 1	Apply the principles of semiconductors devices.
CLO 2	Apply basic principle of diode and interpret its second and third approximation.
CLO 3	Analyze the rectifier circuits, clippers and clamper circuits using diodes.
CLO 4	Analyze and study the various special purpose diodes such as zener diode, schottky diode, varactor diode and photo diode.
CLO 5	Study and Interpret the various biasing methods for transistor.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments

Sr. NO.	Experiment List
1	To Plot V-I characteristics of Zener Diode characteristics.
2	Optoelectronic devices: (a)To plot performance characteristics of LED. (b)To plot I-V Characteristics of Photodiode.
3	To obtain characteristics of a transistor as a switch circuit.
4	To Plot and Study input-output characteristics of common Emitter (CE) configuration of Transistors.
5	To Plot and Study input-output characteristics of common Base (CB) configuration of Transistor.
6	To study Voltage divider bias circuit: To set Q point for operation of transistor amplifier in linear region to observe the effect of change in base current on Q-operating point in voltage divider circuit.
7	To obtain frequency response of a single stage transistor amplifier.
8	To study Single Stage RC Coupled Amplifiers: Biasing, Voltage gain and observe frequency response of amplifiers also find out its cutoff frequency, bandwidth and mid band gain.
9	Determine the efficiency of the push pull power amplifier.
10	Build/test transformer coupled class-A Power amplifier. To study the effect of (a) voltage series feedback on two stage amplifiers (b) current series F/B on single stage CE amplifiers.
11	To test the performance of negative feedback amplifiers and compare gain, BW with amplifiers without feedback.
12	Introduction to simulation tools Multisim and Designing of hybrid two port networks using Multisim.
13	To plot characteristics of Schottky and Varactor diode in Multisim
14	Simulation of Different Transistor Biasing Techniques in Multisim Software. (a)Self Bias (b)Voltage Divider Bias (c)Emitter Resistor Bias.

a. **Course Name:** Signals and Systems for Biomedical
b. **Course Code:** 303111257
c. **Prerequisite:** Inclination to learn mathematics, basic knowledge of differential equations and difference equations, electrical circuits and networks.
d. **Rationale:** The course will provide strong foundation on signals and systems which will be useful for creating foundation of communication and biomedical signal processing. The students will learn basic continuous time and discrete time signals and systems. Student will understand application of various transforms for analysis of signals and systems both continuous time and discrete time for biomedical systems. Students will also explore to power and energy signals and spectrum.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to various types of systems, classify them, analyse them and understand their response behaviour.
CLOBJ 3	Acquire knowledge of signals and systems for observing effects of applying various properties and operations.
CLOBJ 4	Understand a strong foundation of communication and biomedical signal processing to be studied in the subsequent semester.

f. **Course Learning Outcomes:**

CLO 1	Understand electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLO 2	Illustrate about various types of systems, classify them, analyse them and understand their response behaviour.
CLO 3	Carry simulation on signals and systems for observing effects of applying various properties and operations.
CLO 4	Create a strong foundation of communication and biomedical signal processing to be studied in the subsequent semester.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Signal Processing** Signal, System, Analog signal processing, Digital signal processing, Digital system, Advantages of DSP over ASP, Applications of DSP.	15%	4
2	**Signals and Systems** Signal: Introduction, Classification of Signals, Characteristics of continuous and discrete time signal, Representation of discrete time signal, Standard test signals, Operating upon signals: Time-Shifting, Time-Scaling and Amplitude Scaling operations, Related Examples. System: Introduction, Classification of System and related examples, Symbols used in discrete time systems for block schematic representation.	20%	10
3	**Sampling, Aliasing and Reconstruction** A/D conversion process, Sampling theorem, Nyquist criteria, Examples related to sampling theorem, Aliasing: signal ambiguity in frequency domain, Anti-aliasing filter: Importance, Block-diagram of DSP system	15%	4
4	**Linear Time Invariant (LTI) System: Convolution & Correlation** Introduction of LTI System, Analysis of LTI System: Mathematical expression (Analytical), Graphical, Tabular and Multiplication method, Related examples to solve convolution sum, Properties of convolution sum. Concept of correlation, types: Autocorrelation and Cross correlation, Analysis of correlation: Mathematical expression and Tabular method, Related examples, Properties of Autocorrelation and Cross-correlation, Applications of correlation.	25%	15
5	**Z Transform** Introduction, Definition of Z-transform, Region of Convergence, Properties of Z-transform, Inversion of	25%	12

	Z-transform, Evaluation of system frequency response, Applications of Z-transform..		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Signals and Linear Systems, By Gabel R.A. and Robert R.A; John Wiley and Sons, New York
2. Signals and System, By Oppenheim, Wilskey and Nawab; Prentice Hall India
3. Systems and Signal Analysis, By C.T.Chen; Oxford University Press, India.
4. Signals and Systems, By Simon Haykin and Bary Van Veen; Wiley.
5. Digital Signal Processing, By Salivahanan S. , Vallavaraj A., Gnanapriya C.; Tata McGraw-Hill, New Delhi, 2008; 2008

a. **Course Name:** Signals and Systems for Biomedical Lab
b. **Course Code:** 303111258
c. **Prerequisite:** Inclination to learn mathematics, basic knowledge of differential equations and difference equations, electrical circuits and networks.
d. **Rationale:**The course will provide strong foundation on signals and systems which will be useful for creating foundation of communication and biomedical signal processing. The students will learn basic continuous time and discrete time signals and systems. Student will understand application of various transforms for analysis of signals and systems both continuous time and discrete time for biomedical systems. Students will also explore to power and energy signals and spectrum.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLOBJ 2	Solve problems related to various types of systems, classify them, analyze them and understand their response behavior.
CLOBJ 3	Acquire knowledge of signals and systems for observing effects of applying various properties and operations.
CLOBJ 4	Understand a strong foundation of communication and biomedical signal processing to be studied in the subsequent semester.

f. **Course Learning Outcomes:**

CLO 1	Understand electrical current, potential difference, power and energy, sources of electrical energy and elements of electrical circuit.
CLO 2	Illustrate about various types of systems, classify them, analyze them and understand their response behavior.
CLO 3	Carry simulation on signals and systems for observing effects of applying various properties and operations.
CLO 4	Create a strong foundation of communication and biomedical signal processing to be studied in the subsequent semester.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	

-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of experiments:

Sr. NO.	Experiment List
1	Introduction to MATLAB as a tool for signal processing.
2	Identify the nature of signals with their amplitude and phase.
3	To Generate the Following Waveforms Using MATLAB In Continuous And Discrete Time. 1) Sine 2) Cosine 3) Square 4) Saw-Tooth Wave.
4	To Generate the Following Waveforms Using MATLAB In Continuous and Discrete Time. 1) Unit Step 2) Unit Impulse 3) Unit Ramp 4) Exponential
5	Write a program in MATLAB to study the basic operations on the Discrete–time signals.
6	Implementation of Nyquist Criteria Using Sampling Theorem.
7	To Perform Linear Convolution of Two Discrete Time Sequences.
8	To Write A MATLAB Program to Plot Magnitude Response and Phase Response of Digital Butterworth Low Pass & High Pass Filter.
9	To Write A MATLAB Program to Plot Magnitude Response and Phase Response Of Digital Butterworth Band Pass & Band Stop Filter.
10	To Perform Z-Transform from Poles and zeros of a given system.

a. **Course Name** Professional Grooming & Personality Development
b. **Course Code:** 303193252
c. **Prerequisite:** Knowledge of communication theories and basic management skills are essential.
d. **Rationale:** Acquiring soft skills, life skills and aptitude skills are crucial for organisational communication as well as employability respectively.
e. **Course Learning Objective:**

CLOBJ 1	Articulate verbal communication skills.
CLOBJ 2	Enhance non-verbal communication, including body language and facial expressions.
CLOBJ 3	Understand the importance of personal grooming and hygiene in a professional setting.
CLOBJ 4	Apply proper business etiquette in various professional settings.
CLOBJ 5	Develop emotional intelligence to understand and manage one's own emotions and those of others.
CLOBJ 6	Cultivate leadership qualities and skills to inspire and influence others positively.

f. **Course Learning Outcomes:**

CLO 1	Identity and develop soft skills required for personal and professional growth.
CLO 2	Develop professional etiquette & desired behaviour at the workplace.
CLO 3	Speak and participate effectively in oral organizational communication.
CLO 4	Improve comprehensive skills for reading.
CLO 5	Know how to be assertive in professional environment.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
0	**1**	**0**	**1**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content		Teaching Hours
1	**Self-Development and Assessment**: Various self-assessments for personal and professional development skills that are relevant to career development: • Change, Grow, Persist, Prioritize, Read, Learn, Listen, Record, Remember, Guess, Think, Communicate, Relate, and Dream	25%	4
2	**Corporate Etiquette**: Tips and guide to develop personality and gain various etiquettes manners, case studies and activities. • Telephone etiquette • Etiquette for foreign business trips • Etiquette for small talks • Respecting privacy • Learning to say 'No'	25%	4
3	**Public Speaking**: It's process of communicating information to an audience and is helpful in career advancement. Effective Public speaking skills includes: • Choosing appropriate pattern • Selecting appropriate method • Art of persuasion • Making speeches effective • Delivering different types of speeches	20%	4
4	**Reading Skills Activity & Reading Comprehension**: Aims to improve students' Comprehensive Skills in English Language by getting them involved in reading activity and providing practice for reading comprehension.	15%	2
5	**Listening Skills- Inquiry Based Listening Questions**: Aims to improve students' listening skills in English Language providing them practice of various types of inquiry based listening tracks. Students will listen and will be able to find out details from the conversations.	15%	1
	Total:	**100 %**	**15**

i. Reference Books:

1. Business Correspondence and Report Writing SHARMA, R. ANAND MOHAN, K
2. Kumar S and Lata P; New Delhi Oxford University Press
3. Practical English Usage
4. MICHAEL SWAN
5. A Remedial English Grammar for Foreign Student

6. F.T. WOOD
7. On Writing Well
8. William Zinsser; Harper Paperbacks,2006; 30th anniversary edition
9. Oxford Practice Grammar,
10. John Eastwood; Oxford University Press

SEMESTER 5

a. **Course Name:** Cyber Security
b. **Course Code:** 303105304
c. **Prerequisite:** Knowledge of CSS and fundamental C++
d. **Rationale:** For cybersecurity purposes
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with understanding, appreciation, employ, design and implement appropriate security technologies and policies to protect computers and digital information
CLOBJ 2	Solve problems related to Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios.
CLOBJ 3	Acquire knowledge of the trade-offs and compromises that are made in the design and development process of Information Systems.
CLOBJ 4	Understand standards and cyber laws to enhance information security in the development process and infrastructure protection

f. **Course Learning Outcomes:**

CLO 1	Understand, appreciate, employ, design and implement appropriate security technologies and policies to protect computers and digital information
CLO 2	Identify & Evaluate Information Security threats and vulnerabilities in Information Systems and apply security measures to real time scenarios.
CLO 3	Identify common trade-offs and compromises that are made in the design and development process of Information Systems.
CLO 4	Demonstrate the use of standards and cyber laws to enhance information security in the development process and infrastructure protection

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**unit-1(Information Security)** Introduction to information systems, Types of information Systems, Development of Information Systems, Introduction to Information Security, Need for Information Security, Threats to Information Systems, Information Assurance, Cyber Security and Security Risk Analysis.	15%	5
2	**unit-2(Systems Vulnerability Scanning)** Overview of vulnerability scanning, Open Port/Service Identification, Banner/ Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples. Networks Vulnerability Scanning - Netcat, Understanding Port and Services tools, Network Reconnaissance–Nmap. Network Sniffers and Injection tools–Wireshark.	25%	7
3	**unit-3(Network Defense tools)** Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation(NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection System .	20%	6
4	**unit-4(Introduction to Cyber Crime and law)** Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics ,Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian ITACT 2000.	20%	6
5	**unit-5(Introduction to Cyber Crime Investigation)**	20%	6

	Firewalls and Packet Filters, password Cracking, Key loggers and Spyware, Virus And Warms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks.		
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Cryptography and Network Security (Textbook), By William Stallings
2. Anti-Hacker Tool Kit, By Mike Shema; McGraw-Hill
3. Cryptography and Network Security (Textbook), by V.K. Jain; Khanna Publishing House.
4. Cyber Security understanding Cyber Crimes, Computer forensics and Legal Perspectives, By Nina Godbole and Sunit Belapure; WILEY.
5. Information and Cyber Security (Textbook), By Gupta Sarika; Khanna Publishing House
6. Cryptography and Network Security (Textbook), By Atul Kahate; TMH
7. Cryptography and Information Security (Textbook), By V.K. Pachghare; PHI Learning

a. **Course Name:** Fundamentals of Communication Engineering
b. **Course Code:** 303107346
c. **Prerequisite:** Fourier series, Fourier Transforms, Basic Electronics.
d. **Rationale:** This course explores the fundamentals of electronic communication systems. The course has two primary focuses: Understanding electronic communications systems in analog form from deterministic approach they can have a broad understanding of satellite, optical, cellular, mobile, and wireless.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with interpret the basics of communication systems.
CLOBJ 2	Solve problems related to various types of modulations.
CLOBJ 3	Acquire knowledge and should be able to use these communication modules in implementation.
CLOBJ 4	Understand basic understanding of various wireless and cellular, mobile communication.
CLOBJ 5	Demonstrate a clear understanding the basics of Satellite Communication & Optical Communication.

f. **Course Learning Outcomes:**

CLO 1	Interpret the basics of communication systems.
CLO 2	Work on various types of modulations.
CLO 3	Should be able to use these communication modules in implementation.
CLO 4	Will have a basic understanding of various wireless and cellular, mobile communication.
CLO 5	Reproduce the basics of Satellite Communication & Optical Communication

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction:** Need for Modulation, Frequency translation, Electromagnetic spectrum, Gain, Attenuation and decibels.	8%	3
2	**Noise** Introduction, thermal noise, Shot noise, Partition Noise, Low frequency noise, Burst noise, a noise, High frequency noise, BJT and FET noises, Equivalent input noise generators, Signal to noise ratio (SNR), SNR of Tandem connection, Noise factor and noise figure, Amplifier input noise in terms of noise figure, Noise factor in cascaded amplifiers, Noise factor and equivalent input noise generators, noise factor of a lossy network, Noise temperature, Measurement of noise temperature and noise factor, narrow-band band pass noise. Behavior of Analog systems in presence of Noise.	20%	5
3	**Simple description on Modulation:** Analog Modulation-AM, FM, Pulse Modulation-PAM, PWM, PCM, Digital Modulation Techniques-ASK, FSK, PSK, QPSK modulation and demodulation schemes.	22%	6
4	**Networking and Local Area Networks** Network fundamentals, LAN hardware, Ethernet LANs, Token Ring LAN.	14%	4
5	**Satellite Communication & Optical Communication** **Satellite Communication**: Satellite Orbits, satellite communication systems, satellite subsystems, Ground Stations Satellite Applications, Global Positioning systems. **Optical Communication**: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.	22%	6
6	**Cellular and Mobile Communications & Wireless Technologies:**	14%	6

	Cellular and Mobile Communications: Cellular telephone systems, AMPS, GSM, CDMA,and WCDMA. **Wireless Technologies**: Wireless LAN, PANs and Bluetooth, WiFi , Zig Bee and Mesh Wireless networks, Wimax and MANs, Infrared wireless, RFID communication, UWB, LTE , 5G.		
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Electronic Communications, By Dennis Roddy & John Coolen; PHI
2. Electronic Communications, By Kennedy; McGraw Hill Publication
3. Electronic Communications Systems, By Wayne Tomasi; Pearson education India.
4. Electronic Communication Systems, By Roy Blake; Cengage learning.
5. Communication Systems, By Simon Haykins; Wiley India
6. Modern Digital and Analog Communication Systems, By B. P. Lathi, Zhi Ding; Oxford University Press; 4th Edition
7. Wireless Communications Principles and Practice, By T.S.Rappaport; PHI; 2nd edition, 2002
8. Introduction to data communications and networking, By Wayne Tomasi; Pearson Education
9. Theory and Problem Of Electronic Communication, By Lloyd Temes and Mitchel E.Schulz; McGraw Hill Publication.

a. **Course Name:** Internet of Things
b. **Course Code:** 303105305
c. **Prerequisite:** Basic Electronics.
d. **Rationale:** The explosive growth of the [3]Internet of Thingsis changing our world. IoT components are allowing people to innovate new designs and products at home. In this course students will learn the importance of IoT in society, the current components of typical IoT devices and trends for the future. This course will make students understand Hardware and software component of embedded systems. This course is also cover components of the networking and how to connect devices with internet
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the term "Internet of Things".
CLOBJ 2	Solve problems related to state the technological trends which have led to IoT.
CLOBJ 3	Acquire knowledge of the impact of IoT on society.
CLOBJ 4	Understand what an embedded system is in terms of its interface.
CLOBJ 5	Demonstrate a enumerate and describe the components of an embedded system
CLOBJ 6	Study the use of the interactions of embedded systems with the physical world.

f. **Course Learning Outcomes:**

CLO 1	Define the term "Internet of Things".
CLO 2	State the technological trends which have led to IoT.
CLO 3	Describe the impact of IoT on society.
CLO 4	Define what an embedded system is in terms of its interface.
CLO 5	Enumerate and describe the components of an embedded system.
CLO 6	Describe the interactions of embedded systems with the physical world.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content		Teaching Hours
1	**Basic Electronics** Microprocessor, Microcontroller, GPU, I/O devices, clock, memory, other peripherals: ADC, DAC, Sensors and Actuators, Introduction to operating Systems.	**20%**	**5**
2	**Internet of Things (IoT):** Introduction to IOT, Case Study of Refrigerator, IoT Devices, IoT Devices vs. Computers, Societal Benefits of IoT, Risks, Privacy, and Security.	**20%**	**5**
3	**IoT Hardware and Software:** Arduino Platform, Arduino IDE, Compiling Code, Arduino Shields, Arduino Basic Setup. Setting Up Your Environment, Variables, Basic C Operators, Conditionals, Loops, Functions, Global Variables	**35%**	**11**
4	**Networking and the Internet:** Need of Networking, Networking Components, Internet Structure, Protocols: UART and its Synchronization, Serial on Arduino, Reading from Serial	**25%**	**9**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Arduino Cookbook, By Michael Margolis; O'Really Publication
2. "Internet of Things (A Hands-on-Approach)", By Vijay Madisetti and Arshdeep Bahga,; VPT
3. "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", By Francis daCosta,; Apress Publications
4. Embedded systems Architecture, Programming and Design, By Rajkamal; TMH.
5. "IoT Applications for Healthcare" by Arvind Sathi.

a. **Course Name:** Renewable Energy Sources
b. **Course Code:** 303109346
c. **Prerequisite:** Basic knowledge of Renewable energy sources such as geothermal, wind, solar, ocean and bio-energy.
d. **Rationale:** This course develops fundamental understanding about the need for renewable energy sources and energy scenario of a country. Students will learn the concepts about renewable energy sources like solar energy, wind energy, energy from biomass, geothermal energy, energy from the ocean.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with different renewable energy sources: solar energy, wind energy, bio-energy, tidal energy, ocean energy,etc
CLOBJ 2	Solve problems related to different energy production methods: solar energy, wind energy, bio energy etc.
CLOBJ 3	Acquire knowledge of key aspects of renewable energy sources: solar energy, wind energy, bio-energy, tidal energy, geothermal energy etc
CLOBJ 4	Understand applications of solar energy, wind energy, bio-energy, tidal energy, ocean thermal energy, geothermal energy, etc.

f. **Course Learning Outcomes:**

CLO 1	List out different renewable energy sources: solar energy, wind energy, bio-energy, tidal energy, ocean energy etc.
CLO 2	Evaluate different energy production methods: solar energy, wind energy, bio energy etc.
CLO 3	Discuss the key aspects of renewable energy sources: solar energy, wind energy, bio-energy, tidal energy, geothermal energy etc
CLO 4	Describe various applications of solar energy, wind energy, bio-energy, tidal energy, ocean thermal energy, geothermal energy, etc.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction** Thermodynamic laws related to Energy and Power, Energy conversion and unit system. Brief history and need of renewable energy, Global and National scenarios, Prospects of renewable energy sources.	10%	3
2	**Solar Energy** Solar Radiation Geometry, Solar radiation - Outside the earth atmosphere and at earth surface, Instruments for measurement of solar radiation and sunshine, local solar time, derived solar angles, sunrise, sunset and day length. Non concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation and solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells & its applications.	35%	10
3	**Wind Energy** Introduction, power in wind, power coefficient, wind mills-types, design consideration, performance, site selection, advantages and disadvantages, applications, wind energy development in India.	17%	5
4	**Bio Energy** Introduction, types of biogas plants, biogas generation, factors affecting biogas generation, design consideration, advantages and disadvantages, site selection, applications, scope of biogas energy in India, biomass energy, energy plantation.	13%	4
5	**Ocean Energy** Introduction, OTEC principle, open cycle OTEC system, closed cycle, hybrid cycle, site selection, Energy from tides, estimation of tidal power, tidal power plants, single basin, double basin, site requirements, advantages and limitations, wave energy, wave energy conversion devices, advantages and disadvantages, small scale hydro power.	12%	4

6	**Geothermal Energy** Introduction, Vapor dominated system, Liquid dominated system, Binary Cycle, Hot Dry Rock resources, Magma Resources, Geothermal Energy in India.	**13%**	**4**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Renewable Energy Sources and Emerging Technologies, By D.P Kothari , K.C. Singal ,Rakesh Ranjan.; PHI Publication
2. Non-Conventional Resources, By G.S.Sawhney; PHI Publication
3. Non-Conventional Energy Sources, By G. D. Rai; khanna publishers; fifth, 2012.
4. Solar Energy: Principles of Thermal Collections and Storage, By S.P. Sukhatme; McGraw Hill Publishing Co.
5. "Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids" by Lawrence E. Jones.

a. **Course Name:** Biological Modelling and Simulation
b. **Course Code:** 303111301
c. **Prerequisite:** To make students understand basic concepts of modelling this will help them develop biological models and simulate physiological processes for better understanding.
d. **Rationale:** Study of Biomedical Modelling and Simulation will help the Biomedical Engineers to understand human anatomy and physiology.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with hardware and develop software for various biomedical systems.
CLOBJ 2	Solve problems related to basic understanding of physiology (from pre-requisites) to develop a more in-depth level of understanding that will enable engineering analysis of selected physiological systems.
CLOBJ 3	Acquire knowledge of the applying a high-level engineering tool for block diagram modeling (SIMULINK).
CLOBJ 4	Understand models of physiological systems to answer questions relevant to the design of biomedical engineering devices or processes.

f. **Course Learning Outcomes:**

CLO 1	Design hardware and develop software for various biomedical systems.
CLO 2	Build on a basic understanding of physiology (from pre-requisites) to develop a more in-depth level of understanding that will enable engineering analysis of selected physiological systems.
CLO 3	Develop skill in applying a high-level engineering tool for block diagram modeling (SIMULINK).
CLO 4	Implement engineering models of physiological systems to answer questions relevant to the design of biomedical engineering devices or processes.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction:** Systems Analysis: Fundamental Concepts, Physiological Control Systems Analysis: A Simple Example, Differences between Engineering and Physiological Control Systems	25%	10
2	**Mathematical Modelling** Generalized System Properties, Models with Combinations of System Elements, Linear Models of Physiological Systems: Two Examples, Distributed-Parameter versus Lumped-Parameter Models, Linear Systems and the Superposition Principle, Computer Analysis and Simulation-MATLAB and SIMULINK	25%	10
3	**Static Analysis of Physiological Systems** Introduction, Open-Loop versus Closed-Loop Systems, Determination of the Steady-State Operating Point, Steady-State Analysis Using SIMULINK, Regulation of Cardiac Output, Regulation of Glucose, Chemical Regulation of Ventilation.	15%	7
4	**Time-Domain Analysis of Linear Control Systems** Linearized Respiratory Mechanics: Open-Loop versus Closed-Loop, Open-Loop and Closed-Loop Transient Responses: FirstOrder Model, Open-Loop versus Closed-Loop Transient Responses: Second-Order Model, Open-Loop versus Closed-Loop Dynamics: Other Considerations, Transient Response Analysis Using MATLAB, SIMULINK Application: Dynamics of Neuromuscular Reflex Motion	15%	8
5	**Frequency-Domain Analysis of Linear Control Systems** Steady-State Responses to Sinusoidal Inputs, Frequency Response of a Model of Circulatory Control, Frequency Response of Glucose-Insulin Regulation	10%	5
6	**Complex Dynamics in Physiological Control Systems** Spontaneous Variability, Nonlinear Control Systems with Delayed, Feedback, Coupled Nonlinear Oscillators: Model of Circadian Rhythms, Time-Varying Physiological Closed-	10%	5

	Loop Systems: Sleep Apnea Model, Eye movement system and Wertheimer's saccade eye model, Oculomotor muscle model, Linear muscle model.		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Physiological control systems: Analysis, Simulation and Estimation (TextBook), By Michael C.K.Khoo; Prentice Hall of India Pvt. Ltd. New Delhi
2. Bioengineering, Biomedical, Medical and Clinical Engg , By A.Teri Bahil
3. Signals and systems in Biomedical Engg , By Suresh R Devasahayam.
4. Bioelectricity A quantitative approach, By Barr and Ploncey.
5. Biomedical Engineering Handbook, By Bronzino; CRC Press

a. **Course Name:** Biological Modelling and Simulation Lab
b. **Course Code:** 303111302
c. **Prerequisite:** To make students understand basic concepts of modelling this will help them develop biological models and simulate physiological processes for better understanding.
d. **Rationale:** Study of Biomedical Modelling and Simulation will help the Biomedical Engineers to understand human anatomy and physiology
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with skill in applying a high-level engineering tool for block diagram modelling (SIMULINK)
CLOBJ 2	Solve problems related to engineering models of physiological systems to answer questions relevant to the design of biomedical engineering devices or processes
CLOBJ 3	Acquire knowledge of the basic principles of steady-state and dynamic negative feedback control to physiological systems
CLOBJ 4	Understand different between the roles of variables and parameters in a model.
CLOBJ 5	Demonstrate a physiological system into the function of its component subsystems, and then build an engineering model based on subsystems

f. **Course Learning Outcomes:**

CLO 1	Develop skill in applying a high-level engineering tool for block diagram modeling (SIMULINK)
CLO 2	Implement engineering models of physiological systems to answer questions relevant to the design of biomedical engineering devices or processes
CLO 3	Reproduce basic principles of steady-state and dynamic negative feedback control to physiological systems
CLO 4	Able recognize the difference between the roles of variables and parameters in a model.
CLO 5	Resolve a complex physiological system into the function of its component subsystems, and then build an engineering model based on subsystems

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**		
L	**T**	**P**	**C**	**Internal Evaluation**	**ESE**	**Total**

				MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List :

Sr. NO.	Experiment List
1	Introduction to Simulink.
2	To Perform and Study about Simulink of Lung Mechanism for Lumped Parameter Model.
3	To Perform and study about Lung Mechanism using Distributed Parameter Model.
4	Design a Simulink model of circulatory control that accounts for the effect of respiration on heart rate and arterial blood pressure.
5	Design and perform Blood Glucose Insulin Regulation model.
6	To Study and design a Simulink model to determine the steady state operating point of the ventilatory control system.
7	Design a Simulink model of Neuromuscular Reflex Model.
8	Design a SIMULINK model of simplified and linearized version of Hodgkin-Huxley model.
9	To design a Simulink model of Cardiovascular Variability with Single Feedback Loop.
10	To design a Simulink model of Cardiovascular Variability with two interacting Feedback Loops.
11	To Study the Westhimer's Saccadic Eye movement model.

a. **Course Name:** Intellectual Property Rights and Bioethics
b. **Course Code:** 303111303
c. **Prerequisite:** Basic knowledge of ethics required
d. **Rationale:** : Interpersonal skills along with programming skills is essential for placements
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with being able to interpret the basic property laws and application of the laws.
CLOBJ 2	Solve problems related to the ability to implement the rights and rules while designing the machines
CLOBJ 3	Acquire knowledge of the bioethics and follow it.
CLOBJ 4	Understand the knowledge of bioethics while dealing with machines in clinical evaluations.

f. **Course Learning Outcomes:**

CLO 1	Able to interpret the basic property laws and application of the laws.
CLO 2	Develop the ability to implement the rights and rules while designing the machines.
CLO 3	Simulate the bioethics and follow it.
CLO 4	Illustrate the knowledge of bioethics while dealing with machines in clinical evaluations.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**

1	**Chapter 1** Importance of IPR, Patentable subject matter, Novelty and Public Domain.	**10%**	**3**
2	**Chapter 2** Intellectual Property Right and Developing World, Intellectual Property Management, Case studies- Basmati rice, Neem.	**20%**	**6**
3	**Chapter 3** Patent Claims and Legal decision-making process: Brief Study	**10%**	**3**
4	**Chapter 4** International conventions and Treaties (WIPO), patenting a biological material	**10%**	**3**
5	**Chapter 5** Introduction of Patents and patent application process (national and International), Trade Secrets, Copy Rights, Geographical Indicators, Trade Marks, PBR in UPOV, GATT and TRIPS.	**20%**	**6**
6	**Chapter 6** Introduction to bioethics.	**10%**	**3**
7	**Chapter 7** Bioethics: Value of life.	**10%**	**3**
8	**Chapter 8** Professional ethics in biomedical engg.	**10%**	**3**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Intellectual Property Rights In The WTO And Developing Countries, By Watal, Jayashree; Oxford University Press
2. Intellectual Property Rights, By A Primer-R. Anita Rao & Bhanoji Rao Eastern Book Co.
3. Introduction to Bioethics, By John Harris, Oxford University press.
4. Lectures on Intellectual Property Law Eastern Book Co., By Lectures on Intellectual Property Law Eastern Book Co.
5. The Law of Intellectual Property Rights, By Shiv Sahai Singh Eastern Book Co.
6. Cases and Materials on Intellectual Property, By William Cornish, Eastern Book Co.

a. **Course Name:** Medical Instrumentation and Surgical Procedures
b. **Course Code:** 303111305
c. **Prerequisite:** Basic knowledge of electronic components, human anatomy/physiology and laws of physics.
d. **Rationale:** The study of Bio potentials and electrodes are used to construct instrumentation systems to acquire and process different physiological signals. The use of display devices and recorders are also considered, and can be used to display or record type acquired signals. The students learn about Medical instruments and their working features along with their medical applications. Students will understand the Surgical Procedures with various Surgical Instruments.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with types of biological signals, classify them and analyze them.
CLOBJ 2	Solve problems discriminate against the various types of Display devices as well as recorders.
CLOBJ 3	Acquire knowledge of the Cardiac Surgeries and their relevant devices or equipment with their usage.
CLOBJ 4	Understand types of biomedical devices based on biological Signals measurement

f. **Course Learning Outcomes:**

CLO 1	Relate about various types of biological signals, classify them and analyze them.
CLO 2	Able to discriminate the various types of Display devices as well as recorders.
CLO 3	Classify the types of Cardiac Surgeries and their relevant devices or equipment with their usage.
CLO 4	Construct various types of biomedical devices based on biological signals measurement.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Medical Instrumentation** Block diagram of a medical instrumentation system, Bio-signals: Origin and characteristics of Bio-potential-ECG, EEG, EGG, EMG, ENG, BCG, PCG, EOG, and ERG. Problems encountered with measurements from human beings. Generalized medical instrument specifications, Electrode-Electrolyte Interface, Half-cell potential, Offset Voltage. Types of Electrodes- external. Internal and Microelectrodes.	**30%**	**13**
2	**Medical display Devices and recorders** Display Devices: Basic requirements for the display and recording of Bio-signals, Types of medical display devices. Medical recorders: Classification of recorders, PMMC writing systems. General features of ink-jet, thermo-sensitive and optical recorders.	**10%**	**4**
3	**Cardiac Instrumentation** Review of anatomy and physiology of heart, Electrocardiography Block diagram, Circuits, electrodes and their placement. Lead configuration and general ECG waveforms, ECG monitors: Single channel multi-channel ECG systems. Holter monitors, Stress test systems. **Cardiac Surgeries**: Vascular and Cardiovascular Surgery, Heart Surgery: CABG, Heart valve replacement, Arrhythmia Treatment, Aneurysm Repair, Heart Transplant, VAD, TAH, Angiography, Coronary Angioplasty, Cath Lab, PTCA, Stent, Angioplasty, Heart Lung Machine, Catheter.	**30%**	**15**
4	**Biomedical Recorders** Phonocardiograph (PCG): Origin of Heart Sounds, Block Diagram of PCG, Microphones for Phonocardiography, Amplifiers, Writing methods. Electroencephalograph (EEG): Electrodes, Block Diagram of EEG, Recording of evoked potentials, Computerized Analysis of EEG. Electromyograph (EMG): Block Diagram of EMG, Electrodes, Amplifiers, Writing methods. Apex Cardiogram, Ballistocardiograph, Electrooculography, Electroretinography, Respiration Rate Monitor, CPAP,	**30%**	**13**

	BiPAP, Biofeedback Instrumentation: Electro dermal activity measurement.		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Introduction to Biomedical Electronics. McGraw Hill book Company, By Joseph Dubovy
2. Medical Instrumentation Application & Design Houghton Mifflin, Co. Boston. USA, By John G. Webster
3. Biomedical Instruments -Theory and Design, By Weikowisty Etal; Academic press.
4. HandBook of Biomedical Instrumentation. Tata McGraw Hill., By R.S. Khandpur.
5. Principles of Applied Medical Instrumentation. John Wiley & Sons., By L.A. Gedder L.E.

a. **Course Name:** Medical Instrumentation and Surgical Procedures Lab
b. **Course Code:** 303111306
c. **Prerequisite:** Basic knowledge of electronic components, human anatomy/physiology and laws of physics.
d. **Rationale:** The study of Bio potentials and electrodes are used to construct instrumentation systems to acquire and process different physiological signals. The use of display devices and recorders are also considered, and can be used to display or record type acquired signals. The students learn about Medical instruments and their working features along with their medical applications. Students will understand the Surgical Procedures with various Surgical Instruments.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the Arrhythmias based on their patterns.
CLOBJ 2	Solve problems related to the various types of stents based on application
CLOBJ 3	Acquire knowledge of the Heart Sounds using Piezo Crystal microphone
CLOBJ 4	Understand different CPAP and BiPAP machines.

f. **Course Learning Outcomes:**

CLO 1	Identify the Arrhythmias based on their patterns
CLO 2	Design the various types of stents based on application
CLO 3	Measure the Heart Sounds using Piezo Crystal microphone
CLO 4	Describing CPAP and BiPAP machines.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	To study ECG machines.
2	To Study Arrhythmia Simulator.
3	To study about EEG machines.
4	To Study Pacemakers.
5	To Study about Treadmill-Test Systems.
6	Acquisition of Heart sounds using PCG.
7	To Study about EMG Simulators.
8	To Study about Catheterization Laboratory.
9	To Study Heart Lung Machines.
10	To Study about Designing of Various Stents.
11	To Study about Respiration Rate Monitor.
12	To Study about CPAP and BiPAP.

a. **Course Name:** Hospital Management Systems
b. **Course Code:** 303111307
c. **Prerequisite:** Basic Knowledge of managerial activities required
d. **Rationale:** The objective of the course is to provide an understanding of basic concepts, principles and practices of Hospital management. The aim is to inculcate the ability to apply multi-functional approach to organizational objective
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the basic areas of management.
CLOBJ 2	Solve problems related Problems by applying their managerial skills.
CLOBJ 3	Acquire knowledge of the administration of a healthcare institute or a hospital after their graduation.
CLOBJ 4	Understand the requirement of the clinical environment and develop the system as per it.

f. **Course Learning Outcomes:**

CLO 1	Able to interpret the basic areas of management.
CLO 2	Solving Problems by applying their managerial skills.
CLO 3	Manage the administration of a healthcare institute or a hospital after their graduation.
CLO 4	Recognise the requirement of the clinical environment and develop the system as per it.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Introduction to Management** Definition, Functions, Process, Scope and Significance of Management. Nature of Management, Managerial Roles, Managerial Skills and Activities, Difference between Management and Administration, Significance of Values and Ethics in Management, Evolution of Management Thought, Approaches of Management Thought, Functions of Management.	**15%**	**4**
2	**Effective Hospital Management** Introduction, Principles of Management, Managerial Activity of a Hospital, Survey of Problems Faced by Hospitals, Roles and Functions of Hospital Administration, Skills of Effective Managers, Coordination, Characteristics of Effective Managers.	**15%**	**5**
3	**Planning** Introduction, Purpose of Planning, Forecasting, Strategic and Operational Planning, Criteria for Effective Planning, Step by Step Approach to Planning, Decision Making, Diversification.	**10%**	**2**
4	**Organizing** Introduction, Realities of Hospital Organization, Authority Relationships, Delegation, Principles of Delegation, Steps in Delegation, Management Barriers, Multiple Pyramid of Hospital Organization, Medical Staff Committees, The Organizational Chart, Advantages and Limitations of Organizational Chart, Matrix Organization	**15%**	**5**
5	**Directing and Leading** Introduction, Motivation, Leader Behavior, Leadership Styles- Theory X and Theory Y, Induction and Training, Communication Process, Guidelines for Effective Communication.	**10%**	**2**
6	**Controlling** Introduction, The Basic Control Process, Forward Action, Critical Control Points and Standards, Control Techniques, Budget: The Traditional Control Technique, Types of	**15%**	**5**

	Budgets, Break-even Analysis, Programme Evaluation and Review Technique (PERT), Effective Controlling.		
7	**Financial Management** Introduction, Financial Planning, Causes of rise in Hospital Expenditure, Glossary of Financial Terms, Revenue and Cost Centres, Standard Costing, Cost Finding, Depreciation, The Hospital Budget, Income and Expenditure Statement of Hospital, Balance Sheet, Financial Control, Value Engineering, Steps of VE Project, Checklist for Cost Containment.	**20%**	**7**
	Total:	**100%**	**30**

i. Text Book and Reference Book:

1. The Practice of Management by Drucker, By F. Peter
2. Principles and Practices of Management, By L. M. Prasad
3. Principles of hospital administration and planning, By Sakharkar B M; Jaypee Brothers Medical Publishers Pvt Limited.
4. Hospitals: Facilities planning and management, By Kunders G D; Tata Mcgraw Hill; 1st edition, 2008
5. "Healthcare Information Management Systems: Cases, Strategies, and Solutions" by Marion J. Ball, Charlotte Weaver, Joan M. Kiel, and Joan P. Ash.

a. **Course Name:** Telemedicine
b. **Course Code:** 303111335
c. **Prerequisite:** Knowledge about to use various communication techniques in the medical field.
d. **Rationale:** Telemedicine is the use of telecommunication and information technologies in order to provide clinical health care at a distance. It helps eliminate distance barriers and can improve access to medical services that would often not be consistently available in distant rural communities. This course will enable to understand the various techniques used for data transferring in health care services.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the basic telecommunication wireless application.
CLOBJ 2	Solve problems related to data security and standards.
CLOBJ 3	Acquire knowledge of the use of teleradiology.
CLOBJ 4	Understand the desired system as per the requirement of the clinical environment.

f. **Course Learning Outcomes:**

CLO 1	Practise the basic telecommunication wireless application.
CLO 2	Restate data security and standards.
CLO 3	Make use of tele radiology.
CLO 4	Design the desired system as per the requirement of the clinical environment.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**Chapter 1** History of Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health, Tele care, origins and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine	**20%**	**9**
2	**Chapter 2** Types of information: Audio, Video, still Images, text and data, Fax. Types of Communication and Network: PSTN, POTS, ATN, ISDN, Internet, Wireless Communications: GSM, satellite and Micro Wave. Different modulation techniques, Types of antennas depending on requirements, Integration and Operational issues: system integration, Store-and-forward operation, real-time Telemedicine.	**20%**	**9**
3	**Chapter 3** Data Exchanges: Network Configuration, Circuit and packet switching, H.320 series (Video phone-based ISBN) T.120, h.324 (Video phone based PSTN), Video Conferencing.	**20%**	**9**
4	**Chapter 4** Data Security and Standards: Encryption, Cryptography, Mechanisms of encryption, Phases of Encryption. Protocols: TCP/IP, ISO-OSI, Standards to followed DICOM, HL7. Ethical and legal aspects of Telemedicine: Confidentiality and Law, patient rights and consent, access to medical Records, Consent treatment, jurisdictional Issues, Intellectual property rights.	**20%**	**9**
5	**Chapter 5** Tele radiology: Basic parts of Tele radiology system: Image Acquisition system, Display system, Communication network, Interpretation. Tele Pathology: Multimedia databases, colour images of sufficient resolution: Dynamic range, spatial resolution, compression methods, Interactive control of colour, Controlled sampling, security and confidentiality tools. Tele cardiology, Tele oncology, Tele surgery.	**20%**	**9**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Handbook of Telemedicine, IOS press 2002, By Olga Ferrer-Roca, M.Sosa Ludicissa.
2. Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002, By A.C.Norris

a. **Course Name:** Telemedicine Lab
b. **Course Code:** 303111336
c. **Prerequisite:** Understanding of communication, network
d. **Rationale:** Get idea of telemedicine
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the Ethical and legal aspects of Telemedicine.
CLOBJ 2	Solve problems related to Tele-Radiology
CLOBJ 3	Acquire knowledge of the Tele-Radiology.
CLOBJ 4	Understand wireless system

f. **Course Learning Outcomes:**

CLO 1	Reproduce the Ethical and legal aspects of Telemedicine
CLO 2	Operate Tele-Radiology
CLO 3	Operate communication ports and analyse them.
CLO 4	Develop wireless system

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **List of Experiments:**

Sr. NO.	**Experiment List**
1	To study and perform Ring topology
2	To study and perform star topology.

3	To study different types of antennae.
4	To study the microwave test bench.
5	To study active/passive satellites, uplink/downlink & transponders satellite setup.
6	To study GSM architecture.
7	To perform GSM AT commands.
8	To perform network setup for LAN.
9	To study and perform Serial data communication Network.
10	To study and perform Parallel data communication Network.
11	To study and perform the working of a modem.
12	To study and perform telemetry / Audio / video communication through satellite communication kit.
13	Write a MATLAB code for different Filters in spatial domain.
14	Write a MATLAB code for image histogram equalization and specification.
15	Prove the Reciprocating theorem for antennas.

a. **Course Name:** Professionalism & Corporate Ethics
b. **Course Code:** 303193304
c. **Prerequisite:** Basic knowledge of SWOT analysis and understanding of the fundamentals of communication are essential..
d. **Rationale:** Soft skills and ethics are essential for career growth.

e. **Course Learning Objective:**

CLOBJ 1	Articulate the principles of professionalism in a corporate context.
CLOBJ 2	Analyse ethical dilemmas and make informed decisions.
CLOBJ 3	Apply ethical decision-making models to real-world business scenarios
CLOBJ 4	Evaluate the impact of corporate activities on various stakeholders, including the community and the environment.
CLOBJ 5	Practice proper business etiquette in various communication channels.
CLOBJ 6	Develop skills in resolving conflicts ethically and professionally.

f. **Course Learning Outcomes:**

CLO 1	Identity and develop soft skills required for personal and professional growth.
CLO 2	Develop professional etiquette & desired behaviour at the workplace
CLO 3	Speak and participate effectively in oral organizational communication
CLO 4	Improve comprehensive skills for reading.
CLO 5	Know how to be assertive in professional environment

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
0	**1**	**0**	**1**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. course Content:

Sr. No.	Topic	Weightage (%)	Teaching Hrs.
1	**Ethics in Engineering**: • Scope of engineering ethics • Accepting & sharing responsibility • Responsible professionals and ethical corporations • Resolving ethical dilemmas • Case studies	20%	5
2	**Group Discussion**: • Communication core • Definition, types, process, guidelines • Mock round -1	15%	3
3	**Introduction to B-School Tests**: Students will be able to solve verbal questions from the following exams. In these sessions students will learn to distinguish between national & international level of Management exam. • GMAT • CAT	15%	2
4	**Listening Skills- Advanced Level**: Demonstrate ability to listen more than two minutes of audio clips & solve questions based on it.	10%	1
5	**Preparing Brochures**: Students will learn how to establish the purpose of writing & determine audience they are writing for.	15%	2
6	**Agenda & Minutes of Meeting**: Students will be able to explain what an agenda & minutes of meeting are and why they are useful.	15%	1
7	**Reading Comprehension; Intermediate level**: Students will develop their ability to skim for main idea(s). They will able to make use of contextual clues to infer meaning of unfamiliar	10%	1

	words from context and will be able to solve questions based on it.		
	Total:	**100%**	**15**

i. Reference Books:

1. Business Correspondence and Report Writing SHARMA, R. AND MOHAN, K.
2. Ethics in Engineering Practice and Research Caroline Whitbeck, Cambridge University Press
3. Technical Communication : Principles And Practice Sangeetha Sharma, Meenakshi Raman; Oxford University Press
4. How to prepare for verbal ability and reading comprehension for the CAT, Arun Sharma, Meenakshi Upadhyay,

SEMESTER 6

a. **Course Name:** Diagnostic Techniques and Instrumentation
b. **Course Code:** 303111351
c. **Prerequisite:** Basic knowledge of Biosensors and transducers, biomedical instrumentation, human anatomy and physiology is required.
d. **Rationale:** To introduce students to principles, applications and working of medical instruments most commonly used in medical instrumentation systems used for diagnostic medical applications.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the Blood Flow meter, their types and their specific application in the medical field.
CLOBJ 2	Solve problems to measure cardiac output, their measuring methods and based on that calculate Cardiac Output.
CLOBJ 3	Acquire knowledge on measurement of heart rate, Blood pressure, Temperature, Respiration rate.
CLOBJ 4	Understand the Construction of Endoscopes and how to use for specific applications.

f. **Course Learning Outcomes:**

CLO 1	Correlate the Blood Flow meter, their types and their specific application in the medical field.
CLO 2	Classify that how to measure cardiac output, their measuring methods and based on that calculate Cardiac Output.
CLO 3	Measurement of heart rate, Blood pressure, Temperature, Respiration rate.
CLO 4	Illustrate the Construction of Endoscopes and how to use for specific applications.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**BLOOD FLOW METERS** Electromagnetic Blood flow meters, Types of electromagnetic Blood Flow meters, Ultrasonic Blood Flow meters, NMR Blood Flow meter and Laser Doppler Blood Flow meter.	**20%**	**9**
2	**CARDIAC OUTPUT MEASUREMENT** Indicator dilution Method, Dye dilution Method, Thermal dilution Techniques, Measurement of Continuous Cardiac Output Derived from the Aortic Pressure Waveform, Impedance Technique, Ultrasound method, Cardiac Arrhythmias, Ambulatory monitoring Instruments, Phonocardiogram, Plethysmography.	**20%**	**9**
3	**FOETAL MONITORING INSTRUMENTS** Cardiotocography, Foetal heart rate measurements, Foetal scalp pH monitoring, Labour activity monitoring.	**10%**	**4**
4	**PATIENT MONITORING SYSTEMS** Concepts, Measurement of heart rate, Blood pressure, Temperature, Respiration rate, Apnea detectors, computerized patient monitoring system.	**10%**	**5**
5	**PULMONARY FUNCTION ANALYZER** Pulmonary function Analyser, Pulmonary function Measurement, Spirometry, Pneumotachometer, Measurement of volume, Respiratory Gas Analysers.	**20%**	**9**
6	**ENDOSCOPES** Introduction, Basic Endoscope system with its construction, Various types with its application.	**10%**	**4**
7	**AUDIOMETER** Audiometers and Hearing Aids: Mechanism of Hearing, Measurement of sound, Basic Audiometer, Pure Tone Audiometer, Speech Audiometer.	**10%**	**5**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Handbook of Biomedical Instrumentation, By R.S.Khandpur
2. Biomedical Electronics and Instrumentation., By S. K. Venkata Ram; Galgotia Publication Pvt. Ltd.; New Delhi
3. Medical Instrumentation. Application and Design, By John Webster; John Wiley and Sons. Inc.
4. Biomedical Instrumentation and Measurements, By Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer; Prentice Hall, New Delhi; 2nd Edition.
5. "Diagnostic Imaging: Brain" by Anne G. Osborn and Karen L. Salzman.

a. **Course Name:** Diagnostic Techniques and Instrumentation Lab
b. **Course Code:** 303111352
c. **Prerequisite:** Basic knowledge of Biosensors and transducers, biomedical instrumentation, human anatomy and physiology is required.
d. **Rationale:** To introduce students to principles, applications and working of medical instruments most commonly used in medical instrumentation systems used for diagnostic medical applications.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity in Operating ECG, EEG, BP machines.
CLOBJ 2	Solve problems to analyze various types of Biological Signals and classify them.
CLOBJ 3	Acquire knowledge to examine Heart Sounds with the use of PCG Machine.
CLOBJ 4	Understand to discuss three phase-balanced circuits.

f. **Course Learning Outcomes:**

CLO 1	Operate ECG, EEG, BP machines.
CLO 2	Analyse various types of Biological Signals and classify them.
CLO 3	Examine Heart Sounds with the use of PCG Machine.
CLO 4	Discuss three phase-balanced circuits.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **List of Experiments**:

Sr. NO.	**Experiment List**
1	Acquisition of Heart sounds using PCG.
2	To study about Ultrasound blood flow meter.

3	To study about Blood pressure measurement.
4	To study about Patient monitoring system.
5	The study of Pulse oximetry.
6	To study about Plethysmography.
7	To study about ECG machine.
8	To study about EEG machine.
9	The study of Foetal Heart Rate measurement using Doppler Sonography.
10	To study about Endoscope and its components.
11	Respiration rate measurement and pulmonary function analysis using Spirometer.
12	Acquisition and analysis of audiogram using Audiometer.

a. **Course Name:** Biomedical Signal Processing
b. **Course Code:** 303111353
c. **Prerequisite:** Basic knowledge of mathematics and signals and systems is required.
d. **Rationale:** Study of Biomedical Signal Processing is useful for understanding fundamental of signal and systems, Z-transform and Fourier transforms different filter design for biomedical applications for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity to reproduce the Introduction to continuous and discrete time signals and systems.
CLOBJ 2	Solve problems to analyse the Z-transform, Transfer function, Frequency Response.
CLOBJ 3	Acquire knowledge to illustrate the Probability & Random Signal theory.
CLOBJ 4	Understand various biomedical signals used for various diagnosis purposes.

f. **Course Learning Outcomes:**

CLO 1	Reproduce the Introduction to continuous and discrete time signals and systems.
CLO 2	Analyse the Z-transform, Transfer function, Frequency Response.
CLO 3	Illustrate the Probability & Random Signal theory.
CLO 4	Interpret the knowledge of various biomedical signals used for various diagnosis purposes.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Fundamentals of Signal & System** Introduction to continuous and discrete time signals and systems; Signals, types of signal, singularity functions, exponential and sinusoidal signal, sinc and signum function, Standard Test signals, manipulation and operation on signals, Energy and power signal, System and types of system, Conversion of analog signal to digital signal, Application of Signal Processing, Examples.	**20%**	**9**
2	**Introduction and application of Z- Transform & Fourier Transform** Review of Z-transform, Transfer function, Frequency Response, LTI System, Convolution, Correlation, Autocorrelation, Cross-correlation, DTFT, DFT, FFT, Stationary and Non stationary signal, Time frequency analysis of Biomedical signals, Examples.	**20%**	**9**
3	**Flow Graph and Filter Structure** Block Diagram presentation of structure, Structure of FIR System: Direct Form, Cascade Form, Linear Phase FIR Structure, Structure of IIR System: Direct form I, Direct form II structure, Cascade form structure, Parallel form structure, Signal flow graph presentation, Transposed Structure, Design of IIR and FIR Filters, Examples.	**20%**	**9**
4	**Noise Analysis for Bio Signals and their Filters** Noise Analysis and Cancellation for Biomedical Application: Source of noise, Types of Noise, Noise bandwidth, Noise Analysis and Cancellation Using adaptive Filter, Adaptive Noise Canceller and its application, Signal Averaging, Elements of Digital filtering, Active and Passive Filters, General Idea of L.P.F, H.P.F, B.P.F and N.F, First order Passive Filters (L.P.F, H.P.F, B.P.F and N.F), EEG signal Characteristics and Analysis, ECG signal parameters and their estimation; Arrhythmia analysis monitoring; ECG data reduction techniques.	**20%**	**9**
5	**Event Detection and Waveform Analysis** Events (viz. P, QRS and T wave in ECG), Derivative based Approaches for QRS Detection, Pan Tompkins Algorithm for QRS Detection, Dicrotic Notch Detection, Correlation Analysis of EEG Signal, Illustrations of problem with case studies, Morphological Analysis of ECG, Correlation	**20%**	**9**

	coefficient, The Minimum phase correspondent, Signal length, Envelope Extraction, Amplitude demodulation, The Envelogram, Analysis of activity.		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Biomedical Digital Signal Processing, By Willis J. Tompkins; Prentice-Hall Of India Pvt. Limited
2. Digital Signal Processing, By N. G. Palan; Tech-Max Publication; Pune
3. Digital Signal Processing: Principles Algorithms and Applications, By Proakis J. G. and Manolakis D.G.; Pearson Education; 4th.
4. "Biomedical Signal Processing: Principles and Techniques" by D.C. Reddy and K. S. Rao.
5. "Biomedical Signal Processing: Compression and Automatic Recognition" by Mark J.T. Smith and Jahangir Y. Khan.

a. **Course Name:** Biomedical Signal Processing Lab
b. **Course Code:** 303111354
c. **Prerequisite:** Basic knowledge of mathematics and signals and systems is required.
d. **Rationale:** Study of Biomedical Signal Processing is useful for understanding fundamental of signal and systems, Z-transform and Fourier transforms different filter design for biomedical applications for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity in various signals with the help of MATLAB
CLOBJ 2	Solve problems in analyse various properties of signals and systems.
CLOBJ 3	Acquire knowledge in sampling theorem on Biomedical Signals.
CLOBJ 4	Understand various transform techniques and comparing all output sequences.
CLOBJ 5	Demonstrate R-Peak of ECG by applying Pan-Tompkin's algorithm

f. **Course Learning Outcomes:**

CLO 1	Generate various signals with the help of MATLAB
CLO 2	Analyze various properties of signals and systems.
CLO 3	Experimenting sampling theorem on Biomedical Signals.
CLO 4	Applying various transform techniques and comparing all output sequences
CLO 5	Examine R-Peak of ECG by applying Pan-Tompkin's algorithm

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	Introduction of MATLAB as a tool for signal processing.
2	Write a program in MATLAB to generate the standard signals
3	Write a program in MATLAB to study the basic operations on the Discrete – time signals.
4	To verify the sampling theorem and check the effect of aliasing in MATLAB.
5	To perform discrete convolution and discrete correlation using MATLAB.
6	To perform a program for the evaluation of Frequency response and impulse response of the given LTI system.
7	To perform Z-transform from zeros and poles of a given system function.
8	To perform DFT, IDFT and FFT for the given input sequences using MATLAB.
9	To design Infinite Impulse Response (IIR) Filter
10	To design FIR filters in MATLAB using the windowing function.
11	Design and Implementation of filters using FDA tools in MATLAB.
12	To study about R-Peak detection of ECG signal using Pan- Tompkin's algorithm

a. **Course Name:** Mini Project
b. **Course Code:** 303111356
c. **Prerequisite:** Basic knowledge of Basic Electronics, microcontroller and biomedical instrumentation required.
d. **Rationale:** To make students understand basic concepts of electronics and instrumentation which will help them to create new innovation.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with mathematics, science, computer programming and engineering for innovative ideas.
CLOBJ 2	Solve problems related to conduct experiments, as well as to analyse and interpret data.
CLOBJ 3	Acquire knowledge of the a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
CLOBJ 4	Understand multidisciplinary teams, communicate effectively and Knowledge of contemporary issues
CLOBJ 5	Demonstrate and formulate, and solve engineering problems by understanding professional and ethical responsibility.
CLOBJ 6	Study the use of lead and manage change through collaboration with others.

f. **Course Learning Outcomes:**

CLO 1	Apply knowledge of mathematics, science, computer programming and engineering for innovative ideas.
CLO 2	Design and conduct experiments, as well as to analyse and interpret data.
CLO 3	Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
CLO 4	Function on multidisciplinary teams, communicate effectively and Knowledge of contemporary issues
CLO 5	Identify, formulate, and solve engineering problems by understanding professional and ethical responsibility.
CLO 6	Demonstrate capacity to lead and manage change through collaboration with others.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					
				Internal Evaluation			ESE		Total
L	T	P	C	MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. **Course Name:** Employability Skills
b. **Course Code:** 303193353
c. **Prerequisite:** Basic knowledge of ethics, corporate etiquettes and understanding of the fundamentals of communication are essential.
d. **Rationale:** Interpersonal skills and employability skills are essential for better career.
e. **Course Learning Objective:**

CLOBJ 1	Understand the importance of resume customization for different job applications.
CLOBJ 2	Identify job opportunities through various channels.
CLOBJ 3	Demonstrate proficiency in preparing for job interviews.
CLOBJ 4	Build and expand a professional network using both online and offline channels.
CLOBJ 5	Understand workplace communication dynamics, including formal and informal channels.
CLOBJ 6	Practice IELTS mock test.

f. **Course Learning Outcomes:**

CLO 1	Get ready for IELTS tests.
CLO 2	Develop a professional resume.
CLO 3	Get an understanding of the interview process.
CLO 4	Improve employability skills through mock tests.
CLO 5	Use soft skills during job interviews.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**1**	**-**	**1**	**-**	**100**	**-**	**-**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**IELTS Mock Test:** • To develop students English Learning and improve their employment prospects. • To create opportunity for students to study around the globe & give them Practice on : Listening Speaking Reading Writing	25%	5
2	**Resume Building:** • Cover letter & Resume Writing • Students will create a functional resume along with cover letter that they will be able to use when applying for a job, college or a scholarship.	25%	2
3	**Advanced Group Discussion: Mock Round:** • To provide students with an avenue to train themselves in various interpersonal skills. • To prepare students for the Group Discussion after the written test for employment or for admission to educational institutes. • To generate new ideas or new approaches for solving a problem. • To reach a solution on an issue of concern.	25%	4
4	**Personal Interview: Mock Round:** • Preparing For The Interview • Review Question • Employer's Expectation • Case Interview	25%	4
	Total:	100 %	15

i. Text Book and Reference Book:

1. Business Correspondence and Report Writing SHARMA, R. AND MOHAN, K.
2. Communication Skills and Soft Skills Suresh Kumar; Pearson Publication, 2010
3. Technical Communication : Principles And Practice Sangeetha Sharma, Meenakshi Raman; Oxford University Press

a. **Course Name:** Bioinformatics
b. **Course Code:** 303111381
c. **Prerequisite:** Basic knowledge of Biochemistry and computers is required.
d. **Rationale:** Study of Bioinformatics is helpful to the Biomedical Engineers to understand Bioinformatics, data base management in biotechnology and DNA mapping and sequencing.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Basics of Bioinformatics.
CLOBJ 2	Solve problems related to Fundamentals Information theory for biomedical applications.
CLOBJ 3	Acquire knowledge of the DNA mapping.
CLOBJ 4	Understand DNA sequencing.

f. **Course Learning Outcomes:**

CLO 1	Interpret Basics of Bioinformatics
CLO 2	Interpret Fundamentals Information theory for biomedical applications.
CLO 3	Interpret DNA mapping
CLO 4	Interpret DNA sequencing

g. **Teaching & Examination Scheme: -**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**
1	**Introduction to Bioinformatics**	**20%**	**9**

	Bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST), databases (GENBANK, PubMed, PDB) and software (RASMOL, Ligand Explorer).		
2	**Data generation** Generation of large-scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.	**20%**	**9**
3	**Biological Database and its Types** Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases:(SGD, TIGR) Structure databases (CATH, SCOP, and PDBsum)	**20%**	**9**
4	**Data storage and retrieval** Flat files, relational, object-oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, Swiss rot).	**20%**	**9**
5	**Sequence Alignments and Visualization** Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal Walgorithm).	**20%**	**9**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Bioinformatics sequence and genome analysis (TextBook) , By DAVID W MOUNT; Cold spring harbor laboratory press
2. Bioinformatics- Concepts, Skills, and Applications) , By S.C. Rastogi; CBS
3. Basic Bioinformatics , By S. Ignacimuthu; Narosa Publishing House.
4. "Introduction to Bioinformatics" by Arthur M. Lesk.
5. "Bioinformatics and Functional Genomics" by Jonathan Pevsner.

a. **Course Name:** Bioinformatics Lab
b. **Course Code:** 303111382
c. **Prerequisite:** Basic knowledge of Biochemistry and computers is required.
d. **Rationale:** Study of Bioinformatics is helpful to the Biomedical Engineers to understand Bioinformatics, data base management in biotechnology and DNA mapping and sequencing.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Basics of Bioinformatics.
CLOBJ 2	Solve problems related to Fundamentals Information theory for biomedical applications.
CLOBJ 3	Acquire knowledge of the DNA mapping.
CLOBJ 4	Understand DNA sequencing.

f. **Course Learning Outcomes:**

CLO 1	Interpret Basics of Bioinformatics.
CLO 2	Interpret Fundamentals Information theory for biomedical applications.
CLO 3	Interpret DNA mapping.
CLO 4	Interpret DNA sequencing

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **List of Experiments**:

Sr. No.	**Experiment List**
1	To view and use the various biological databases available on the World Wide Web with Reference to Expasy.

2	To view and use the various biological databases available on the World Wide Web with Reference to NCBI.
3	To browse Genomic databases using MapViewer & ensembl, viewing genetic, linkage maps for human and other model organisms.
4	To retrieve the sequence of the Human keratin protein from UniProt database and to interpret the results.
5	To retrieve the gene sequence in FASTA format corresponding to P00519.
6	To retrieve any one FASTA sequence of GABA transaminase in Human, mouse, pig and chick.
7	To determine the Secondary structure of P68871 AND P24071.
8	To determine the conserved domain present inQ8NFM4.
9	To find the gene sequences of Mouse origin similar to U80226.1.
10	To retrieve the sequence of the Human keratin protein from GenBank database and to interpret the results.
11	To retrieve the structure of a protein and viewing it in RASMOL viewer.
12	To align more than two sequences and find out the similarity between those sequences.
13	To study the phylogenic relationships of nucleotide and protein sequence(s) by using PHYLIP Package.
14	To model a protein sequence using Swiss model.
15	To perform the local alignment between the given sequences using any two variants of BLOSUM.

a. **Course Name:** Biomechanics & Rehabilitation Engineering
b. **Course Code:** 303111383
c. **Prerequisite:** Basic knowledge of physics and Biology is required.
d. **Rationale:** Study of Bio mechanics is useful for understanding Human body motion and load, joint structure, and kinetics of human movements for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with different forms of movements in human body.
CLOBJ 2	Solve problems related to design the system as per the requirement of human body at different conditions.
CLOBJ 3	Acquire knowledge of the different loads on various parts of the human body.
CLOBJ 4	Understand the building of wheelchairs.

f. **Course Learning Outcomes:**

CLO 1	Categorizing different forms of movements in human body.
CLO 2	Classify and design the system as per the requirement of human body at different conditions.
CLO 3	Predicting the different loads on various parts of the human body.
CLO 4	Building wheelchairs.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**
1	**HUMAN BODY MOTION AND LOADS ON HUMAN BODY**	**10%**	**4**

	Terminology, reference position and cardinal planes, Forms of motion and movements with respect to cardinal planes, mechanical load on the body and effect of loading		
2	**BIOMECHANICS OF JOINT STRUCTURE AND SKELETAL MUSCLE** Types of joint and architecture, Properties of skeletal muscle, Tension in muscle fibers on stimulation, skeletal muscle function, force velocity and length-tension relationships, muscular force, torque and power, Muscular endurance, Muscle fatigue.	**20%**	**10**
3	**BIOMECHANICS OF LOWER EXTREMITIES** Structure and movements of hip joint, loads on the hip; structure and movements of knee, loads on the knee; Structure and movements of ankle, Foot structure and movements, Loads on the ankle and foot.	**15%**	**7**
4	**BIOMECHANICS OF UPPER EXTREMITIES** Structure and movements of shoulder joint, loads on the shoulder; Structure and movements of elbow joint, loads on the elbow, structure and movements of wrist, loads on wrist; Structure and movements of joints of the hand.	**15%**	**7**
5	**EQUILIBRIUM AND HUMAN MOVEMENTS** Anatomical levers in the human body, Equation of static and dynamic equilibrium, C.G. of human body and locating C.G. of human body, Stability and balance.	**15%**	**7**
6	**KINETICS OF HUMAN MOVEMENTS** GAIT cycle, phases of GAIT, basic functioning, data analysis.	**10%**	**3**
7	**PROSTHETIC & ORTHOSTIC DEVICE FOR MOBILITY** Impairments, disabilities and handicaps, Measurement and assessment. Characterizing engineering concepts in sensory and motor rehabilitation, Categories of Wheelchairs, Wheelchair Structure and Component Design, Ergonomics of Wheelchair propulsion, Power Wheelchair: Electrical Systems and its Control.	**15%**	**7**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Basic Biomechanics (Textbook) , By Sujan J Hall; McGraw Hill
2. GAIT Analysis- Normal and Pathological Function, By Jacquelin Perry; Slack Inc
3. "Biomechanics: Concepts and Computation" by Valery I. Ivanenko.
4. "Biomechanics in Rehabilitation" by Donald A. Neumann.
5. "Biomechanics of Human Motion: Applications in the Martial Arts" by Emeric Arus, Ph.D.

a. **Course Name:** Biomechanics & Rehabilitation Engineering Lab
b. **Course Code:** 303111384
c. **Prerequisite:** Basic knowledge of physics and Biology is required.
d. **Rationale:** Study of Bio mechanics is useful for understanding Human body motion and load, joint structure, and kinetics of human movements for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Categorizing different models/devices for rehabilitation engineering.
CLOBJ 2	Solve problems related to new prosthetic devices.
CLOBJ 3	Acquire knowledge of the importance of rehabilitation engineering.
CLOBJ 4	Understand the problems and rectify them by using different methods of Biomechanics.

f. **Course Learning Outcomes:**

CLO 1	Categorizing different models/devices for rehabilitation engineering.
CLO 2	Designing new prosthetic devices.
CLO 3	Reproduce importance of rehabilitation engineering.
CLO 4	Illustrate the problems and rectify them by using different methods of Biomechanics.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	To study about muscles and forces acting on it
2	To study about forces in ligament.
3	To study about Biomechanical properties of cervical spine.
4	To study about Biomechanical properties of lumbar spine.
5	To study about Biomechanical aspect of bones.
6	To study about Biomechanics of human foot.
7	To study about Upper limb prosthesis.
8	To study about Lower limb prosthesis
9	To study about Centre of Gravity of the human body.
10	To study about Hybrid assistive system
11	To study about Mobility aids.
12	To study about general wheelchairs.

a. **Course Name:** Embedded System
b. **Course Code:** 303111385
c. **Prerequisite:** Digital Electronics fundamentals, Microprocessors (8085), Micro controller (8051) and Basic knowledge of high-level languages like C
d. **Rationale:** Course provides the concept of Embedded System Design using AVR Micro controllers, programming skills and various protocols. This subject covers sufficient knowledge in all aspects to design Small Scale Embedded Systems.
e. **Course Learning Objective:**

CLOBJ 1	Understand the architecture and functioning of microcontrollers, including their memory, I/O ports, and instruction set.
CLOBJ 2	Acquire proficiency in programming microcontrollers using assembly language and high-level languages for embedded systems.
CLOBJ 3	Design and implement interfaces between microcontrollers and external devices, sensors, and actuators for practical applications.
CLOBJ 4	Apply microcontroller programming skills to develop real-time control systems for monitoring and regulating external processes.
CLOBJ 5	Investigate and apply communication protocols, such as UART and SPI, for data exchange between microcontrollers and external devices.
CLOBJ 6	Develop skills to troubleshoot and debug microcontroller-based systems, ensuring efficient and reliable operation in various applications.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of microcontroller architecture and proficiently program in assembly language and high-level languages for embedded systems.
CLO 2	Design and implement effective interfaces between microcontrollers and external devices, sensors, and actuators for diverse applications.
CLO 3	Apply microcontroller programming skills to develop real-time control systems, showcasing the ability to monitor and regulate external processes.
CLO 4	Investigate, select, and apply communication protocols, such as UART and SPI, for efficient data exchange between microcontrollers and external devices.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**		
L	**T**	**P**	**C**	**Internal Evaluation**	**ESE**	**Total**

				MSE	CE	P	Theory	P	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction** Embedded system and general-purpose computers, Embedded system components, Embedded System Design Process, Classification of an embedded system, Examples of an embedded system, and Applications of an embedded system.	**10%**	**4**
2	**Overview of AVR and Related Software** Introduction to AVR Studio 6, Introduction to BASSCOM, Introduction to AVR IDE/WINAVR, Overview of AVR family, AVR microcontroller architecture, Register, AVR status register, ROM space and other hardware modules, ATmega32 pin configuration & function of each pin, addressing modes of AVR, overview of instruction set of AVR.	**20%**	**8**
3	**AVR Interfacing with peripherals and programming in C** Data types, I/O programming, logic operations, Intel HEX file, Timer programming in Interrupt programming in C, Serial Port programming in C, LCD and Keyboard Interfacing, ADC, DAC and sensor interfacing, Stepper Motor Interfacing, PWM programming and DC motor control, SPI protocol and Display interfacing, I2C Protocol and RTC interfacing.	**30%**	**17**
4	**Inter process Communication and Synchronization of processes, Thread and Task** Multiple process and thread in application, Task and Task state, Task control block, Task coding, Task scheduling, Semaphores, Semaphores for synchronization, Data sharing and deadlocks, Inter process communication, Sockets and remote procedure call.	**20%**	**8**

5	**RTOS** Operating system service, Process management, Timer and Event function, Memory management, Device, File and I/O subsystem management, Interrupt routine in RTOS environment and handling of interrupt service calls, Basic design using RTOS, RTOS task scheduling models, Interrupt latency and response of tasks as performance metrics, OS security issue.	**20%**	**8**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Embedded Systems, Architecture, Programming and Design (Textbook), By Raj Kamal; TMH
2. The AVR Microcontroller and Embedded Systems Using Assembly and C, By Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi, Pearson Education
3. Introduction to Embedded Systems, By K. Shibu; TMH Edition.
4. Programming and Customizing the AVR Microcontroller, By Dhananjay Gadre; McGraw Hill Education.
5. AVR ATmega32 data sheet

a. **Course Name:** Embedded System Lab
b. **Course Code:** 303111386
c. **Prerequisite:** Digital Electronics fundamentals, Microprocessors (8085), Microcontroller (8051) and Basic knowledge of high-level languages like C.
d. **Rationale:** Course provides the concept of Embedded System Design using AVR Microcontrollers, programming skills and various protocols. This subject covers sufficient knowledge in all aspects to design Small Scale Embedded Systems.
e. **Course Learning Objective:**

CLOBJ 1	Understand the architecture and functioning of microcontrollers, including their memory, I/O ports, and instruction set.
CLOBJ 2	Acquire proficiency in programming microcontrollers using assembly language and high-level languages for embedded systems.
CLOBJ 3	Design and implement interfaces between microcontrollers and external devices, sensors, and actuators for practical applications.
CLOBJ 4	Apply microcontroller programming skills to develop real-time control systems for monitoring and regulating external processes.
CLOBJ 5	Investigate and apply communication protocols, such as UART and SPI, for data exchange between microcontrollers and external devices.
CLOBJ 6	Develop skills to troubleshoot and debug microcontroller-based systems, ensuring efficient and reliable operation in various applications.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of microcontroller architecture and proficiently program in assembly language and high-level languages for embedded systems.
CLO 2	Design and implement effective interfaces between microcontrollers and external devices, sensors, and actuators for diverse applications.
CLO 3	Apply microcontroller programming skills to develop real-time control systems, showcasing the ability to monitor and regulate external processes.
CLO 4	Investigate, select, and apply communication protocols, such as UART and SPI, for efficient data exchange between microcontrollers and external devices.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**		
L	**T**	**P**	**C**	**Internal Evaluation**	**ESE**	**Total**

				MSE	CE	P	Theory	P	
-	-	2	1	-	-	20	-	30	50

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. NO.	Experiment List
1	Familiarization with AVR simulator and trainer kit.
2	Assembly Code: Transfer, Arithmetic and Logical.
3	Assembly Code: Branch and Bitwise.
4	Assembly and Embedded C: Chip peripherals.
5	Installation of Arduino software and write program for blinking LED.
6	Read Push-button switch and display its status on LED using Arduino.
7	Interfacing Buzzer with AVR Board.
8	Serial Communication using AVR Board.
9	Interfacing of LED using AVR Board.
10	Interfacing 7-Segment LED Display with AVR Board.
11	Interfacing of 16x2 LCD with AVR board.
12	Interface 4x4 matrix keyboard with AVR microcontroller.
13	Read analogue voltage using AVR board.
14	Interfacing of Real Time Clock DS1307.
15	Interface DC Motor with AVR Microcontroller.

SEMESTER 7

a. **Course Name:** Medical Imaging Technology
b. **Course Code:** 303111401
c. **Prerequisite:** Basic knowledge of Physics, frequency spectrum and fundamentals of Electromagnetics is must.
d. **Rationale:** Advancement in the medical field due to imaging technology has opened up new field of interest, hence study of this subject will helpful for the Biomedical Engineers to understand the concept of imaging technology, instruments and applications.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the fundamentals of imaging based on radiation.
CLOBJ 2	Solve problems related to the various imaging modalities like X-ray, CT scan, MRI and Ultrasound.
CLOBJ 3	Acquire knowledge of the various imaging machines.
CLOBJ 4	Understand generation and detection of X-rays.
CLOBJ 5	Demonstrate a clear understanding of the different techniques for image reconstruction.

f. **Course Learning Outcomes:**

CLO 1	Explain the fundamentals of imaging based on radiation.
CLO 2	Classify the various imaging modalities like X-ray, CT scan, MRI and Ultrasound.
CLO 3	Sketch various imaging machines.
CLO 4	Reproduce generation and detection of X-rays.
CLO 5	Apply different techniques for image reconstruction.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**X-Ray Imaging** Fundamentals of X-Ray: Electromagnetic Radiation, Interactions between X-rays and Matter: Coherent Scattering, Photoelectric Effect, Compton Scattering, Pair Production and Photodisintegration, Attenuation. X-Ray Generation & Detection: White Radiation, Characteristic Radiation, X-ray tube or Generators, Line Focus Principle, Factors affecting X-ray Emission Spectrum, Filters, Beam Restrictors and Grids, Intensifying Screens, Image Intensifies, X-ray Film, H & D Curve, Radiation Detectors, quality and exposure. X- Ray Image Characteristic: Spatial Resolution, Point Spread Function, Line Spread Function, Edge Spread Function, System Transfer Function, Image Noise, Image Contrast. X-ray Diagnostic Method: Conventional X- ray Radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Digital Subtraction Angiography. Biological Effects of Ionizing Radiation	**25%**	**12**
2	**Computed Tomography** Operational modes: First, Second, Third, Fourth, Fifth generation Scanners. System components: Gantry, Collimation. Image characteristics: Image matrix, CT numbers, Image reconstruction algorithms, Spatial resolution, System noise, Image Artifacts.	**15%**	**6**
3	**Ultrasound Imaging** Fundamentals of Acoustical Propagation: Reflection and Refraction, Attenuation, Absorption and Scattering. Generation and Detection of Ultrasound: Piezoelectric Effect, Ultrasonic Transducers, Mechanical and Electrical Matching, Transducer Beam Characteristic, Huygens principle, Doppler effect, Beam profiles, pulsed ultrasonic filed, Visualization and mapping of the Ultrasonic field, Axial and Lateral Resolution, Focusing, Transducer Arrays. Ultrasonic Diagnostic Methods: Pulse-Echo Systems [A or Amplitude mode, B or Brightness mode, M or Motion mode & C or Constant depth mode], Doppler Methods, Duplex Imaging, Tissue Characterization [velocity, Attenuation or absorption, Scattering]. Developments in Ultrasound technique: Colour Doppler Flow Imaging [CW Doppler imaging device, Pulsed	**25%**	**12**

	Doppler imaging system, clinical applications], Ultrasound Contrast Media, Intracavity Imaging, 2-D echo cardiograph. Biological Effects of Ultrasound.		
4	**Magnetic Resonance Imaging** Principles of NMR imaging system, Image reconstruction techniques, Basic NMR components, Advantages and biological effect of NMR imaging system	**15%**	**6**
5	**Radionuclide Imaging** Radio-isotopes in medical diagnosis, Interaction of Nuclear particles with Matter. Radionuclide generators, Nuclear Radiation Detectors, Rectilinear Scanner, Gamma camera, Longitudinal Section Tomography, Single Photon Emission Computed Tomography, Positron Emission Tomography, Internal Radiation Dosimetry and Biological Effect.	**15%**	**6**
6	**Thermal imaging** Fundamentals of Medical Thermography, Infrared detectors, Thermographic equipment	**5%**	**3**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Principles of Medical Imaging, By K. Kirk Shung, Michael B. Smith, and Benjamin Tsui.; Academic Press
2. Handbook of Biomedical Instrumentation, By R.S.Khandpur
3. Radiologic science for Technologists, By Stewart C. Bushong; Mosby: A Harcourt Health Sciences Company.
4. Introduction to biomedical imaging, By Andrew Web; IEEE press series: Wiley Intercedence.
5. "Medical Imaging Signals and Systems" by Jerry L. Prince and Jonathan M. Links.

a. **Course Name:** Medical Imaging Technology Lab
b. **Course Code:** 303111402
c. **Prerequisite:** Basic knowledge of Physics, frequency spectrum and fundamentals of Electromagnetics is must.
d. **Rationale:** Advancement in the medical field due to imaging technology has opened up new field of interest, hence study of this subject will helpful for the Biomedical Engineers to understand the concept of imaging technology, instruments and applications.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the various Diagnostic methods of X-ray and Ultrasound Imaging.
CLOBJ 2	Solve problems related to various types of operational modes of CT scan.
CLOBJ 3	Acquire knowledge of the all-medical imaging modalities.
CLOBJ 4	Understand various image characteristics of X-ray, CT, MRI and USG.
CLOBJ 5	Demonstrate a clear applications of different imaging modalities.

f. **Course Learning Outcomes:**

CLO 1	Describe the various Diagnostic methods of X-ray and Ultrasound Imaging.
CLO 2	Classify various types of operational modes of CT scan.
CLO 3	Operate all medical imaging modalities.
CLO 4	Explain various image characteristics of X-ray, CT, MRI and USG.
CLO 5	Interpret Applications of different imaging modalities.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. No.	Experiment List
1	To study X-ray Imaging Techniques.
2	To study Computed Tomography.
3	To study Image Reconstruction Algorithms for CT scan.
4	To study about Imaging with Ultrasound.
5	To study different modes of Ultrasonography and Colour Doppler Flow Imaging.
6	To study Magnetic Resonance Imaging.
7	To study Radionuclide Imaging.
8	To study About Single Photon Emission Computed Tomography (SPECT).
9	To Study About Positron Emission Tomography (PET).
10	To study about Thermal Imaging

a. **Course Name:** Therapeutic Equipment
b. **Course Code:** 303111403
c. **Prerequisite:** Basic knowledge of biology, human anatomy, physiology, and chemistry is must.
d. **Rationale:** Due to growing need in the area of Health care sector and Biomedical instruments Study of Therapeutic Equipment will give insight to the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the Diagnostic and Therapeutic Equipment.
CLOBJ 2	Solve problems related the various Equipment with their working principle.
CLOBJ 3	Acquire knowledge of the various terminology related to therapeutic techniques.
CLOBJ 4	Understand the various terminology related to therapeutic techniques.
CLOBJ 5	Demonstrate a various heat balance methods.

f. **Course Learning Outcomes:**

CLO 1	Differentiate the Diagnostic and Therapeutic Equipment.
CLO 2	Describe the various Equipment with their working principle.
CLO 3	Identify the various terminology related to therapeutic techniques.
CLO 4	Classify the various LASERs with their Specific applications.
CLO 5	Explain various heat balance methods.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Cardiac Pacemakers** Need for cardiac pacemakers, External pacemaker, Implantable pacemakers, Type of Leads and Electrodes, Problems with leads and electrodes, Recent Developments in Implantable pacemakers, Pacing system analyser	10%	4
2	**DC Defibrillator** Need for a Defibrillator, DC defibrillator, Defibrillator electrode, DC defibrillator with synchronizer, Cardioverter, Implantable defibrillator and defibrillator analysers.	10%	4
3	**Surgical Diathermy** Principle of Surgical Diathermy, Electrosurgical equipment's & techniques- Electro tome, fulguration, coagulation, desiccation. Electrosurgery units- spark gap valve, solid-state generator. Construction and working of surgical diathermy machines, electrodes of surgical diathermy. Safety aspects in electro surgical units, surgical diathermy analyser.	20%	10
4	**The LASER** Principle operation of Laser, Types of Laser- Pulsed Ruby, CO2, HeNe, ND-YAG, Argon Laser, fibre-optic gastric photo coagulator, Application of LASER in surgery.	10%	4
5	**Physiotherapy Equipment's** High Frequency Heat Therapy, Short wave Diathermy, Microwave Diathermy, Ultrasonic Therapy unit, Electrotherapy, Electro diagnosis waveforms, Pain Relief through Electrical stimulation-TENS, spinal cord stimulator	15%	7
6	**Neonatal instrumentation** Incubator: physiological heat balance, heat production and heat loss methods, Apnea detection, Photo therapy devices.	5%	3
7	**Dialyzer**	12%	6

	Principle of dialysis, artificial kidney, function and working of dialyzer, Block diagram and working of haemodialysis machine, Blood leak detector, portable kidney machine.		
8	**Ventilator** Mechanics of Respiration, Artificial Ventilation, Types of Ventilator, Humidifiers, Nebulizers and Aspirators.	**8%**	**3**
9	**Anaesthesia Machine** Need of Anaesthesia, Delivery of Anaesthesia, Anaesthesia Machine, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.	**10%**	**4**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Handbook of Biomedical Instrumentation, By R.S.Khandpur
2. Introduction to Biomedical Equipment Technology, By J. J. Carr and J. M. Brown; Pearson Education, Delhi
3. “Bioinstrumentation”, By J.Webster,; Wiley & Sons.
4. Instrumental Methods of Analysis, By Willard, Merritt, Dean, Settle,; CBS Publishers & Distributors, New Delhi, Seventh edition.
5. "Medical Imaging Signals and Systems" by Jerry L. Prince and Jonathan M. Links.

a. **Course Name:** Therapeutic Equipments Lab
b. **Course Code:** 303111404
c. **Prerequisite:** Basic knowledge of biology, human anatomy, physiology, and chemistry is must.
d. **Rationale:** Due to growing need in the area of Health care sector and Biomedical instruments Study of Therapeutic Equipment will give insight to the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the working principle of haemodialysis machines.
CLOBJ 2	Solve problems related to Humidifiers, Nebulizers and Aspirators.
CLOBJ 3	Acquire knowledge of the Electro surgery techniques as per their different modes of operations.
CLOBJ 4	Understand various Electro diagnosis current waveforms.
CLOBJ 5	Demonstrate various Therapeutic Equipment.

f. **Course Learning Outcomes:**

CLO 1	Illustrate working principle of haemodialysis machine.
CLO 2	Differentiate Humidifiers, Nebulizers and Aspirators.
CLO 3	Write various Electro surgery techniques as per their different modes of operations.
CLO 4	Distinguish various Electro diagnosis current waveforms.
CLO 5	Operate various Therapeutic Equipment.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. No.	Experiment List
1	The study of Cardiac Pacemaker.
2	The study of Defibrillator along with its electrode and its basic instrumentation system.
3	The study of Surgical Diathermy Machine and Surgical Diathermy Analyzer.
4	The study of LASER along with its types and applications.
5	The study of short Wave, long wave & ultrasonic Diathermy.
6	The study of Neonatal Instrumentation.
7	The study of Heamodialysis Machine along with its types.
8	The study of ventilator machine.
9	The study of Anaesthesia Machine.

a. **Course Name:** Analytical techniques & Instrumentation
b. **Course Code:** 303111405
c. **Prerequisite:** Basic knowledge of biomedical instrumentation systems.
d. **Rationale:** Study of clinical science is useful for understanding Bioanalytical aspects of various instruments.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with different types of absorption instruments.
CLOBJ 2	Solve problems related to different techniques for analysing biological substances.
CLOBJ 3	Acquire knowledge of the utilization of optical instruments in biomedical engineering.
CLOBJ 4	Understand knowledge by developing the analytical system as per the clinical requirement with high accuracy.

f. **Course Learning Outcomes:**

CLO 1	Categorizing different types of absorption instruments.
CLO 2	Identifying different techniques for analyzing biological substances.
CLO 3	Expressing utilization of optical instruments in biomedical engineering.
CLO 4	Reproduce the knowledge by developing the analytical system as per the clinical requirement with high accuracy.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**

1	**Introduction** Fundamental concept of analytical instruments, Basic laboratory instruments- centrifuge, autoclave, hot air oven & their importance in clinical diagnosis. Electron microscopy & their importance in clinical diagnosis.	**10%**	**5**
2	**COLORIMETERS AND SPECTROPHOTOMETERS** Colorimeters: Principle, Constructional details, Single and double beam instruments, Sources and detectors, Application. Spectrophotometers: UV-Visible spectrophotometer, IR spectrophotometers. Flame Photometry: Principle, Constructional details, Application. Mass Spectrometer (MS): Principle, Constructional details, Ionization methods, X-ray spectrometry: Instrumentation for X-ray spectrometry, X-ray diffractometer.	**25%**	**12**
3	**CHROMATOGRAPHY** Classification, Gas chromatography: Principle, Constructional details, GC detectors, Liquid Chromatography, High Performance Liquid Chromatography (HPLC): Principle, constructional details.	**15%**	**7**
4	**BLOOD CELL COUNTERS** Types of blood cells, Methods of cell counting, Automatic recognition and differential counting of cells.	**15%**	**6**
5	**BLOOD GAS ANALYZERS** Blood pH Measurement, Measurement of blood pCO2, calculated bicarbonate, Total CO2 and Base excess, Blood pO2 measurement, Complete blood gas analyser.	**20%**	**8**
6	**ELECTROPHORESIS** Overview of electrophoresis, Types of Electrophoresis, Basis for electrophoretic separations, various types of detection in capillary electrophoresis, Applications to biomolecules.	**15%**	**7**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Handbook of Analytical Instruments, By R. S. Khandpur; Tata McGraw–Hill Publications; 3rd edition

2. Principles and techniques of Biochemistry and Molecular Biology, By Keith Wilson and John Walker.
3. "Analytical Chemistry: A Practical Approach" by K. A. Rubinson and R. K. Ziemer.
4. "Quantitative Chemical Analysis" by Daniel C. Harris. "Analytical Chemistry: An Introduction" by Douglas A. Skoog, Donald M. West, F. James Holler, and Stanley R. Crouch.
5. "Introduction to Instrumental Analysis" by Robert D. Braun.

a. **Course Name:** Analytical techniques & Instrumentation Lab
b. **Course Code:** 303111406
c. **Prerequisite:** Basic knowledge of biomedical instrumentation systems.
d. **Rationale:** Study of clinical science is useful for understanding Bioanalytical aspects of various instruments.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with different techniques used in medical laboratories.
CLOBJ 2	Solve problems related to different chromatography techniques
CLOBJ 3	Acquire knowledge of the devices used in medical laboratories.
CLOBJ 4	Understand the working mechanism of various lab instruments.

f. **Course Learning Outcomes:**

CLO 1	Summarizing different techniques used in medical laboratories.
CLO 2	Differentiating different chromatography techniques
CLO 3	Identifying the devices used in medical laboratories.
CLO 4	Interpret the working mechanism of various lab instruments.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **List of Experiments:**

Sr. No.	**Experiment List**
1	To analyse the morphology of cells.
2	To study thin layer chromatography.
3	To study about HPLC.
4	To study about Flame photometers.
5	To perform gas chromatography

6	To perform Gel Electrophoresis.
7	To measure concentration of substance using a colorimeter.
8	To study the density of bands on a polyacrylamide gel.
9	To study about Mass spectrometry
10	To study absorption of unknown samples using a spectrophotometer.
11	To learn about immune analyzer
12	To learn about automated biochemistry analyser

a. **Course Name:** Hospital Information System & Regulatory Standards
b. **Course Code:** 303111407
c. **Prerequisite:** Hospital training, Basic knowledge of medical device and hospital management
d. **Rationale:** The purpose of learning this course for biomedical engineering students is to acquire knowledge and understand the basic functionalities of hospital services with their standards.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the basic role and designing of hospitals
CLOBJ 2	Solve problems related to the clinical and diagnostic services of hospitals
CLOBJ 3	Acquire knowledge of the need for staff and safety management
CLOBJ 4	Understand foundational information related to the global regulation of medical devices with emphasis placed on the US and EU and their submission process.
CLOBJ 5	Demonstrate a role of the global regulatory professional will be examined in the context of these regulatory frameworks to design medical devices

f. **Course Learning Outcomes:**

CLO 1	Illustrate the basic role and designing of hospitals
CLO 2	Reproduce the clinical and diagnostic services of hospitals
CLO 3	Interpret The need for staff and safety management
CLO 4	Analyse and provide foundational information related to the global regulation of medical devices with emphasis placed on the US and EU and their submission process.
CLO 5	Reproduce The role of the global regulatory professional will be examined in the context of these regulatory frameworks to design medical devices

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
2	**-**	**-**	**2**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Role of Hospitals in Health Care** Hospitals in India, the changing roles of hospital in healthcare, Hospital Viewed as a System, Components of a hospital system, Intramural and Extramural Functions of Hospital, Proliferation of specialty hospitals, Classification of Hospitals, Levels of Medical Care, Various tasks of planning and designing in hospital	12%	3
2	**Clinical, Diagnostic and Supportive Services** Outpatient Services, Intensive Care Unit, Nursing Services, Operation theatre services, Laboratory services, Radiology and imaging services, Pharmacy services, Central Sterile Supply Department (CSSD)	13%	5
3	**Staff, Safety and Material Management** Biomedical waste management, Hospital Linen and Laundry Service, Hospital Infection, Hospital Utilisation Statistics, Materials Management	12%	5
4	**Introduction to medical devices and need of Regulatory Affairs** Introduction, Classification of medical devices, Purpose and principle for regulations, Development of regulations and safety standards for medical devices	8%	2
5	**Governmental regulations of medical devices and standards** Phases in the life span of a medical device, Participants in ensuring the safety of medical devices, the role of each participant/stakeholder, Shared responsibility for medical device safety and performance, Critical elements for regulatory attention, Stages of regulatory control, Standards - Need of standards, Standards development process, Conformity assessment with standards, Identification of standards	20%	4
6	**The Process of Gaining approval for New Medical Device** Introduction, USA: Classification of device, Premarket submission, Documentation for necessary submission to FDA, Premarket review, Final registration and listing	10%	3

7	**Regulations and Standards in Medical Devices for USA and EU** Introduction, Legislation and Device Laws, Total Product Life Cycle Approach, The Regulatory Environment for Bringing a Medical Device to Market, Regulatory Considerations to Market and Keep Devices in Distribution, New Approach concept for European directives, Harmonized standards and various bodies in EU, Overview of medical devices directives in EU, Risk based classification of medical devices as per EU, CE mark and procedure to obtain CE Mark, Essential requirements for obtaining CE mark for medical devices	**25%**	**8**
	Total:	**100 %**	**30**

i. Text Book and Reference Book:

1. Principles of hospital administration and planning, By B M Sakharkar; Jaypee Brothers Medical Publishers; 2ndedition, 2009
2. Handbook of Medical Device Regulatory affairs in Asia, By Jack Wong, Raymond K. Y. Tong; Pan Stanford Publishing
3. Medical Devices: Regulations, Standards and Practices, By Seeram Ramakrishna, Lingling Tian, Charelene Wang, Susan Liao and Wee Eong Teo; Woodhead publishing house.
4. Medical Products and Regulatory Affairs – Pharmaceuticals, Diagnostics, Medical Device, By John J. Tobin and Gary Walsh; Wiley- VCH.
5. "Hospital and Healthcare Security" by Russell L. Colling.

a. **Course Name:** Virtual Biomedical Instrumentation
b. **Course Code:** 303111410
c. **Prerequisite:** Simulation & Design tools and biomedical Instrumentation
d. **Rationale:** To Learn to acquire, condition, and reduce data collected from biomedical instrumentation
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity and acquire, condition, and reduce data collected from biomedical instrumentation.
CLOBJ 2	Solve problems of mathematics, physical sciences, life sciences and engineering to formulate and study or solve engineering problems, including problems at the interface of engineering, medicine, and biology.
CLOBJ 3	Acquire knowledge of the virtual instruments for practical works.
CLOBJ 4	Understand design of the clinically required instruments.

f. **Course Learning Outcomes:**

CLO 1	Learn to acquire, condition, and reduce data collected from biomedical instrumentation.
CLO 2	Apply knowledge of mathematics, physical sciences, life sciences and engineering to formulate and study or solve engineering problems, including problems at the interface of engineering, medicine, and biology.
CLO 3	Create virtual instruments for practical works.
CLO 4	Interpret and design the clinically required instruments.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**4**	**2**	**-**	**-**	**50**	**-**	**50**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments:

Sr. No.	Experiment List
1	To perform basic arithmetic operations using LabVIEW
2	To perform Boolean operations using LabVIEW
3	To find the sum of 'n' numbers using 'FOR' and 'WHILE' Loop.
4	To perform the factorial of a given number using 'FOR' and 'WHILE' Loop.
5	To perform ARRAY operation using LabVIEW
6	To perform functions using flat and stacked sequence
7	To perform functions using Case structure
8	To design sine wave Generator
9	To perform convolution of two signals
10	To apply filtering technique for a given input signal
11	To perform transform technique on the given signal
12	To apply different windowing technique on the given input signal
13	To acquire and analyze an ECG signal using Lab VIEW
14	To perform Blood Pressure measurement using LabVIEW
15	To perform Heart rate measurement and analysis of HRV using LabVIEW
16	To perform Temperature measurement using LabVIEW

a. **Course Name:** Project-I
b. **Course Code:** 303111412
c. **Prerequisite:** Basic knowledge of Basic Electronics, microcontroller and Biomedical instrumentation required
d. **Rationale:** To make students understand basic concepts of electronics and instrumentation which will help them to create new innovation.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Various Diagnosis Instruments
CLOBJ 2	Solve problems related to Various therapeutic Instruments
CLOBJ 3	Acquire knowledge of the Various life-threatening instruments
CLOBJ 4	Understand any new innovative solution for the healthcare industry.

f. **Course Learning Outcomes:**

CLO 1	Design Various Diagnosis Instruments
CLO 2	Modify Various therapeutic Instruments
CLO 3	Design Various life-threatening instruments
CLO 4	Develop any new innovative solution for the healthcare industry.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**12**	**6**	**-**	**-**	**100**	**-**	**100**	**200**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. **Course Name:** Summer Internship-II
b. **Course Code:** 303111414
c. **Prerequisite:** Basic knowledge of equipment
d. **Rationale:** To make students understand basic concepts of electronics and instrumentation which will help them to create new innovation.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Various Diagnosis Instruments
CLOBJ 2	Solve problems related to Various therapeutic Instruments
CLOBJ 3	Acquire knowledge of the Various life-threatening instruments
CLOBJ 4	Understand new innovative solution for healthcare industry

f. **Course Learning Outcomes:**

CLO 1	Interpret Various Diagnosis Instruments
CLO 2	Analyse Various therapeutic Instruments
CLO 3	Design Various life-threatening instruments
CLO 4	Develop any new innovative solution for healthcare industry

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**-**	**2**	**-**	**-**	**50**	**-**	**-**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. **Course Name:** Nanotechnology for Medical Applications
b. **Course Code:** 303111431
c. **Prerequisite:** Basic Physics, Mechanics, Basic principles of different sensors, Basics of Material science required
d. **Rationale:** Bio-MEMS and Nano technology is the growing field. The application of Bio-MEMS and Nano technology in the medical instrumentations gives insight for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the MEMS Technology and its biomedical application
CLOBJ 2	Solve problems related to MEMS Sensors and Actuators, biosensors, smart sensors
CLOBJ 3	Acquire knowledge of the MEMS Sensors and Actuators, biosensors, smart sensors
CLOBJ 4	Understand various applications for curing different diseases accurately by using BioMEMS Technology.

f. **Course Learning Outcomes:**

CLO 1	Interpret the MEMS Technology and its biomedical application
CLO 2	Learn MEMS Sensors and Actuators, biosensors, smart sensors
CLO 3	Learn MEMS Sensors and Actuators, biosensors, smart sensors
CLO 4	Illustrate the various applications for curing different diseases accurately by using BioMEMS Technology.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage(%)	Teaching Hours
1	**Introduction to Micro-electro-mechanical (MEMS) Technology** Historical perspective, Development of MEMS Technology, MEMS Technology: Present, Future and Challenges, MEMS Applications, Comparison of MEMS and Microelectronics.	12%	7
2	**MEMS Sensors and Actuators** MEMS Actuators, MEMS Sensing, Electron Tunnelling, Sensor Noise, MEMS Physical Sensors, Chemical Sensors.	8%	2
3	**Micro/Nano Biosensors** Classification of physical sensors, Integrated, Intelligent or Smart sensors, Bio sensing Principles and sensing methods, Biosensors arrays and Implantable devices	10%	6
4	**Introduction to different Biomedical Applications of Microsystems** Delivery of Diagnostic and Therapeutic Agents to Vascular Targets, Real-Time Biological Imaging and Detection, Diagnostic and Therapeutic Applications of Metal Nano shells, Micro devices for Oral Drug Delivery etc	10%	6
5	**Introduction to Nanotechnology** Nanoparticles and Colloids, structure and bonding in nanoparticles, Nanomaterials fabrication by Bottom-up and Top- down approaches, Classification of Nano devices based on the characteristics, Quantum dots and their properties.	20%	8
6	**Carbon nanotubes** Carbon nanoparticles, types of carbon nanotubes, single-walled, multiwalled, torus, Nano bud, properties of carbon nanotubes, and synthesis by Arc discharge, laser ablation, chemical vapour deposition techniques.	20%	8
7	**Nano medicine** Medical use of Nanomaterials, Drug delivery systems, Cancer treatment, Surgery, Drug tracking systems, Targeted drug delivery systems.	10%	4
8	**Nano molecular imaging**	10%	4

	Applications of Nanomaterials in Medical imaging, Neuro-electronic interfaces.		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, By Tuan Vo-Dinh; CRC press, 2006
2. Introduction to Nanotechnology, By Charles Pooles, Frank J. Ownes; Wiley, 2003
3. Handbook of Nanotechnology, By Bharat Bhushan; Springer, 2003.
4. Nanotechnology-Enabled Sensors, By Kourosh Kalantar-zadeh, Benjamin Fry; Springer US; 1 edition.
5. Emerging Nanotechnology, By M. P. Arora; Discovery Publication House Pvt. Ltd

a. **Course Name:** Nanotechnology for Medical Applications Lab
b. **Course Code:** 303111432
c. **Prerequisite:** Basic Physics, Mechanics, Basic principles of different sensors, Basics of Material science required
d. **Rationale:** Bio-MEMS and Nano technology is the growing field. The application of Bio-MEMS and Nano technology in the medical instrumentations gives insight for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with MEMS Sensors and Actuators, biosensors, smart sensors
CLOBJ 2	Solve problems related different challenges to design Biomedical Microsystems
CLOBJ 3	Acquire knowledge of the various applications for curing different diseases accurately by using BioMEMS Technology
CLOBJ 4	Understand interpret the required modification needed in the various systems with help of nanotech

f. **Course Learning Outcomes:**

CLO 1	Reproduce MEMS Sensors and Actuators, biosensors, smart sensors
CLO 2	Illustrate different challenges to design Biomedical Microsystems.
CLO 3	Interpret the various applications for curing different diseases accurately by using BioMEMS Technology
CLO 4	Analyse and interpret the required modification needed in the various systems with help of nanotech.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Sr. No.	Experiment List
1	To Study about MEMS
2	To study about MEMS Actuators
3	To Study about Micro/Nano Biosensors
4	To study about the applications of Microsystems in Biomedical Engineering
5	To Study about Carbon Nanotubes
6	To Study about Nano medicine
7	To study about Nano molecular Imaging
8	To Study about Drug delivery systems
9	To Study about the application of sensors

a. **Course Name:** Internet of Things
b. **Course Code:** 303111433
c. **Prerequisite:** Fundamentals of Embedded system, Wireless Communication, internet technology
d. **Rationale:** The explosive growth of the [3]Internet of Things" is changing our world. IoT components are allowing people to innovate new designs and products at home. In this course students will learn the importance of IoT in society, the current components of typical IoT devices and trends for the future. This course will make students understand Hardware and software component for IoT. This course is also cover components of the networking and how to connect devices with internet.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the term "Internet of Things".
CLOBJ 2	Solve problems and the technological trends which have led to the “Internet of Things”.
CLOBJ 3	Acquire knowledge of the impact of the “Internet of Things” on society.
CLOBJ 4	Understand the impact of IoT on society.
CLOBJ 5	Demonstrate the interactions of embedded systems with the physical world.

f. **Course Learning Outcomes:**

CLO 1	Reproduce the term "Internet of Things".
CLO 2	State the technological trends which have led to the “Internet of Things”.
CLO 3	Describe the impact of “Internet of Things” on society.
CLO 4	Describe the impact of IoT on society.
CLO 5	Describe the interactions of embedded systems with the physical world.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction** The Internet of Things Today, Internet of Things Vision, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technology Embedded System, Wireless Sensor Networks, Communication Protocols, Big Data analysis, Cloud Computing, IoT Devices, IoT Devices vs. Computers, Societal Benefits of IoT, Risks, Privacy, and Security.	**15%**	**7**
2	**IoT and M2M** Introduction, Machine-to-Machine communication, Difference between IoT and M2M, Software Defined Networking and Network Function Virtualization, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies.	**15%**	**7**
3	**IoT Architecture** Introduction, Architecture Reference Model, IoT Design Methodology Purpose and Requirement Specification, Process Specification, Domain Model Specification, Functional View, Information View, Deployment and Operational View, Device and Component Integration, Other Relevant architectural views, Application Development, Protocol of IoT	**15%**	**7**
4	**Hardware and Software** Arduino Board: Arduino Platform, Arduino IDE, Compiling Code, Arduino Shields, Arduino Basic Setup & Interface. Raspberry Pi: About the board, Raspberry Pi Interfaces, Serial, SPI, Programming Raspberry Pi, Controlling LED with Raspberry pi	**20%**	**9**
5	**IoT Applications** Introduction, IoT applications for industry: Future Factory Concepts, Smart Objects, Smart Applications, Opinions on IoT Application and Value for Industry, Home Automation, Environment, Energy, Health and Lifestyle, Retail & Logistics, Agriculture, Case Studies : Smart Cities.	**20%**	**8**
6	**Internet of Things Privacy, Security and Governance**	**15%**	**7**

	Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoTData-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities		
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. "Internet of Things (A Hands-on-Approach)", By Vijay Madisetti and Arshdeep Bahga,; VPT
2. Arduino Cookbook, By Michael Margolis; O'Really Publication
3. "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", By Francis daCosta,; Apress Publications.
4. Getting Started with the Internet of Things, By Cuno Pfister,; O"Reilly Media.
5. The internet of things, Enabling Technologies, platform and use cases, By Pethuru raj and anupama c. rajann ,; CRC press
6. Internet of things- from research and innovation to market deployment, By Dr. ovidiu vermason ,; river publishers.

a. **Course Name:** Internet of Things Lab
b. **Course Code:** 303111434
c. **Prerequisite:** Fundamentals of Embedded system, Wireless Communication, internet technology.
d. **Rationale:** The explosive growth of the [3]Internet of Things" is changing our world. IoT components are allowing people to innovate new designs and products at home. In this course students will learn the importance of IoT in society, the current components of typical IoT devices and trends for the future. This course will make students understand Hardware and software component for IoT. This course is also cover components of the networking and how to connect devices with internet.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the Arduino with Motors
CLOBJ 2	Solve problems related to Raspberry Pi with any system components.
CLOBJ 3	Acquire knowledge of the Arduino platform for their research project
CLOBJ 4	Understand the knowledge by working on the real time project and develop new systems.

f. **Course Learning Outcomes:**

CLO 1	Interface the Arduino with Motors
CLO 2	Connect Raspberry Pi with any system components.
CLO 3	Work on Arduino platform for their research project
CLO 4	Reproduce the knowledge by working on the real time project and develop new systems.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiments :

Sr. NO.	Experiment List
1	To Study about basic Architecture of the internet of things.
2	Demonstrations of Different IOT devices.
3	Introduction to Arduino board (NODE MCU) and working of Raspberry Pi.
4	Interfacing of Arduino board with LED and Switches also Interfacing Raspberry Pi board with LED.
5	Interfacing of Arduino with Sensor like IR sensor.
6	Interfacing of Arduino with Temperature sensor & Humidity sensor (DHT 22).
7	Interfacing of Arduino with Motors.
8	Connect Raspberry Pi with your existing system components.
9	Introduction and working of Raspberry Pi.
10	Interfacing Raspberry Pi board with LED.
11	Interfacing Raspberry Pi Board with Light sensor (LDR).
12	Interfacing Raspberry Pi Board with Switch and other Devices.
13	Interfacing of Raspberry Pi Board with, Temperature Sensor, Ultrasonic Sensor.
14	Case Study on IoT Applications.
15	To study on OEP

a. **Course Name:** Artificial Organ & Rehabilitation Devices
b. **Course Code:** 303111435
c. **Prerequisite:** Basic knowledge of physics and Biology is required
d. **Rationale:** Study of Biomechanics is useful for understanding Human body motion and load, joint structure, and kinetics of human movements for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the availability of different artificial organs.
CLOBJ 2	Solve problems related to Implementing artificial organs.
CLOBJ 3	Acquire knowledge of the Analysing & designing artificial organs.
CLOBJ 4	Understand the modern requirements of the artificial organs.

f. **Course Learning Outcomes:**

CLO 1	Summarizing availability of different artificial organs.
CLO 2	Implementing artificial organs.
CLO 3	Analysing & designing artificial organs.
CLO 4	Illustrate the modern requirements of the artificial organs.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**
1	**INTRODUCTION TO ARTIFICIAL ORGANS** Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction. Rheological	**15%**	**7**

	properties of blood, blood viscosity variation: effect of shear rate, haematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow.		
2	**ARTIFICIAL KIDNEY** Brief of kidney filtration, basic methods of artificial waste removal, haemodialysis, equation for artificial kidney and middle molecule hypothesis. Hemodialyzers: flat plate type, coil type and hollow fibre. Analysis of mass transfer in dialyzers (cross current & concurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients.	**20%**	**9**
3	**HEART-LUNG MACHINE** Brief of lungs gaseous exchange / transport, artificial heart-lung devices. Oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators. Liver support system, artificial pancreas, blood and skin.	**25%**	**11**
4	**REHABILITATION ENGINEERING** Artificial hands, prosthetic heart valves. Externally powered and controlled orthotics and prosthetics. Myoelectric hand and arm prostheses. The Marcus intelligent hand prostheses, spinal rehabilitation.	**25%**	**11**
5	**MISCELLENEOUS** Audiometry: air conduction, bone conduction, masking, functional diagram of an audiometer. Hearing aids: different types, receiver amplifiers. Bionic eye	**15%**	**7**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Artificial Organs, By Gerald E. Miller; Morgan &Claypool Publishers, 2006
2. Rehabilitation Engineering, By Robbinson C.J; CRC press, 1995
3. "Artificial Organs" by Joseph F. Cataldo and Ronald E. Gordon.
4. "Artificial Organs" edited by Martin Lysaght and Thomas R. Schuman.
5. "Artificial Organs" edited by Claudio Ronco and William H. Fissell.
6. "Artificial Organs" edited by Anthony Atala and Robert Lanza.

a. **Course Name:** Artificial Organ & Rehabilitation Devices Lab
b. **Course Code:** 303111436
c. **Prerequisite:** Basic knowledge of physics and Biology is required
d. **Rationale:** Study of Biomechanics is useful for understanding Human body motion and load, joint structure, and kinetics of human movements for the Biomedical Engineers.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the availability of different artificial organs.
CLOBJ 2	Solve problems related to Implementing artificial organs.
CLOBJ 3	Acquire knowledge of the Analysing & designing artificial organs.
CLOBJ 4	Understand the modern requirements of the artificial organs.

f. **Course Learning Outcomes:**

CLO 1	Summarizing availability of different artificial organs.
CLO 2	Implementing artificial organs.
CLO 3	Analysing & designing artificial organs.
CLO 4	Illustrate the modern requirements of the artificial organs.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. **List of Experiments**

Sr. NO.	**Experiment List**
1	To study different types of material properties for artificial organs.
2	Analysis of the function of the dialyzer.
3	To study about artificial pancreas
4	To study bioelectric eye.
5	To study biomechanics properties of the upper limb.
6	To study biomechanics properties of the lower limb.

7	To study EMG signals for myoelectric arm.
8	To study artificial noses.
9	To study the properties of artificial heart valves.
10	To study about materials for pacemaker
11	To learn about different orthosis
12	To learn about different prostheses.

SEMESTER 8

a. **Course Name:** Digital image processing for Biomedical
b. **Course Code:** 303111451
c. **Prerequisite:** Basic knowledge of Mathematics is required.
d. **Rationale:** Knowledge of Digital Image Processing is required to understand representation of image in pixels and applying various image processing techniques for enhancement of image quality.

e. Course Learning Objective:

CLOBJ 1	Gain familiarity with digital image processing in various applications.
CLOBJ 2	Solve problems related to the knowledge to design the digital system for various image processing applications.
CLOBJ 3	Acquire knowledge of the implement image processing algorithms.
CLOBJ 4	Understand experience in using software tools for processing digital images.

f. Course Learning Outcomes:

CLO 1	Apply principles and techniques of digital image processing in various applications.
CLO 2	Reproduce the knowledge to design the digital system for various image processing applications.
CLO 3	Analyze and implement image processing algorithms.
CLO 4	Gain hands-on experience in using software tools for processing digital images.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Digital Image Fundamentals** Human visual system, Image as a 2D data, Image representation - Gray scale and Colour images, image sampling and quantization.	**12%**	**5**
2	**Image enhancement in Spatial domain** Basic gray level Transformations, Histogram Processing, Spatial Filtering.	**15%**	**7**
3	**Filtering in the Frequency Domain** Preliminary Concepts, Extension to functions of two variables, Image Smoothing, Image Sharpening, Homomorphic filtering, 2D- DFT, 2DFFT, 2D- DCT, Fundamentals of 2D-wavelet transform, Image pyramids, sub-band coding.	**15%**	**7**
4	**Image Restoration and Reconstruction** Noise Models, Noise Reduction, Inverse Filtering, MMSE (Wiener) Filtering.	**12%**	**5**
5	**Colour Image Processing** Colour Fundamentals, Colour Models, Pseudocoelom image processing	**11%**	**5**
6	**Image Compression** Fundamentals of redundancies, Basic Compression Methods: Huffman coding, Arithmetic coding, LZW coding, JPEG Compression standard.	**11%**	**5**
7	**Image Segmentation** Edge based segmentation, Region based segmentation, Region split and merge techniques, Region growing by pixel aggregation, optimal thresholding.	**13%**	**6**
8	**Morphological Image Processing** Erosion, dilation, opening, closing, Basic Morphological Algorithms: hole filling, connected components, thinning, skeletons.	**11%**	**5**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Digital Image Processing, By Rafael C. Gonzalez and Richard E. Woods; Pearson Education
2. Digital Image Processing, By S Sridhar; Oxford University Press
3. Digital Image Processing using MATLAB, By Gonzalez, Rafael C. , Woods, Richard E., Eddins, Steven L.; Dorling Kindersley (India) Pvt. Ltd. ,.
4. Digital Image Processing, By S Jayaraman, S Esakirajan and T Vera Kumar; McGraw Hill.
5. "Handbook of Biomedical Image Analysis" edited by David Wilson and Swamy Laxminarayan.

a. **Course Name:** Digital image processing for Biomedical Lab
b. **Course Code:** 303111452
c. **Prerequisite:** Basic knowledge of Mathematics and MATLAB is required.
d. **Rationale:** Knowledge of Digital Image Processing is required to understand representation of image in pixels and applying various image processing techniques for enhancement of image quality.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with digital image processing in various applications.
CLOBJ 2	Solve problems related to the knowledge to design the digital system for various image processing applications.
CLOBJ 3	Acquire knowledge of the implement image processing algorithms.
CLOBJ 4	Understand experience in using software tools for processing digital images.

f. **Course Learning Outcomes:**

CLO 1	Apply principles and techniques of digital image processing in various applications.
CLO 2	Reproduce the knowledge to design the digital system for various image processing applications.
CLO 3	Analyze and implement image processing algorithms.
CLO 4	Gain hands-on experience in using software tools for processing digital images.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
-	**-**	**2**	**1**	**-**	**-**	**20**	**-**	**30**	**50**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. List of Experiment:

Sr. NO.	Experiment List
1	Write a program to read and display digital images using MATLab or SciLab.
2	To write a program for Histogram calculation and Equalization.
3	To write and execute image processing programs using point processing methods.
4	To write and execute programs for Image arithmetic operations.
5	To write and execute programs for Image Logical operations.
6	To write and execute a program for geometry transformations of image.
7	To understand various image Noise models and to write programs for Image Restoration
8	To write and execute programs to remove Noise using spatial filters.
9	To write and execute program for edge detection of medical image
10	To write and execute program for Image morphological operations
11	To write and execute a program for marker-controlled watershed segmentation on an image.
12	To study Image Processing Operations in ImageJ Software.

a. **Course Name:** Project-II
b. **Course Code:** 303111454
c. **Prerequisite:** Basic knowledge of Basic Electronics, microcontroller and biomedical instrumentation required.
d. **Rationale:** To make students understand basic concepts of electronics and instrumentation which will help them to create new innovation.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Various Diagnosis Instruments.
CLOBJ 2	Solve problems related to Various therapeutic Instruments.
CLOBJ 3	Acquire knowledge of the Various life-threatening instruments.
CLOBJ 4	Understand any new innovative solution for the healthcare industry.

f. **Course Learning Outcomes:**

CLO 1	Design Various Diagnosis Instruments.
CLO 2	Modify Various therapeutic Instruments.
CLO 3	Design Various life-threatening instruments.
CLO 4	Develop any new innovative solution for the healthcare industry.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
-	**-**	**12**	**6**	**-**	**-**	**100**	**-**	**100**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

a. **Course Name:** Tissue Engineering
b. **Course Code:** 303111481
c. **Prerequisite:** Basic knowledge of human anatomy and physiology, biomaterials and implants
d. **Rationale:** This course will help in understanding the replacing or restoring function in injured or diseased tissues. Biomaterials, particularly novel polymeric materials, are essential to the goals of tissue engineering, and also include the development of materials for controlled drug delivery and other biomedical applications.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with interpret cell biology to engineering problems in regenerative medicine
CLOBJ 2	Solve problems related to material science to the design of tissue-engineered constructs.
CLOBJ 3	Acquire knowledge of the working mechanism of different tissues at various levels.
CLOBJ 4	Understand the use of regenerative nature of tissue by enforcing it to maximum extent.

f. **Course Learning Outcomes:**

CLO 1	Reproduce and interpret cell biology to engineering problems in regenerative medicine
CLO 2	Illustrate material science to the design of tissue-engineered constructs.
CLO 3	Analyse the working mechanism of different tissues at various levels.
CLO 4	Interpret the use of regenerative nature of tissue by enforcing it to maximum extent.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to tissue engineering** Introduction to tissue engineering, Biochemical influence on cell function, Interaction between cells and their environment.	**15%**	**7**
2	**Cell growth and differentiation** The cell cycle, stem cell and cell differentiation, agents that regulate cell growth and differentiation.	**12%**	**6**
3	**Cell adhesion** Mechanics of cell adhesion, cell junctions, cell adhesion receptors, extracellular matrix, cell adhesion and intracellular signalling.	**12%**	**6**
4	**Cell migration** Overview of cell migration. Cell aggregation and cell sorting overview.	**10%**	**5**
5	**Cells micro mechanisms** Cells micro mechanisms for regeneration and repair stem cells, Biomaterials in tissue engineering, Tissue culture, Bioreactors and bimolecular production, Immunity and surface reaction	**20%**	**8**
6	**Skin tissue engineering** Skin tissue engineering, Bone and cartilage tissue engineering, Cardiac tissue engineering, Valve tissue engineering, Vascular tissue engineering, neural tissue engineering, visceral tissue engineering.	**15%**	**7**
7	**Organ and tissue transplantation, Scaffold design and fabrication** Organ and tissue transplantation, Scaffold design and fabrication	**8%**	**3**
8	**Case studies in tissue engineering** Tissue engineered cartilage, tissue engineered skin, Tissue engineering approaches to nerve regeneration.	**8%**	**3**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Biomaterials Medical Devices and Tissue Engineering, By Fredrick H. Silver Chapman and Hall
2. Tissue engineering: Principles for the design of replacement organs and tissues (TextBook), By W. Mark Saltzman; Oxford University Press
3. Biomaterials - Principles and Applications – CRC Press, 2003 (TextBook), By JoonB.Park Joseph D. Bronzino.
4. Biomaterials Science- An introduction to materials in medicine, By Buddy D. Ratner, Allan S. Hoffman, Frederick j. Schoen, Jack E. Lemons.
5. "Tissue Engineering and Regenerative Medicine: A Nano Approach" by Murugan Ramalingam, Seeram Ramakrishna, and S. M. Ali Jawaid.

a. **Course Name:** Radiotherapy
b. **Course Code:** 303111483
c. **Prerequisite:** Basic knowledge of biomedical instruments, medical physic
d. **Rationale:** To obtain the knowledge about the specialty of medicine those deals with the study and application of imaging technology and enable the students to understand about radiation therapy and effects of radiation.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with Interpretation about radiation therapy and effects of radiation.
CLOBJ 2	Solve problems related to the use of radiation in therapy and treatment purposes.
CLOBJ 3	Acquiring knowledge illustrates the harmful effects produced by various radiation.
CLOBJ 4	Understand the knowledge for developing the system for minimum radiation effect on the individuals.

f. **Course Learning Outcomes:**

CLO 1	Interpretation about radiation therapy and effects of radiation.
CLO 2	Illustrate the use of radiation in therapy and treatment purposes.
CLO 3	Analyze and illustrate the harmful effects produced by various radiation.
CLO 4	Reproduce the knowledge for developing the system for minimum radiation effect on the individuals.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	**Content**	**Weightage (%)**	**Teaching Hours**

1	**ELEMENTS OF RADIATION** Radioactive elements and Radioisotopes in medicine, Radioactivity, General properties of alpha, beta and gamma rays - Laws of radioactivity, Radioactive decay - alpha decay, beta decay, positron decay, decay energy and half-life. Radiation units-Roentgen, Rad – rem - Sievert. Radiation sources - Natural and artificial radioactive sources.	**20%**	**9**
2	**RADIATION GENERATORS** Particle Accelerators- Cyclotron, Klystron, Magnetron, Cascade generator, Van De Graff generator X ray films, X ray film processing, X Ray cassettes, Intensifying screens-New phosphor technology, Photostimulable phosphor imaging.	**15%**	**6**
3	**RADIO DIAGNOSIS** Fluoroscopy, Digital radiography, Angiography, Image intensifier, PET, SPECT, collimators, grids bucky grids, Body section radiography, Xeroradiography	**15%**	**6**
4	**RADIOTHERAPY** COBALT-60, Linac, Gamma camera, Nuclear scintigraphy, Brachytherapy, Cyber Knife, Gamma knife, Intraoperative radiotherapy	**20%**	**9**
5	**RADIATION SAFETY MEASURE** Radiation Protection, Protective barrier-primary& secondary, Equivalent Dose, Biological effects of radiation, Somatic & genetic effects of radiation-LD 50/30, Effect of radiation on skin, blood forming organs, Personnel and area monitoring systems, Radiation measuring devices - dosimeter, survey meter.	**30%**	**15**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Radiologic science for Technologists (TextBook), By Stewart C. Bushong; Mosby: A Harcourt Health Sciences Company
2. Principles of Medical Imaging (TextBook), By K. Kirk Shung, Michael B. Smith, and Benjamin Tsui.; Academic Press
3. The Physics of Radiation Therapy (TextBook), By Faiz M Khan; 3rd.
4. Radiobiology for the Radiologist (TextBook), By Hall E J; 6th.
5. "Clinical Radiation Oncology" by Leonard L. Gunderson and Joel E. Tepper

a. **Course Name:** Biomedical microsystems
b. **Course Code:** 303111485
c. **Prerequisite:** Basic Physics, Mechanics, Basic principles of different sensors, Basics of Material science.
d. **Rationale:** To impart in students detailed knowledge about Principle and working of Micro electro mechanical system (MEMS), to give brief knowledge about Fabrication process of MEMS. To give brief knowledge about applications of Bio Microelectromechanical System (Bio-MEMS) technology for therapeutic, diagnosis etc.
e. **Course Learning Objective:**

CLOBJ 1	Gain familiarity with the MEMS Technology and its biomedical application.
CLOBJ 2	Solve problems related to the Fabrication process of Micro electro mechanical systems.
CLOBJ 3	Acquire knowledge of the MEMS Sensors and Actuators, biosensors, smart sensors
CLOBJ 4	Understand Different challenges to design Biomedical Microsystems.
CLOBJ 5	Demonstrate a clear understanding of the various applications for curing different diseases accurately by using BioMEMS Technology.

f. **Course Learning Outcomes:**

CLO 1	Interpret the MEMS Technology and its biomedical application.
CLO 2	Learn the Fabrication process of Micro electro mechanical systems.
CLO 3	Learn MEMS Sensors and Actuators, biosensors, smart sensors
CLO 4	Analyse different challenges to design Biomedical Microsystems.
CLO 5	Illustrate the various applications for curing different diseases accurately by using BioMEMS Technology.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
L	**T**	**P**	**C**	**Internal Evaluation**			**ESE**		**Total**
				MSE	**CE**	**P**	**Theory**	**P**	
3	**-**	**-**	**3**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Microelectromechanical (MEMS) Technology** Historical perspective, Development of MEMS Technology, MEMS Technology: Present Future and Challenges, MEMS Applications, Comparison of MEMS and Microelectronics	**15%**	**7**
2	**Fabrication Processes** Different Materials, Substrates, Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD), Etching Processes, Patterning, Wafer Bonding, Annealing, Chemical Mechanical Polishing (CMP), Material Doping.	**20%**	**9**
3	**MEMS Technologies** Bulk Micromachining, LIGA (Lithographie, Galvanoformung, Abformung), Sacrificial Surface Micromachining.	**15%**	**7**
4	**MEMS Sensors and Actuators** MEMS Actuators, MEMS Sensing, Electron Tunnelling, Sensor Noise, MEMS Physical Sensors, Chemical Sensors.	**10%**	**4**
5	**MICRO/NANO BIOSENSORS** Classification of physical sensors, Integrated, Intelligent or Smart sensors, Bio sensing Principles and sensing methods, Biosensors arrays and Implantable devices.	**20%**	**9**
6	**Introduction to different Biomedical Applications of Microsystems** Delivery of Diagnostic and Therapeutic Agents to Vascular Targets, Real-Time Biological Imaging and Detection, Diagnostic and Therapeutic Applications of Metal Nanoshells, Micro devices for Oral Drug Delivery etc**.**	**20%**	**9**
	Total:	**100 %**	**45**

i. Text Book and Reference Book:

1. Microsystem Design (TextBook), By Senturia, Stephen, D; Kluwer Academic Publisher.
2. Microsystem Technology in Chemistry and Life Sciences, By Manz, A., & Becker, H.(Eds.)
3. Micromechanical Transducers: Pressure sensors, accelerometers, and gyroscopes , By Bao, M.H; Elsevier Publications; New York, 2000.
4. Microelectromechanical system design (TextBook), By James J. Allen. Taylor & Francis; 2nd edition.
5. BioMEMS and Biomedical Nanotechnology (TextBook), By Tejal desai, sangetha Bhatia
6. Fundamentals of BioMEMS and Medical Micro devices, By Saliterman Steven S.; Wiley Interscience, SPIE Press Monograph; PM153
7. Biomedical Nanotechnology (TextBook), By Neelina H Malsch , Taylor & Francis