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ABOUT BIOMEDICAL ENGINEEERING

Biomedical engineering integrates engineering science with medical science for knowledge advancement and development of new applications with the amalgamation of engineering, biology and medicine.

VISION

Pioneering excellence in Biomedical engineering education and research in undergraduate and post graduate level, nationally and internationally to provide society with world-class competitive professional in Biomedical Engineering.

MISSION

To develop Biomedical engineering professionals for excellence in biomedical engineering related healthcare application through academic advancement, personal growth and skill development of biomedical engineering students in addition to technology transfer to industry and continuous workforce training.

Programme (B. Tech in Biomedical Engineering) Educational Objective (PEOs):-

1. To prepare students for diverse career in engineering and science including human body systems that build career and pursue higher studies in Biomedical Engineering.
2. To identify, analyze and solve the problems by applying principles of Biomedical engineering with novelty and updated knowledge in the development of product/process/technique related to healthcare to meet the societal demands.
3. To develop skills necessary for communications in their professions and to impart value added continuing education for sustained growth beneficial for society.
4. To apply the acquired practical knowledge for effective teaching, research, development and entrepreneurship in biomedical field.
5. To provide opportunity for students to work as part of teams on multidisciplinary projects with the multifaceted aspects of using modern tools.

Graduate Attributes:

1. Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2. Problem Analysis: Identify, formulate, research literature and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

3. Design/ Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal and environmental considerations.

4. Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

5. Modern Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.

7. Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams and in multi disciplinary settings.

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.

11. Project Management and Finance: Demonstrate knowledge and understanding of 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.

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.

The Program Outcomes (Biomedical Engineering)

1. Ability to define/list/give example/ comprehend/explain concepts of Biomedical Engineering
2. Ability to **apply knowledge** of mathematics, science and engineering fundamentals to solve the problems related to Biomedical Engineering.
3. Ability to **perform logical analysis** of results/ systems/ sub-systems of Biomedical Engineering to arrive at suitable conclusions.
4. Ability to design solutions for systems/ subsystems that meet desired specifications of healthcare engineering
5. Ability to research literature to **conduct investigations/ evaluate results/ interpret results** to arrive at the most effective solution for solving problems Biomedical Engineering
6. Ability to design and conduct experiments using electronic components, electronic instruments and/or **modern engineering tools** to demonstrate concepts in Biomedical Engineering
7. Ability to understand the **sustainability** of Biomedical Engineering solutions and its impact on health, safety, cultural issues, **environment and society**
8. Ability to conform to **professional ethics**, and understand the responsibilities and norms of Biomedical Engineering practice
9. Ability to function effectively as an **individua**l, and as a member **in a team**
10. Ability to **communicate effectively**, write reports and make effective presentation using available technology
11. Ability to apply the knowledge and understanding of **project management**, Biomedical Engineering resource management and **cost analysis** while implementing projects
12. Ability to **engage in independent** self-study to enhance knowledge

Engineering Education

It is undeniable that Engineering & Technology professionals are key personnel in any country responsible for its economic progress and prosperity, leading to increased comfort and satisfaction levels of its people and the society at large. The developed countries have already benefitted from their knowledge and skills and have demonstrated the crucial role played by these professionals in strengthening their R&D, industries and economies. As India is now engaged in such an endeavour and has prepared a road map for becoming a developed nation by the year 2020, serious efforts are now going on in the country in this direction. In this context, the education and training of Engineering & Technology professionals are now receiving much attention here. But, there are challenges being faced by these professionals in the on-going 21st century, recognized as the Knowledge Age, like:

1) Rapidly changing technological scene worldwide, with a shrinking time scale for new developments and for obsolescence of old practices, leading to:

- Increase in investment on R&D in industry and other sectors;
- Demand for innovative products and services, based on contemporary technologies; and,
- Growing need for enhancement of abilities to manage change, so frequent, now a days;

2) Globalization and liberalization of Indian industry, leading to:

- Comprehensive restructuring of industry sector for enhancing efficiency;
- Increase in world-wide mobility of Engineering & Technology professionals; and,
- Growth of competitive environment globally and also in the country;

3**) Emergence of new career opportunities for Engineering & Technology professionals, leading to:**

- Demand for broad-based, flexible education in multi/inter- disciplinary subjects;
- Emphasis on PG courses, research training and institute-industry interaction; and,
- Advances in learner-centric programmes and life-long learning opportunities;

4) Penetration of IT in all sectors of the Engineering & Technology profession, leading to:

- Increased demand for IT-based solutions to industrial and societal problems;
- Expertise in emerging IT developments to solve complex, Engineering & Technology problems; and,
- Improved access to worldwide information/data bases and knowledge centres.

5) Increased social/environmental concerns in the Engineering & Technology context, leading to:

- Effective means for protection of endangered environment and depleting energy sources;
- Seeking environment- and energy- friendly solutions to Engineering & Technology problems;
- Wealth generation using environmentally benign and energy efficient techniques;

These challenges require appropriate orientation of Engineering & Technology education and research in the country at all levels, particularly at UG and revitalizing the same as outlined below, so that Engineering & Technology professionals of the 21st century are equipped to face the challenges with determination and courage becoming ready in a short time to contribute to national development.

Approach to Curriculum

The major objective of Biomedical Engineering Department of JIS College of Engineering, Kalyani, Nadia, West Bengal is to develop Biomedical Engineering professionals having competencies, intellectual skills and knowledge equipping them to contribute to the society through productive and satisfying careers as innovators, decision makers and leaders in the national and global economies of the 21st century; the Approach to Curriculum for B.Tech in Biomedical Engineering Programme needs to lay special emphasis on educating/preparing the students well for being able to demonstrate the following abilities:

1. Effective application of knowledge of mathematics, science and technical subjects;
2. Planning and design to conduct scientific and technical experiments;
3. Analysis and interpretation of scientific, technical and economic data collected;
4. Design of parts, subsystems, systems and/or processes to meet specific needs;
5. Identification, formulation and solving of problems using simulation or otherwise;
6. Use of techniques/tools including software in all disciplines, as may be required;
7. Effective communication skills and leadership/participation in team work;
8. Fulfillment of professional, social and ethical responsibilities;
9. Sensitivity to environmental and energy issues and concerns;
10. Planning, development and implementation of strategies for life-long learning.

These requirements call for the following objectives to the Approach to Curriculum relating to B.Tech students in Biomedical Engineering Programme:

1. **Preparation:** To prepare the students to excel in various educational programmes or to succeed in industry / technical profession through further education/training;
2. **Core Competence:** To provide the students with a solid foundation in mathematical, scientific and Biomedical Engineering fundamentals required to solve Biomedical Engineering related problems;
3. **Breadth:** To train the students with a breadth of scientific and Biomedical Engineering knowledge to comprehend, analyze, design & create novel products and solutions for real life problems;
4. **Professionalism:** To inculcate in the students professional/ethical attitude, effective team work skills, multidisciplinary approach and to relate Biomedical Engineering issues to a broader context;
5. **Learning Environment:** To provide the Biomedical Engineering students with academic environment of excellence, leadership, ethical guidelines and life-long learning needed for a long/productive career.

Definitions/Descriptions:

Thus, in framing a suitable curriculum for the **B.Tech in Biomedical Engineering (BME) Programme**, the following definitions/descriptions have been followed for the different terms used.

1. Semester Scheme: B.Tech in Biomedical Engineering Degree Programme to be ordinarily of 4 academic years (=8 Semesters), with the year being divided into two Semesters (>=90 working days) each for course work, followed by Continuous Internal Evaluation (CIE) in the Semester & Semester End Examination (SEE) as reforms in Achievement Testing;

2. Credit System: A system enabling quantification of course work, with one credit being assigned to each unit after a student completes its teaching-learning process, followed by passing in both CIE & SEE;

3. Credit Courses: All Courses registered by a student in a Semester to earn credits; students to earn One Credit by registering and passing:

- One hour/week/Semester for Theory/Lecture (L) Courses or Tutorials (T); and,
- Three hours/week/Semester for Laboratory/Practical (P) Courses;

4. Credit Representation: Table 1 represents the Credit values representation for the proposed curriculum structure:

Table 1: Credit Representation

Lectures (hrs/wk/Sem.)	Tutorials (hrs/wk/Sem.)	Practical /Sessional (hrs/wk/Sem.)	Credits (L: T: P)	Total Credits
4	**0**	**0**	**4:0:0**	**4**
3	**0**	**0**	**3:0:0**	**3**
3	**1**	**0**	**3:1:0**	**4**
0	**0**	**3**	**0:0:3**	**2**
0	**1**	**3**	**0:1:3**	**3**
0	**0**	**2**	**0:0:2**	**1**

5. Course Load: Every student to register for a set of Courses in each Semester, with the total number of their Credits being limited by considering the permissible weekly Contact Hours

6. Course Registration: Every student to formally register for Courses(Credits) under faculty advice in each Semester for the Institution to maintain proper record; Helpful for monitoring the CIE, SEE performance in each case and to assist the students in self-paced learning by dropping/withdrawing from Course(s);

7. Course Evaluation: CIE and SEE to constitute the major evaluations prescribed for each Course, with only those students maintaining a minimum standard in CIE (to be fixed by the institution) being permitted to appear in SEE of the Course; CIE and SEE to carry 30% and 70% respectively, to enable each Course to be evaluated for 100 marks, irrespective of its Credits;

8. CIE: To be normally conducted by the Course Instructor and include midterm/weekly/ fortnightly class tests, home work, problem solving, group discussion, quiz, mini-project & seminar throughout the Semester, with weightage for the different components being fixed at the institutional level; Instructor also to discuss on CIE performance with students;

9. SEE: To be normally conducted at the institutional level and cover the entire Course Syllabi; For this purpose, Syllabi to be modularized and SEE questions to be set from each module, with choice if any, to be confined to module concerned only. The questions to be comprehensive emphasizing analysis, synthesis, design, problems & numerical quantities;

10. Grading: To be normally done using Letter Grades as qualitative measure of achievement in each Course like: S(Superb), E(Excellent), A(Very Good), B(Good), C(Average), D(Poor) & F(Fail), based on the marks(%) scored in (CIE+SEE) of the Course and conversion to Grade done by Relative/Absolute Grading ,the former being more useful;

11. Grade Point (GP): Students to earn GP for a Course based on its Letter Grade; e.g., on a typical 10-point scale, GP to be: S=10, E=09, A=08, B=07, C=06, D=04 & F=00; Useful to assess students' achievement quantitatively & to compute Credit Points (CrP)= GP/X Credits for the Course; Student passing a Course only when getting GP>= 04 (D Grade);

12. Grade Point Average (GPA): Computation of Semester GPA (SGPA) to be done by dividing the sum of CrP of all Courses by the total number of Cr registered in a Semester, leading finally to CGPA for evaluating student's performance at the end of two or more Semesters cumulatively; This reform serving as a better performance index than total marks or %;

13. Passing Standards: Both SGPA & CGPA serving as useful performance measures in the Semester System; Student to be declared successful at the Semester-end or Programme-end only when getting SGPA or CGPA >=5.00, with none of the Courses registered in a Semester or for the Degree Award remaining with F Grade;

Curriculum Structure:

A typical Curriculum Structure for B.Tech in Biomedical Engineering Degree Programme evolved as a result of the Approach to Curriculum and Definitions/Descriptions provided above can be broadly as given in Table 2

Table 2: Typical Curriculum Structure for UG Biomedical Engineering Degree Programme

Sl.No.	Course Work - Subject Area
1	Humanities and Social Sciences (HS), including Management, Technical English, Group Discussion and Personality Development Skills
2	Basic Sciences(BS) including Mathematics, Physics, Chemistry
3	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering/Environmental Engineering/Engineering Physiology and Anatomy etc
4	Professional Subjects-Core (PC), relevant to the chosen specialization/branch;
5	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;
6	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;
7	Project Work, Seminar and/or Internship in Industry or elsewhere.
8	Extra Curricular Activities (NSS/NCC etc)

Table 3: Semester-wise Credit Distribution for Courses at UG Biomedical Engineering Degree Programme

SEMESTERS	HS (T+S/P)	BS (T+S/P)	ES (T+S/P)	PC (T+S/P)	PE (T+S/P)	OE (T+S/P)	NSS/ NCC	Project/Seminar/ Grand Viva	Total (Row- wise) Credit
SEM-1	3	10	12	0	0	0	1	0	***26***
SEM-2	3	12	13	0	0	0	0	0	***28***
SEM-3	2	9	6	10	0	0	0	0	***27***
SEM-4	3	0	5	20	0	0	0	0	***28***
SEM-5	0	0	0	20	3	5	0	0	***28***
SEM-6	0	0	0	14	5	3	0	1	***23***
SEM-7	0	0	0	13	3	3	0	2	***21***
SEM-8	0	0	0	9	0	3	0	8	***20***
Total (Column-wise) Credit	***11***	***31***	***36***	***86***	***11***	***14***	***1***	***11***	***201***

Table 4: Typical Sequencing Plan for Courses at UG Biomedical Engineering Degree Programme

Semesters	Subject Area Coverage
I –II	HS, BS, ES Courses and Extra Curricular Activities; common for all Branches;
III-IV	HS, BS, ES and PC Courses
V-VI	PC, PE and OE Courses; Branch-wise Orientation; Add-On Courses; Seminar;
VII	PC, PE and OE Courses; HS Course (Group Discussion);
VIII	PC and OE Courses; Project work and Dissertation, Internship, Seminar: Add-On Courses; Final wrap-up of Programme;

B.Tech in Biomedical Engineering Course Curriculum & Syllabus

1ST YEAR B.TECH

1ST SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	HU 101	Professional Communication	2	0	0	**2**
2	M 101	Mathematics-I	3	1	0	**4**
3	CH (BME)101	Engineering Chemistry	3	1	0	**4**
4	ME 101	Engineering Mechanics	3	1	0	**4**
5	EE 101	Basic Electrical Engineering	3	1	0	**4**
B. PRACTICAL/SESSIONAL						
6	HU 181	Students Project Presentation Laboratory	0	0	2	**1**
7	CH 191	Engineering Chemistry Practical	0	0	3	**2**
8	ME 194	Engineering Graphics	0	0	3	**2**
9	EE 191	Basic Electrical Engineering Laboratory	0	0	3	**2**
10	XC 181	Extra Curricular Activities (NSS/NCC)	0	0	2	**1**
		TOTAL CREDIT POINTS				**26**

2ND SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	M 201	Mathematics-II	3	1	0	**4**
2	PH 201	Physics-I	3	0	0	**3**
3	CH 201	Environment & Ecology	3	0	0	**3**
4	EC 201	Elements of Electronics Engineering	3	1	0	**4**
5	BME(CS) 201	Introduction to Programming	3	0	0	**3**
6	HU 201	Value & Ethics in Profession	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
7	PH 291	Physics-I Lab	0	0	3	**2**
8	ME 293	Workshop Practice	0	0	3	**2**
9	BME(CS) 291	Introduction to Programming Laboratory	0	0	3	**2**
10	EC 291	Elements of Electronics Engineering Laboratory	0	0	3	**2**
		TOTAL CREDIT POINTS				**28**

2ND YEAR B.TECH

3RD SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	M (BME) 301	Biomathematics & Biostatistics	3	1	0	**4**
2	PH (BME) 301	Physics-II	3	0	0	**3**
3	BME 301	Engineering Physiology & Anatomy	3	1	0	**4**
4	BME (EE) 302	Circuit Theory & Networks	3	0	0	**3**
5	BME (EC) 303	Analog Electronic Circuits	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
6	PH (BME) 391	Physics-II Laboratory	0	0	3	**2**
7	BME 391	Engineering Physiology & Anatomy Laboratory	0	0	3	**2**
8	BME (EE) 392	Circuits & Networks Laboratory	0	0	3	**2**
9	BME (EC) 393	Analog Electronic Circuits Laboratory	0	0	3	**2**
10	HU 381	Personality Development Laboratory	0	0	3	**2**
		TOTAL CREDIT POINTS				**27**

4TH SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	BME 401	Biomechanics	3	0	0	**3**
2	BME 402	Biophysical Signals & Systems	3	0	0	**3**
3	BME (EC) 403	Digital Electronics & Integrated Circuits	3	1	0	**4**
4	BME(CS) 404	Object Oriented Programming using C++	3	0	0	**3**
5	BME 405	Biomaterials	3	1	0	**4**
6	HU 401	Engineering Economics & Management	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
7	BME 491	Biomaterials & Biomechanics Laboratory	0	0	3	**2**
8	BME 492	Biophysical Signals & Systems Laboratory	0	0	3	**2**
9	BME (EC) 493	Digital Electronics & Integrated Circuits Laboratory	0	0	3	**2**
10	BME(CS) 494	Programming Practices Laboratory	0	0	3	**2**
		TOTAL CREDIT POINTS				**28**

3RD YEAR B.TECH

5TH SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	BME 501	Biomedical Instrumentation	3	1	0	**4**
2	BME 502	Biosensors & Transducers	3	1	0	**4**
3	BME 503	Biomedical Digital Signal Processing	3	0	0	**3**
4	BME 504	Medical Imaging Techniques	3	0	0	**3**
5	**Electives (PE)**		3	0	0	**3**
	BME 505A	Control Engineering				
	BME 505B	Biophysics & Biochemistry				
	BME 505C	Modelling of Physiological Systems				
6	**Electives (OE)**		3	0	0	**3**
	BME(CS) 506A	Data Structure & Algorithm				
	BME(CS) 506B	Soft-computing				
	BME(EC) 506C	VLSI & Embedded System				
B. PRACTICAL/SESSIONAL						
7	BME 591	Biomedical Instrumentation Laboratory	0	0	3	**2**
8	BME 592	Biosensors & Transducers Laboratory	0	0	3	**2**
9	BME 593	Biomedical Digital Signal Processing Laboratory	0	0	3	**2**
10	**Electives (OE)**		0	0	3	**2**
	BME(CS) 596A	Data Structure & Algorithm Laboratory				
	BME(CS) 596B	Soft-computing Laboratory				
	BME(EC) 596C	VLSI & Embedded System Laboratory				
					TOTAL CREDIT POINTS	**28**

6TH SEMESTER

THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	BME 601	Analytical & Diagnostic Equipments	3	0	0	**3**
2	BME 602	Microprocessors & Microcontrollers	3	1	0	**4**
3	BME 603	Advanced Imaging Systems	3	0	0	**3**
4	**Electives (PE)** BME 604A BME 604B BME 604C	 Communication Systems Bionanotechnology Tissue Engineering	3	0	0	**3**
5	**Electives (OE)** BME(EE) 605A BME(EE) 605B BME(IT) 605C	 Electrical & Electronic Measurement and Instrumentation Fuzzy Control & Systems Software Engineering	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
6	BME 691	Biomedical Equipments Laboratory	0	0	3	**2**
7	BME 692	Microprocessors & Microcontrollers Laboratory	0	0	3	**2**
8	**Electives (PE)** BME 693A BME 693B BME 693C	 Communication Systems Laboratory Bionanotechnology Laboratory Tissue Engineering Laboratory	0	0	3	**2**
9	BME 694	Group Discussion & Seminar	0	0	2	**1**
Hospital Training						
		TOTAL CREDIT POINTS				**23**

4TH YEAR B.TECH

7TH SEMESTER

SL. NO.	PAPER CODE	PAPER	CONTACT HRS/WEEK			
			L	T	P	C
A. THEORY						
1	BME 701	Therapeutic Equipments	3	0	0	**3**
2	BME 702	Medical Image Processing	3	0	0	**3**
3	BME 703	Artificial Organ & Rehabilitation Engineering	3	0	0	**3**
4	**Electives (PE)** BME 704A BME 704B BME 704C	 Biological Control Systems Biotelemetry & Telemedicine BioMEMs	3	0	0	**3**
5	**Electives (OE)** BME(ME) 705A BME(ME) 705B BME(EC) 705C	 Engineering System Modeling & Simulation Medical Robotics & Automation Lasers & Optics in Medicine	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
6	BME 791	Medical Instruments & Systems Laboratory	0	0	3	**2**
7	BME 792	Medical Image Processing Laboratory	0	0	3	**2**
8	BME 793	Project Part-I	0	0	3	**2**
Industrial Training						
		TOTAL CREDIT POINTS				**21**

8TH SEMESTER

A. THEORY						
SL. NO.	**PAPER CODE**	**PAPER**	**CONTACT HRS/WEEK**			
			L	**T**	**P**	**C**
1	BME801	Design Concept & Maintenance of Biomedical Instruments	3	0	0	**3**
2	BME802	Hospital Engineering & Management	3	0	0	**3**
3	BME803	Biomedical Hazards & Safety	3	0	0	**3**
4	**Electives (OE)** BME 804A BME 804B BME 804C	 Radiotherapy & Nuclear Medicine Bioinformatics Body Area Networks	3	0	0	**3**
B. PRACTICAL/SESSIONAL						
6	BME 891	Seminar	0	0	3	**2**
7	BME 892	Project Part-II	0	0	6	**4**
8	BME 893	Grand Viva				**2**
					TOTAL CREDIT POINTS	**20**

Total No of Credits throughout 8 Semesters=201

Detailed Syllabus

B.Tech-1st Year-1st Semester

THEORY PAPERS

Professional Communication
Code: HU 101, Contacts: 2L, Credit: 2

Course Objective:
The aim of this course is to enable an individual to speak, read, and listen with understanding to simple current English and to write a connected passage about a simple subject or incident. The following are the requirements that the course caters to:

1. To develop in the learners the ability to listen, read and understand English.
2. To train pupils' ears to understand English uttered by speakers.
3. To help pupils read and analyse extensive texts for information, pleasure and enlightenment.
4. To help pupils reinforce grammatical points already taught.
5 To enable pupils speak good English.
6. To teach the basic tenses of present, past and future
7. To teach pupils to practice important writing techniques.
8. To develop in the learners the ability to promote the writing skill until they are able to write a complete paragraph and are ready to do any writing required in the university or in life.

Course Outcome:

1. English acts as a link language. Therefore students acquire the ability to apply the knowledge acquired in other subject areas like, *Mathematics, BasicSciences, Engineering Sciences, Professional Subjects and Environmental Issues.*
2. Strong foundation in reading, writing, listening and speaking English language.
3. Expertise in understanding instructions, following rules, interpreting data which are made in English language.
4. Capacity to function in multi/inter-disciplinary teams with a spirit of tolerance, patience and understanding so necessary for team work;
5. Competence to acquire *knowledge* on one's own through libraries/data bases for contributing to *knowledge assimilation, creation, dissemination & life-long learning;*
6. Better understanding and acceptance of professional, social, moral and ethical responsibilities and good *knowledge* of contemporary issues;
7. Familiarity with the current social, poltical issues and confidence to freely express and share concerns about them.
8. Broad education necessary to get a perception of the impact of solutions provided for developmental issues in a global/societal context;
9. Capacity for rational, objective, orderly and logical thinking and ability to communicate with fellow professionals/society effectively in written/oral forms; and,
10. Good attitudes and skills in personnel management and maintenance of human relations, required in every ones working life.

Topic	No of Periods
Fundamentals of Technical Communication : process of communication, language as a tool of communication, levels of communication , flow of communication, barriers to communication, communication across cultures; Technical Communication: meaning, significance, characteristics, difference between technical and general communication.	4
Elements of Written Communication: words and phrases, word formation, synonyms and antonyms, homophones, one word substitution, sentence construction, paragraph construction, tense, preposition, voice change .	8
Forms of Technical Communication: business letters, job application letter and resume, business letters: sales & credit letters, letters of enquiry, letters of quotation, order, claim and adjustment letters, official letters: D.O. letters, government letters, letters to authorities, etc. , Technical Reports: general format of a report, formal and informal reports, memo report, progress report, status report, survey report, trip report, trouble report, laboratory report, research papers, dissertations and theses. Technical Proposals: purpose, characteristics, types, structure.	8

Presentation Strategies: defining the subject, scope and purpose, analysing audience & locale, collecting materials, preparing outlines, organising the contents, visual aids, nuances of delivery, extemporaneous, manuscripts, impromptu, memorization and non- verbal strategies.	6
Value-based Text Reading: (A) Study of the following essays from the text book with emphasis on writing skills: 1. The Thief by Ruskin Bond 2. The Open Window by Saki 3. Marriage is a private Affair by Chinua Achebe 4. The Moon in the Earthen Pot by Gopini Karunakar	4
Total	30

BOOKS - RECOMMENDED:

1. Board of Editors: Contemporary Communicative English for Technical Communication Pearson Longman, 2010
2. Dr. D. Sudharani: Manual for English Language Laboratory Pearson Education (W.B. edition), 2010
3. Technical Communication Principles and Practice by Meenakshi Raman, Sangeeta Sharma (Oxford Higher Education)
4. Effective Technical Communication by Barun K.Mitra(Oxford Higher Education)
5. V. Sashikumar (ed.): Fantasy- A Collection of Short Stories Orient Black swan (Reprint 2006)

Mathematics-I
Code: M 101, Contacts: 3L+1T, Credit: 4

Course Objectives:

The objectives of offering this course are

1. To make aware students about the importance and symbiosis between Mathematics and Engineering.
2. To achieve fluency with Mathematical tools, which is an essential weapon in modern Graduate Engineer's armor.
3. To compute the rank and inverse of a matrix.
4. To solve the system of the algebraic equations.
5. To compute Eigen values and Eigen vectors of a given matrix.
6. To understand the geometrical interpretation of mean value theorems.
7. To compute the extreme values of a given function in two variables.
8. To evaluate double and triple integrals over a region.
9. To compute volume of solids between the surfaces.
10. To compute normal vector of a surface and angle between the surfaces.

Course Outcomes:

On the successful completion of this course; student shall be able to

1. Be able to carry out matrix operations, including inverses and determinants.
2. Demonstrate understanding of linear independence, span, and basis.
3. Determine Eigenvalues and eigenvectors and solve problems involving Eigenvalues.
4. Use vector calculus to analyze scalar and vector fields and compute the gradient, divergence and curl.
5. Evaluate line, surface and volume integrals.
6. Apply Green's Theorem, Divergence Theorem and Stoke's theorem to evaluate integrals.

Topic	No of Periods
Module I **Matrix**: Determinant of a square matrix, Minors and Cofactors, Laplace's method of expansion of a determinant, Product of two determinants, Adjoint of a determinant, Jacobi's theorem on adjoint determinant. Singular and non-singular matrices, Adjoint of a matrix, Inverse of a non-singular matrix and its properties, orthogonal matrix and its properties, Trace of a matrix. Rank of a matrix and its determination using elementary row and column operations. Solution of System of Linear equations, Eigenvalue & Eigenvector of a square matrix, Caley Hamilton Theorem & Its Application.	10L
Module II **Calculus of functions of single variable**: Successive differentiation : Higher order derivatives of a function single variable, Leibnitz's theorem(statements and its applications).Rolle's theorem and its applications.	10L

Mean value theorem- Lagrange & Cauchy and their application, Taylor's theorem with Lagrange's and Cauchy's form of remainders and its application, Taylor's and Maclaurin's theorem(Statements only), Maclaurin's infinite series expansion of functions: sinx, cosx , e^x, log(1+x), (a+x)^n , n being an positive integer or a fraction (assuming that the remainder $R_n \to 0$ as $n \to \infty$ in each case). Reduction formulae both for indefinite and definite integrals of types $\int \sin^n x,\ \int \cos^n x,\ \int \sin^m x \cos^n x,\ \int \cos^m x \sin nx,\ \int \frac{dx}{\left(x^2+a^2\right)^n},\ m,n$ are positive integers.	
Module III **Calculus of functions of several variables**: Introduction to functions of several variables with examples, Knowledge of limit and continuity, Partial derivatives and related problems, Homogeneous functions and Euler's theorem and related problems up to three variables, Chain rules, Differentiation of implicit functions, Total differentials and their related problems, Jacobians up to three variables and related problems, Maxima, minima and saddle points of functions and related problems, Concept of line integrals, Double and triple integrals.	8L
Module IV **Vector Calculus**: Scalar and vector fields. Vector function of a scalar variable, Differentiation of a vector function, Gradient of a scalar point function, Directional derivative. Divergence and curl of a vector point function and related problems. Green's Theorem, Gauss Divergence Theorem and Stoke's Theorem (Statements and Applications).	7L
Module V ***Infinite Series:*** Preliminary idea of sequence, Infinite series and their convergences/divergences, Infinite series of positive terms, Tests for convergence: Comparison test, Cauchy's root test, D'Alembert's ratio test and Raabe's test. Alternating series, Leibnitz's test. Absolute convergence and Conditional convergence. Power series (Definition and Examples).	5L
Total	40L

Suggested Text / Reference Books:

1. Advanced Engineering Mathematics 8e by Erwin Kreyszig is published by Wiley India.
2. Engineering mathematics: B.S.Grewal (S.Chand &Co.).
3. Higher Engineering Mathematics: John Bird (4th Edition, 1st India Reprint 2006,Elsevier.
4. Mathematics Handbook : for Science and Engineering,L.Rade and B.Westergen(5th edition,1st Indian Edition 2009,Springer)
5. Calculus :M.J.Strauss,G.L.Bradly and K.L.Smith (3PrdP,1PstP Indian Edition 2007,Pearson Education)
6. Engineering mathematics: S.S.Sastry (PHI,4PthP Edition,2008)
7. Advanced Engineering Mathematics,3E:J.L.Goldberg and E.F.Abonfadel (OUP),Indian Edition.

Engineering Chemistry
Code: CH (BME) 101, Contacts: 3L+1T, Credit: 4

Course Objective:
The Objectives of the curriculum are listed below:

- Chemistry is the basis of technologies to produce materials which are essential for any manufacturing and development of technologies. It aims at training engineers with knowledge of chemistry, regardless of their majors, through basic chemistry subjects and basic experimentations. The course for BME stream has been generated including the modules based on
  - Polymer
  - Phase rule, steel and alloy
  - Biochemistry and analytical method
  - Lubricants and catalysis
  - Nano-materials and composite

- These modules have incorporated to provide students the fundamental knowledge of chemistry which is indispensible for development of basic concept in their respective stream.

- ❖ Graduates will have sound training in chemistry that will facilitate successful pursuit of advanced degrees in related fields.

- ❖ The graduates will have independent critical thinking and problem solving skills that can be applied to support interdisciplinary teams that may include members from multidisciplinary field.

Course Outcomes:

Upon successful completion of this curriculum students should be able to:

- Have more competency students with respect to global scenario
- Develop of innovative technologies based on different disciplines
- Have the fundamental knowledge for higher studies
- Motivate themselves in the field of interdisciplinary research
- Possess general awareness about the everyday's life.
- Apply knowledge of chemistry in the respective field of their engineering discipline and to demonstrate an understanding of applicable approaches, techniques and methods and an appreciation of their limitations
- Combine theory and practice to solve scientific, technical and practical problems.

Module	**Topic**	**No of Lectures**
Module 1	**Polymers** Introduction, classification, Hydrocarbon Molecules, Thermoplastic, Thermosetting Polymers. Basic Concepts Molecular Weight, Polymer Crystallinity. Crystallization, Melting and glass transition phenomena, Polymerization: addition, condensation, Copolymerization.	3L
	Viscoelasticity, Deformation Fracture, Defects in Polymers. Advanced polymeric material, Conductiong Polymers, Electrical Properties of Polymers. Liquid Crystal Properties, Supramolecular chemistry	3L
	Fabrication of Polymers i) Compression Moulding ii) Injection Moulding iii) Transfer Moulding iv) Extrusion Moulding	2L
	Synthesis, properties and uses of PE, PMMA, Formaldehyde based resin	1L
Module 2	**Phase Rule and steels:** Gibbs Phase Rule, One Component System Water, Two Component System Iron-carbon Equilibrium Diagram with Microstructures. Limitations & Application of Phase Rule. Plain Carbon Steel, Limitations. Introduction to Alloy Steels, special steels. Principles of shape memory effect & its applications.	4L
	Alloys: Alloys, Types of alloys, alloys of Al, Cu & Pb. Their composition properties and uses. Recent advances in alloy related materials. Powder Metallurgy Methods of metal powder formation, Metal ceramic powders Technology of Powder metallurgy. Applications of powder metallurgy.	3L
Module 3	**Biochemistry:** Introduction, Types of Colloids, Characteristics of Colloidal Solution, Properties of Colloidal Solution, Applications of colloidal system.	3L
	Analytical Methods: Classification of Chromatographic Methods, Technology used in chromatography, Isolation of separated components (Elution).	3L
	Spectroscopy: Introduction, Concept of Photochemical Reaction, Absorption, Lambert-Beer's Law, UV-Spectroscopy, IR-Spectroscopy.	4L
Module 4	**Lubricants:** Definition, classification, characteristic properties, problems on acid value and saponification value. Theories of lubrication. Additives for lubricants, selection of lubricant.	3L
	Catalysis: Introduction, Importance of catalysts, Activation energy and catalysts. Molecular design for catalysts, Molecular design by natural Zeolites, zeotypes, pillared clays, Metal complexes and clusters, Oxide materials carbon materials,	4L
Module 5	**Nano-materials:** Introduction to nano-materials. Production methods for Carbon based nanomaterial: Graphite, Fullerenes, Carbon nanotubes,	4L

	Nanowires, Nanocones, Haeckelites. Their electronic and mechanical properties, Applications of nano materials in i) Medicine ii) Catalysis, Electrical and electronic properties	
	Composite Materials: Introduction. Constitution, Characteristic properties, Classification of composite materials Particle, fiber reinforced composites, structural composites, Application of composite materials.	3L

Reference Books:

1. Engineering Chemistry-Jain & Jain, dhanpat Rai
2. Engineering Chemistry-Dara & dara, S Chand
3. Sashi Chawla, A Text Book of Engineering Chemistry, Dhanpat Rai & Co.Pvt. Ltd.
4. Materials Science & Engineering – William Callister,
5. Chemistry of advanced materials- CNR Rao, RSC Pbl
6. P. C. Rakshit, Physical Chemistry, Sarat Book House (7th Edition).
7. P. Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw Hill Publishing Company Limited.
8. F.W.Billmeyer : Textbook of Polymer Science is published by Wiley India (is now an Indian Imprint.)
9. Joel R. Fried, Polymer Science and Technology, Pearson Education (2nd Edition).
10. I. L. Finar, Organic Chemistry, Addison Wesley Longman, Inc.
11. Physical Chemistry, Atkins, 6th Edition, Oxford Publishers.
12. Organic Chemistry, Mark Loudon, 4th Edition, Oxford Publishers..
13. Concise Inorganic Chemistry, J. D. Lee, Black Well Science

Engineering Mechanics
Code: ME 101, Contacts: 3L+1T, Credit: 4

Course Objective:
Ability to draw complete and correctly labeled Free Body Diagrams of rigid bodies or systems of rigid bodies in static equilibrium, ability to compute the resultant of any number of concurrent forces in 2- or 3- dimensions, ability to compute the dot product and cross product of two vectors, and demonstrate, understanding of the meaning of the results, ability to solve particle equilibrium problems in 2- or 3- dimensions, ability to compute the moment generated by a force about any point in 2-D space and ability to find support reactions for truss and frame/machine problems, ability to reduce a system of forces acting on a rigid body to a single equivalent force and compute its point of application, Ability to solve rigid body equilibrium problems in 2- or 3-dimensions for statically determinate systems, ability to compute frictional forces for sliding motion and for belts/pulleys, ability to solve the tip/slip problem, ability to compute the centroid and the area moment of inertia of 2-D bodies using the method of composite areas, ability to construct shear force and bending moment diagrams for systems of concentrated forces and/or distributed loads acting on statically determinate beams, ability to solve for the internal forces acting on any member of a pin-jointed truss structure or a frame/machine component, Ability to find the centroid and area moment of inertia for 2-D shapes by the method of integration and ability to compute the moment about any axis in 3-D space generated by a force or a system of forces.

Course Outcome:
Students will understand the basics of mechanics. They will acquire the knowledge of direction and quantity of various mechanical parameters like force, moment, inertia, friction etc. of rigid body as well as moving parts. They will be able to compute above parameters whenever necessary.

SL. NO.	Syllabus	Contact Hrs	Reference Books & Chapters and Problems for practice
MOD-1	Importance of Mechanics in engineering; Introduction to Statics; Concept of Particle and Rigid Body; Types of forces: collinear, concurrent, parallel, concentrated, distributed; Vector and scalar quantities; Force is a vector; Transmissibility of a force (sliding vector).	2L	Meriam&Kraig: Vol-I Chapt: 1/1, 2/2,1/3
	Introduction to Vector Algebra; Parallelogram law; Addition and subtraction of vectors; Lami's theorem; Free vector; Bound vector;Representation of forces in terms of i,j,k; Crossproduct and Dot product and their	4L+1T	1. Meriam&Kraig: Vol-I Chapt: 1/3, 2/4, 2/7 2. I.H. Shames Chapt: 2.1 to 2.8

	applications.		Probs: 2.1, 2.2, 2.3,2.6, 2.10, 2.48, 2.52, 2.54, 2.64, 2.68
	Two dimensional force system; Resolution of forces; Moment; Varignon's theorem; Couple;Resolution of a coplanar force by its equivalent force-couple system; Resultant of forces.	4L+2T	1. Meriam&Kraig: Vol-I Chapt: 2/3, 2/4, 2/5, 2/6, 2/9 Probs: 2/1 to 2/8; 2/13, 2/16, 2/20; 2/27, 2/31 to 2/33, 2/35, 2/37, 2/39; 2/53, 2/55, 2/57, 2/61, 2/66; 2/75, 2/77, 2/79, 2/78 to 2/82; 2/135 to 2/137, 2/139, 2/141, 2/146, 2/147,2/151, 2/157
MOD-2	Concept and Equilibrium of forces in two dimensions; Free body concept and diagram; Equations of equilibrium.	3L+1T	Meriam&Kraig: Vol-I Chapt: 3/2, 3/3 Probs: 3/1, 3/3, 3/4 to 3/7, 3/11, 3/13, 3/15, 3/21, 3/25, 3/27, 3/31,3/39
	Concept of Friction; Laws of Coulomb friction; Angle of Repose; Coefficient of friction.	3L+1T	Meriam&Kraig: Vol-I Chapt: 6/1, 6/2, 6/3 Probs: 6/1 to 6/6, 6/13, 6/15, 6/17; 2. I.H. Shames; Chapt: 7.1,7.2
MOD-3	Distributed Force: Centroid and Centre of Gravity; Centroids of a triangle, circular sector, quadrilateral, composite areas consisting of above figures.	4L+1T	1. Meriam&Kraig: Vol-I Chapt: 5/1, 5/2, 5/3Sample probs: 5/1 to 5/5Probs: 5/2, 5/5, 5/7, 5/9, 5/12, 5/20,5/25, 5/30, 5/43,5/47
	Moments of inertia: MI of plane figure with respect to an axis in its plane, MI of plane figure with respect to an axis perpendicular tothe plane of the figure; Parallel axis theorem; Mass moment of inertia of symmetrical bodies, e.g. cylinder, sphere, cone.	3L+1T	1. Meriam&Kraig: Vol-I Chapt: Appendix A/1, A/2 Sample Probs: A/1 to A/5; Probs: A/1, A/5, A/9, A/15, A/20
	Concept of simple stresses and strains: Normal stress, Shear stress, Bearing stress, Normal strain, Shearing strain; Hooke's law; Poisson's ratio; Stress-strain diagram of ductile and brittle materials; Elastic limit; Ultimate stress; Yielding; Modulus of elasticity; Factor of safety.	2L+1T	1.Elements of strength of Materials by Timoshenko & Young Chapt: 1.1,1.2,1.3, 2.2 Prob set 1.2 : Prob: 3,4,5,8,9,10 Prob set 1.3: Prob: 1,3,5,7 2. Nag &Chanda -3rd Part Chapt: 1.1, 1.2.1 to 1.2.3, 1.2.6, 1.2.7
MOD-4	Introduction to Dynamics: Kinematics and Kinetics; Newton's laws of motion; Law of gravitation & acceleration due to gravity; Rectilinear motion of particles; determination of position, velocity and acceleration under uniform and non-uniformly accelerated rectilinear motion; construction of x-t, v-t and a-t graphs.	3L+1T	Meriam&Kriag: Vol-II Chapt: 1/3, 1/5,1/7, 2/1,2/2 Probs: 1/1 to 1/10; 2/1 to 2/14; 2/15, 2/17, 2/19, 2/25, 2/27;
	Plane curvilinear motion of particles: Rectangular components (Projectile motion); Normal and tangential components (circular motion).	3L+1T	Meriam&Kraig: Vol-II Chapt: 2/3, 2/4, 2/5, Probs: 2/59 to 2/65, 2/67, 2/71, 2/81, 2/84, 2/89; 2/97, 2/99 to 2/103;
MOD-15	Kinetics of particles: Newton's second law; Equation of motion; D.Alembert's principle and free body diagram; Principle of work and energy ; Principle of conservation of energy; Power and efficiency.	5L+2T	5L+2T Meriam&Kraig: Vol-II Chapt: 3/2, 3/3, 3/4,3/6, 3/7; Probs: 3/1, 3/3, 3/4,3/7, 3/11, 3/12; 3/17, 3/19, 3/23; 3/103 to 3/107, 3/113, 3/115, 3/116; Sample probs: 3/16, 3/17; Probs: 3/143,3/145, 3/158 Books Recommended

Basic Electrical Engineering
Code: EE 101, **Contacts: 3L+1T, Credit: 4**

Course Objective:

- The students will be introduced with an introductory and broad treatment of the field of Electrical Engineering.
- This course provides comprehensive idea about circuit analysis, working principles of machines and common measuring instruments.
- The students will be introduced with an introductory and broad treatment of the field of Electrical Engineering. They will be able to analyze different problems in basic electrical engineering.

Course Outcome:

At the end of the course students will be able:

1. To understand the basic concepts of Electric and Magnetic circuits, AC & DC circuits
2. To explain the working principle, construction, applications of DC machines, AC machines & measuring instruments.
3. To understand the AC fundamentals.
4. To understand the working of various Electrical Machines.
5. To get the knowledge about various measuring instruments and house wiring.

Topic	No of Periods
Electrostatics: Coulomb's law, Electric Field Intensity, Electric field due to a group of charges, continuous charge distribution, Electric flux, Flux density, Electric potential, potential difference, Gauss's law, proof of gauss's law, its applications to electric field and potential calculation, Capacitor, capacitance of parallel plate capacitor, spherical capacitor, isolated spheres, concentric conductors, parallel conductors. Energy stored in a capacitor.	5L
DC Network Theorem: Definition of electric circuit, network, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, Kirchhoff's law, Principle of superposition. Source equivalence and conversion, Thevenin's Theorem, Norton Theorem, nodal analysis, mesh analysis, star-delta conversion. Maximum power transfer theorem with proof.	7L
Electromagnetism: Biot-savart law, Ampere's circuital law, field calculation using Biot-savart & ampere's circuital law. Magnetic circuits, Analogous quantities in magnetic and electric circuits, Faraday's law, Self and mutual inductance. Energy stored in a magnetic field, B-H curve, Hysteretic and Eddy current losses, Lifting power of Electromagnet.	5L
DC Machines: Construction, Basic concepts of winding (Lap and wave). DC generator: Principle of operation, EMF equation, characteristics (open circuit, load) DC motors: Principle of operation, Speed-torque Characteristics (shunt and series machine), starting (by 3 point starter), speed control (armature-voltage and field control).	6L
AC Fundamentals: Production of alternating voltage, waveforms, average and RMS values, peak factor, form factor, phase and phase difference, phasor representation of alternating quantities, phasor diagram, behaviour of AC series, parallel and series parallel circuits, Power factor, Power in AC circuit, Effect of frequency variation in RLC series and parallel circuits, Resonance in RLC series and parallel circuit, Q factor, band width of resonant circuit.	6L
Single Phase Transformer: Core and shell type construction, EMF equation, no load and on load operation, phasor diagram and equivalent circuit, losses of a transformer, open and short circuit tests, regulation and efficiency calculation.	4L
3 phase Induction Motor: Types, Construction, production of rotating field, principle of operation, equivalent circuit and phasor diagram, rating, torque-speed characteristics (qualitative only). Starter for squirrel cage and wound rotor induction motor. Brief introduction of speed control of 3 phase induction motor (voltage control, frequency control, resistance control)	5L
Three Phase System: Voltages of three balanced phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams. Power measurement by two watt meters method.	3L
General Structure of an Electrical Power System: Power generation to distribution through overhead lines and under-ground cables with single line diagram.	1L

Text books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Fundamental of electrical Engineering, Rajendra Prasad, PHI, Edition 2005.
3. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition

4. Basic Electrical Engineering, J.P. Tewari, New age international publication

Reference books:

1. Basic Electrical Engineering (TMH WBUT Series), Abhijit Chakrabarti & Sudipta Nath, TMH
2. Electrical Engineering Fundamental, Vincent.D.Toro, Pearson Education, Second Edition.
2. Hughes Electrical & Electronics Technology, 8/e, Hughes, Pearson Education.
3. Basic Electrical Engineering, T.K. Nagsarkar & M.S. Sukhija, Oxford
4. Introduction to Electrical Engineering, M.S. Naidu & S, Kamakshaiah, TMH
5. Basic Electrical Engineering, J.J. Cathey & S.A Nasar, TMH, Second Edition.

PRACTICAL/SESSIONAL PAPERS

Students Project Presentation Laboratory
Code: HU 181, Contacts: 2P, Credit: 1

Course Objective:
To familiarize students with basic Listening Skill, Speaking Skill, Linguistic/Paralinguistic features, Conversation Skill, Group Discussion, Reading Skills and Writing Skill and relevant sub-skills in the view point of project presentation

Course Outcome:
After completion of the course the students will be able to

1. Understand & present their Listening Skill and relevant sub-skills
2. Understand & present their Speaking Skill and relevant sub-skills
3. Understand & present their Conversation Skill and relevant sub-skills
4. Understand & present their Reading Skills and relevant sub-skills
5. Understand & present their Writing Skill and relevant sub-skills

Topic	No of Periods
a) Honing 'Listening Skill' and its sub skills through Language Lab Audio device;	3P
b) Honing 'Speaking Skill' and its sub skills;	2P
c)Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/Voice modulation/Stress/ Intonation/ Pitch &Accent) of connected speech;	2P
j) Honing 'Conversation Skill' using Language Lab Audio –Visual input; Conversational Practice Sessions (Face to Face / via Telephone , Mobile phone & Role Play Mode);	2P
k) Introducing 'Group Discussion' through audio –Visual input and acquainting them with key strategies for success;	2P
f) G D Practice Sessions for helping them internalize basic Principles (turn- taking, creative intervention, by using correct body language, courtesies & other soft skills) of GD;	4P
g) Honing 'Reading Skills' and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non Technical Passages; Learning Global / Contextual / Inferential Comprehension;	2P
h) Honing 'Writing Skill' and its sub skills by using Language Lab Audio –Visual input; Practice Sessions	2P
Total	17

Books Recommended:

1. Dr. D. Sudharani: Manual for English Language Laboratory Pearson Education (WB edition),2010
2. Board of Editors: Contemporary Communicative English for Technical Communication, Pearson Longman, 2010

Engineering Chemistry Laboratory
Code: CH191, Contacts: 3P, Credit: 2

Course Objective:
To familiarize students with fundamental engineering chemistry experiments and their applications

Course Outcome:
After completion of the course the students will be skilled to

1. Determine alkalinity in a given water sample
2. Determine organic & inorganic ions in water
3. Determine the strength of unknown acid solution by different methods
4. Determine dissolved oxygen in a given water sample
5. Determine reaction rate constant by hydrolysis of ester
6. Determine partition coefficient of acetic acid in the heterogeneous equilibrium condition

List of Experiment:

1. Determination of alkalinity in a given water sample
2. Determination of amount of Fe^{+2} in a given mohr salt solution by red-ox titration
3. Determination of Cl^- ion in a given water sample by argentometric titration
4. Determination of hardness of water by complexometric titration
5. Determination of strength of unknown acid solution by ph metric titration
6. Determination of strength of unknown acid solution by conductometric titration
7. Determination of percentage composition of sugar solution by relative viscosity method
8. Determination of dissolved oxygen in a given water sample
9. Determination of reaction rate constant by hydrolysis of ester
10. Determination of partition co efficient of acetic acid in the heterogeneous equilibrium formed between n- butanol and water

Engineering Graphics
Code: ME 194, Contacts: 3P, Credits: 2

Course Objective:
The ability to read drawing is the most important requirement of all technical people in engineering profession. The potentialities of drawing as an engineer's language may be made use of, as a tool for imparting knowledge and providing information on various aspects of engineering.

1. Learn to sketch and take field dimensions.
2. Learn to take data and transform it into graphic drawings.
3. Learn basic Auto Cad skills.
4. Learn basic engineering drawing formats

Course Outcome:

1. Students' ability to write letters and numbers will improve.
2. Students' ability to perform basic sketching techniques will improve.
3. Students will be able to draw orthographic/isometric projections and sections.
4. Students' ability to produce engineered drawings will improve.
5. Students' ability to convert sketches to engineered drawings will increase.
6. Students will become familiar with office practice and standards.
7. Students will become familiar with Auto Cad (two dimensional) drawings.
8. Students will develop good communication skills and team work

A) THEORETICAL PART

1. Introduction to Lines, Lettering, Dimensioning, Scales.
2. Geometrical Construction and Curves.
3. Projection of Points, Lines and Surfaces.
4. Projection of Solids.
5. Isometric Views.
6. Sectional Views.
7. Development of Surfaces.
8. Introduction to computer Aided Drafting.

B) PRACTICAL PART

1. LINES, LETTERING, DIMENSIONING, SCALES; Plain scale, Diagonal scale.
2. GEOMETRICAL CONSTRUCTION AND CURVES; Construction of polygons, Parabola, Hyperbola, Ellipse.
3. PROJECTION OF POINTS, LINES, SURFACES; Orthographic projection- 1st and 3rd angle projection, Projection of lines and surfaces– Hexagon.
4. PROJECTION OF SOLIDS; Cube, Pyramid, Prism, Cylinder, Cone.

Basic Electrical Engineering Laboratory
Code: EE 191, Contacts: 3P, Credit: 2

Course Objective:
The subject aims to provide the student with:
The capability to design and construct circuits, take measurements of circuit behaviour and performance, compare with predicted circuit models and explain discrepancies.

Course Outcome:
The students will be able
1. To acquaint with the basic concepts and properties of electrical circuits and networks;
2. To gain basic laboratory experience with analyzing and building simple circuits;
3. To analyze fluorescent lamp
4. To prove superposition theorem
5. To prove Thevnin's theorem
5. To prepare students for follow-up courses in the Circuits area of the Electrical Engineering program

List of Experiments:

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. Verification of Thevenin's theorem.
4. Verification of Norton's theorems.
5. Verification of Maximum power theorem.
6. Verification of Superposition theorem
7. Calibration of ammeter and voltmeter.
8. Study of R-L-C Series circuit
9. Study of R-L-C parallel circuit
10. Open circuit and Short circuit test of a single phase Transformer.
11. No load characteristics of D.C shunt Generators
12. Starting and reversing of speed of a D.C. shunt
13. Speed control of DC shunt motor.
14. Measurement of power in a three phase circuit by two wattmeter method.

Extra Curricular Activities (NSS/NCC)
Code: XC 181, Contacts: 2P, Credit: 1

Course Objective:
The main objectives of National Service Scheme (NSS) are:

i. understand the community in which they work
ii. understand themselves in relation to their community
iii. identify the needs and problems of the community and involve them in problem-solving
iv. develop among themselves a sense of social and civic responsibility
v. utilise their knowledge in finding practical solutions to individual and community problems
vi. develop competence required for group-living and sharing of responsibilities
vii. gain skills in mobilising community participation
viii. acquire leadership qualities and democratic attitudes
ix. develop capacity to meet emergencies and natural disasters and
x. practise national integration and social harmony

Course Outcome:

NSS is a part of the course curricula of the college. The students are exposed to various NSS activities and projects and they are actively participating in the above programmes. Through the above participants the students develop a strong awareness and an concerns various social issues .

They develop a sense of responsibility and accountability for the society as well as for the whole nation, which is essential in shaping them as essential good future citizens of the country. The outcomes of student evaluation are addressed in the formal processes of annual monitoring and evaluation and periodic review. Feedback from students is used internally to plan for, and facilitate, change and to improve the student experience. Analysis of the survey results also highlights areas of commendable practice which can be shared across the institution.

Topics

a) Creating awareness in social issues
b) Participating in mass education programmes
c) Proposal for local slum area development
d) Waste disposal
e) Environmental awareness
f) Production Oriented Programmes
g) Relief & Rehabilitation work during Natural calamities

Creating awareness in social issues:

1. Women's development – includes health, income-generation, rights awareness.
2. Hospital activities – Eg. writing letters for patients, guiding visitors
3. Old age home – visiting the aging in-mates, arranging for their entertainment.
4. Children's Homes - visiting the young in-mates, arranging for their entertainment
5. Linking with NGOs to work on other social issues. (Eg. Children of sex-workers)
6. Gender issues- Developing an awareness, to link it with Women's Cell of college

Participating in mass education programmes

1.Adult education
2. Children's education

Proposal for local slum area development

One or two slums to be identified and according to the needs, activities to be developed and proposals and reports are to be submitted.

Environmental awareness

• Resource conservation – Awareness to be developed on water, energy,soil.
• Preservation of heritage monuments- Marches, poster campaigns
• Alternative energy consciousness amongst younger school-children.
• Plantation and beautification- Plantation of trees, their preservation and upkeep, developing NSS parks.
• Waste disposal- Proper methods of domestic waste disposal.

Production Oriented Programmes

5. Working with people and explaining and teaching improved agricultural practices
6. Rodent control land pest control practices;
7. Soil-testing, soil health care and soil conservation;
8. Assistance in repair of agriculture machinery;
9. Work for the promotion and strengthening of cooperative societies in villages;
10. Assistance and guidance in poultry farming, animal husbandry, care of animal health etc.;
11. Popularization of small savings and
12. Assistance in procuring bank loans

Relief & Rehabilitation work during Natural calamities

g) Assisting the authorities in distribution of rations, medicine, clothes etc.;
h) Assisting the health authorities in inoculation and immunization, supply of medicine etc.;
i) Working with the local people in reconstruction of their huts, cleaning of wells, building roads etc.;
j) Assisting and working with local authorities in relief and rescue operation;
Collection of clothes and other materials, and sending the same to the affected areas;

1st Year-2nd Semester

THEORY PAPERS

Mathematics-II
Code: M 201, Contacts: 3L+1T, Credit: 4

Course Objectives:

The objectives of offering this course are

1. To identify the order and degree of a differential equation.
2. To know how to solve the first order and higher order ordinary differential equations.
3. To apply the first order and higher order ordinary differential equations to physical problems.
4. To compute the general solution of 2nd order ordinary differential equations and apply them to solve the L-C-R circuits.
5. To make aware students about the Applications of graph theory in real life application.
6. To evaluate Laplace transforms and inverse Laplace transform.
7. To apply Laplace transforms to solve ordinary differential equations arising in engineering problems.

Course Outcomes:

On the successful completion of this course; student shall be able to

1. Represent certain mechanical, electrical, biological systems in terms of ordinary differential equations and provision of effective solutions to them.
2. Represent periodic functions corresponding to objects following periodic phenomena in terms of sine and cosine functions.
3. Solve the Laplace, heat and wave equations for a variety of boundary conditions in

   domains of simple geometry and with simple boundary conditions; the techniques available will include, separation of variables, Laplace Transform methods.

Topic	No of Lectures
Module I **Ordinary differential equations (ODE**)- First order and first degree Exact equations, Necessary and sufficient condition of exactness of a first order and first degree ODE (statement only), Rules for finding Integrating factors, Linear equation, Bernoulli's equation. General solution of ODE of first order and higher degree (different forms with special reference to Clairaut's equation).	5L
Module II **ODE- Higher order and first degree**: General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations, Solution of simultaneous linear differential equations.	5L
Module III **Basics of Graph Theory**: Graphs, Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph,; Walks, Paths, Circuits, Euler Graph, Cut sets and cut vertices, Matrix representation of a graph, Adjacency and incidence matrices of a graph, Graph isomorphism, Bipartite graph.	10L
Module IV **Tree**: Definition and properties, Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees, Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using Kruskal's and Prim's algorithm.	10L
Module V **Improper Integral**: Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations. Problems related to Beta and Gamma functions.**Laplace Transform (LT):** Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property; LT of $\frac{f(t)}{t}$, LT of $t^n f(t)$, LT of derivatives of $f(t)$, LT of $\int f(u)\,du$. Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties; Convolution Theorem(statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT. Z transform.	3L 7L
TOTAL	40L

Suggested Text / Reference Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern)
2. Graph Theory: V. K. Balakrishnan, (Schaum's Outline, TMH)
3. A first course at Graph Theory: J. Clark and D. A. Holton (Allied Publishers LTD)
4. Introduction to Graph Theory: D. B. West (Prentice-Hall of India)
5. Graph Theory: N. Deo (Prentice-Hall of India)
6. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
7. Higher Engineering Mathematics: John Bird (4th Edition, 1st Indian Reprint 2006, Elsevier)
8. Calculus: Strauss, Bradley and Smith (3PrdPedition, Pearson Education)
9. Engineering Mathematics (Volume 2): S. S. Sastry (Prentice-Hall of India)
10. Advanced Engineering Mathematics, 3E: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition
11. An Introduction to Differential Equations, R.K. Ghosh and K.C.Maity (New Central Book Agency)

Physics-I
Code: PH 201, Contacts: 3L, Credit: 3

Course Objective:
The aim of courses in Physics is to provide an adequate exposure and develop insight about the basic principles of physics along with the possible applications. The acquaintance of basic physics principles would help engineers to understand the tools and techniques used in the industry and provide the necessary foundations for inculcating innovative approaches. This would create awareness about the vital role played by science and engineering in the development of new technologies. The courses would provide the necessary exposure to the practical aspects, which is an essential component for learning science.

Course Outcome:
Through the 1st year basic physics course, **s**tudents will be equipped with basic physical laws, principles and formalism to apply them in their core curriculum. Through laboratory sessions they will be exposed to basic error analysis and some phenomenological experiments which are essential for the understanding of the core curriculum.

Topic	No of Lectures
Module 1: Classical Mechanics **1.01: Classical Mechanics:** Limitations of Newtonian Mechanics, constraint, degree of freedom, generalized coordinates, Lagrange's equation (No derivation), Hamilton's principle, Applications of Lagrange's equation: Linear Harmonic Oscillators-Differential equation and its solution, superposition of two linear SHM's (with same frequency), Lissajous' figures. **1.02: Damped vibration:** Introduction – differential equation and its solution, critical damping, Logarithmic decrement. **1.03: Forced vibration**: Introduction – differential equation, Amplitude and velocity resonance, Sharpness of resonance and Quality factor, Application to L-C-R Circuit **1.04: Electromagnetic theory-I:** **1.04-A:** Vector operators, Gradient, Divergence, Curl-Physical significance, Gauss's divergence theorem (statement only), Stoke's theorem (statement only) and their applications. **1.04-B:** Development of electromagnetic theory, Electromagnetic spectrum, Concept of displacement current, equation of continuity, Maxwell's field equations with physical significance, wave equation in free space, transverse nature of electromagnetic wave, electromagnetic waves in a charge free conducting medium, skin depth, Poynting vector.	4L 1L 2L 2L 3L
Module 2: OPTICS 1: **2.01: Interference** – Conditions for sustained interference, Young's double slit as an example. Qualitative idea of Spatial and Temporal Coherence, Conservation of energy and intensity distribution, Fresnel's Biprism, thin films of uniform thickness (derivation) Newton's ring. **2.02: Diffraction of light** – Fresnel and Fraunhofer class. Fraunhofer diffraction for single slit and double slits (elementary treatment, Intensity distribution). Plane transmission grating (No deduction of	4L 3L

the intensity distributions is necessary). Missing orders, Dispersive power, Rayleigh criterion (qualitative), Resolving power of grating (Definition and formulae). Use of grating as a monochromator. **2.03: Polarization**: General concept of Polarization, Plane of vibration and plane of polarization, Concept of Plane, Circularly and Elliptically polarized light (using wave equations), Polarization through reflection and Brewster's law, Double refraction (birefringence) -Ordinary and Extra-ordinary rays, Nicol's Prism. **2.04: Laser :** Spontaneous and Stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient (derivation of the mutual relation), concept of laser as a polarized source, Optical resonator and Condition necessary for active Laser action, Ruby Laser, He-Ne Laser, semiconductor Laser- applications of laser. **2.05: Fiber optics**: Optical Fibers – Core and cladding, total internal reflection step index and graded index fiber, Calculation of Numerical aperture and acceptance angle, losses in the fiber, applications.	3L 3L 2L
Module 3: Elementary solid state physics **3.00: Crystallography & Solid state physics:** Space lattice, unit cell, crystal systems, Bravais lattices, basis, co-ordination number and atomic packing fraction, scc, bcc and fcc and hcp structures lattice planes, indexing of directions, Miller indices, interplaner spacing, Bragg's law & its application to real crystal structure (NaCl, KCl).	4L
Module 4: Quantum Mechanics I: **4.01: Matter waves:** Concept of de Broglie's Matter waves, derivation of wavelength of matter waves in different forms, Concept of Phase velocity and Group velocity (qualitative) **4.02: Wave mechanics:** Concept and Physical significance of wave function Ψ and interpretation of $\|\Psi\|^2$, Ψ(normalization and probability interpretation), Heisenberg's Uncertainty principle with illustration; Schrödinger's equation- time dependent and time independent form (derivation). Discussion with relevant problems. **4.03: Operator algebra:** Operator, Commutator, Formulation of quantum mechanics and Basic postulates, Operator correspondence, Expectation values, Ehrenfest theorem. Discussion with relevant problems.	2L 3L 4L
TOTAL	40L

List of recommended Books:

Module 1: Experiments on Classical Mechanics:

1. Classical Mechanics- J. C. Upadhyay (Himalya Publishers)
2. Classical Mechanics-Shrivastav
3. Classical Mechanics-Takwal & Puranik (TMH)
4. Sound-N. K. Bajaj (TMH)
5. Advanced Acoustics-D. P. Roy Chowdhury (Chayan Publisher)
6. Principles of Acoustics-B.Ghosh (Sridhar Publisher)
7. A text book of sound-M. Ghosh (S. Chand publishers)
8. Electromagnetics-B.B. Laud (TMH)
9. Electricity Magnetism-B.Ghosh (Book & Allied Publisher)
10. Electricity Magnetism-Chattopadhyay & Rakshit (New Central Book Agency)
11. A text book of Light- K.G. Mazumder & B.Ghoshs, (Book & Allied Publisher)
12. Electricity Magnetism-Fewkes and Yardwood (Oxford University Press)

Module 2: OPTICS 1:

1. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
2. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers)
3. Modern Optics-A. B. Gupta (Book & Allied Publisher)
4. Optics-Ajay Ghatak (TMH)
5. Optics-Hecht
6. Optics-R. Kar, Books Applied Publishers

Module 3: Elementary solid state physics

1. Solid state physics-Puri & Babbar (S. Chand publishers)
2. Materials Science & Engineering-Kakani Kakani
3. Solid state physics- S. O. Pillai
4. Introduction to solid state physics-Kittel (TMH)
5. Solid State Physics and Electronics- A. B. Gupta, Nurul Islam (Book & Allied Publisher)

Module 4: Quantum Mechanics I:

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde Singh (S. Chand Publishers)

3. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
4. Quantum Mechanics-Binayak Datta Roy (S. Chand Publishers)
5. Quantum Mechanics-Bransden (Pearson Education Ltd.)
6. Perspective of Modern Physics-A. Beiser (TMH)

General Reference:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3)-C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics-Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Basic Engineering Physics-I -Sujoy Bhattacharya, Saumen Paul (TMH)
4. University Physics-Sears & Zemansky (Addison-Wesley)

Environment & Ecology
Code: CH 201, Contacts: 3L, Credit: 3

Course Objective:

The Objectives of the curriculum are listed below:

- To introduce students to environmental science, its central ideas, concepts, models and applications
- To help students in application of the fundamentals of environmental science to important local, regional, national and global environmental problems and potential solutions to maintain our sustainability
- To give you an opportunity to analyze and discuss the relevance of environmental science to your personal, professional, and academic life
- Communicate scientific information to both professional and lay audiences

Course Outcome:

Upon successful completion of this curriculum students should be able to:

- Describe the structure and function of significant environmental systems.
- Use scientific reasoning to identify and understand environmental problems and evaluate potential solutions.
- Critically evaluate arguments regarding environmental issues.
- Develop new project with good environmental impact leading to better earth for the future.
- Control industrial pollution as there are a good number of technologists with basic environmental awareness

Topic	No of Lectures
Module 1 **General:** Definition, Scope & Importance, Need For Public Awareness- Environment definition, Eco system – Balanced ecosystem, Material cycles- Carbon, Nitrogen and Sulphur Cycles. Human activities – Food, Shelter, Economic and social Security. Basics of Environmental Impact Assessment. Sustainable Development.	5L
Module 2 **Natural Resources:** Water Resources: Availability and Quality aspects, Water borne diseases, Water induced diseases, Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Rain water harvesting, **Forest resources:** Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Mineral resources: Use and exploitation, environmental effects of extracting and mineral resources. **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. **Energy resources:** Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources Different types of energy, Electro-magnetic radiation. Conventional and Non-**Conventional sources –** Hydro Electric, Fossil Fuel based Nuclear, Solar, Biomass and Bio-gas. Hydrogen as an alternative future source of Energy.	3L 1L 1L 2L 2L
Module 3 **Pollution:** Population Growth and Urbanization Environmental Pollution and their effects (Previous disaster) AirPollution (Atmospheric structure, Primary and Secondary pollutant, Green house effect and Global	2L 1L 3L

warming, Acid Rain, Ozone Layer depletion, Smog, Control measure). Water pollution (Effects of heavy metals, Sewage, BOD, COD, Water treatment). Land pollution and Solid waste management. Noise pollution, e-Waste.	 3L 4L
Module 4 **Control:** Environmental Protection- Role of Government, Legal aspects, Initiatives by Non-governmental Organizations (NGO), Environmental Education, Women Education. **Green chemistry:** Introduction, Goals Significance, Basic ideas in the field of green chemistry research. Industrial applications of green chemistry.	 2L 2L
TOTAL	31

Reference Books

1. Garg, S.K and Garg, R., Ecological and Environmental Studies, Khanna Publishers, Delhi, 2012.
2. Henry J.G. and Heinke G.W., Environmental Science and Engineering, 2nd Edition, Prentice Hall of India, New Delhi, 2004.
3. Masters G.M., Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall of India, New Delhi, 2004.

Elements of Electronics Engineering
Code: EC 201, Contacts: 3L+1T, Credit: 4

Pre-requisites: Knowledge of Class XII level electronics, Physics & Mathematics. Recapitulation and Orientation lectures:

Course Objective:
The objective of this subject is to build up the fundamental idea of semiconductor devices and their electrical characteristics when they are associated with the lump elements.

Course Outcome:
At the end of the course students should be able to explain the fundamentals of the operation of semiconductor devices and their electrical characteristics.

Topic	No of Lectures
Module-I **Semiconductors:** Conductors, Semiconductors and Insulators, electrical properties, band diagrams. Intrinsic and extrinsic, energy band diagram, electrical conduction phenomenon, P-type and N-type semiconductors, drift and diffusion carriers. Diodes and Diode Circuits Formation of P-N junction, energy band diagram, built-in-potential forward and reverse biased P-N junction, formation of depletion zone, V-I characteristics, Zener breakdown, Avalanche breakdown and its reverse characteristics; Junction capacitance and Varactor diode. Simple diode circuits, load line, linear piecewise model; Rectifier circuits: half wave, full wave, PIV, DC voltage and current, ripple factor, efficiency, idea of regulation.	12L
Module-II **Bipolar Junction Transistors:** Formation of PNP / NPN junctions, energy band diagram; transistor mechanism and principle of transistors, CE, CB, CC configuration, transistor characteristics: cut-off active and saturation mode, transistor action and current amplification factors for CB and CE modes. Biasing and Bias stability.	10L
Module-III **Field Effect Transistors:** Concept of Field Effect Transistors (channel width modulation), Gate isolation types, JFET Structure and characteristics, MOSFET Structure and characteristics, depletion and enhancement type; CS, CG, CD configurations; CMOS: Basic Principles.	8L
Module-IV **Feed Back Amplifier (basic concept), Oscillators and Operational Amplifiers:** Concept (Block diagram), properties, positive and negative feedback, loop gain, open loop gain, feedback factors; topologies of feedback amplifier; effect of feedback on gain, output impedance, input impedance, sensitivities (qualitative), bandwidth stability; effect of positive feedback, instability and oscillation, condition of oscillation, Barkhausen criteria.	10L

Introduction to integrated circuits: Introduction to binary number; Basic Boolean algebra; Logic gates and function realization.	
TOTAL	40L

TEXT BOOKS:

• Millman & Halkias: Integrated Electronics.
• Sedra & Smith: Microelectronics Engineering.

References:

• Malvino: Electronic Principle.
• Schilling & Belove: Electronics Circuits.
• Millman & Grabal: Microelectronics.
• Salivahanan: Electronics Devices & Circuits.
• Boyelstad & Nashelsky: Electronic Devices & Circuit Theory.

Introduction to Programming
Code: CS (BME) 201, Contacts: 3L, Credit: 3

Course Objective:

1. To understand the nature of programming as human activity
2. To learn and experience main components of programming process
3. To understand main control structures of procedural programming languages
4. To learn and being able to use major programming patterns
5. To understand the principles of data storage and manipulation

Course Outcome:

After completion of this course the students will be able to

1. Understand the basic terminology used in computer programming
2. Write, compile and debug programs in C language.
3. Use different data types in a computer program.
4. Design programs involving decision structures, loops and functions.
5. Explain the difference between call by value and call by reference
6. Understand the dynamics of memory by the use of pointers.
7. Use different data structures and create/update basic data files.

Topic	No of Lectures
Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers, Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices, Binary & Allied number systems, representation of signed and unsigned numbers. Basic concepts of Assembly language, high level language, compiler and assembler, Basic concepts of operating system, Concept of Algorithm & flow chart. Basic concepts of operating systems like MS DOS, MS-WINDOW, UNIX.	4L
C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements	3L
Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf.	5L
Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels	5L
Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register variables, scope rules, recursion, function prototypes, C preprocessor, command line arguments , Recursion, Call-By-Value, Call-By-Reference, Linear Search, Binary Search.	6L
Arrays , String and Pointers: One dimensional arrays, Two Dimensional Arrays, String application using string function and without using string function, pointers and functions.	12L
Structures Union and Files: Basic of structures, structures and functions, arrays of structures, bit fields, formatted and unformatted Files.	5L
TOTAL	40L

Text Book:
1. Introduction To Computing , E. Balagurusamy,TMH
2. Gottfried Programming with C Schaum
3. Kerninghan B.W. & Ritchie D.M. The C Programming Language
4. Sinha & Sinha Fundamental of Computers
5. Kanetkar Y. Let us C

Value & Ethics in Profession
Code: HU 201, Contacts: 3L, Credit: 3

Course Objective:
1. To improve the student's Personality and Attitude.
2. To improve the skill of theories of Motivation
3. To improve the skill of Group Behaviour

Course Outcome:
After completion of this course the students will be able to
1. Build up Organizational Behaviour, Personality and Attitude.
2. Develop Group Behaviour & Communication skill
3. Handle the Organizational Politics.
4. Improve Organizational Design structure

Topic	No of Lectures
Science, Technology and Engineering as knowledge and as Social and Professional Activities ***Effects of Technological Growth:*** Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development Energy Crisis: Renewable Energy Resources Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology	18
Ethics of Profession: Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.	8
Profession and Human Values: Values Crisis in contemporary society Nature of values: Value Spectrum of a good life Psychological values: Integrated personality; mental health Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.	14
TOTAL	40L

Books:
1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

PRACTICAL/SESSIONAL PAPERS

Physics-I Laboratory
Code: PH 291, Contacts: 3P, Credit: 2

Course Objective:
This course is objected to

1. Train students with basic idea on measurement techniques & related error
2. Train students with handful of experiments in the domain of Classical & Quantum mechanics, optics & electromagnetic theory

Course Outcome:
After completion of this course the students will be able to

1. Understand and apply the basic idea on measurement techniques & related error in engineering experiments
2. Understand and apply experimental techniques of Classical & Quantum mechanics, optics & electromagnetic theory in the domain of versatile engineering fields

General idea about Measurements and Errors (Mandatory):
Measurand (objects to be measured) precision, significant number., accuracy, certainty, resolution; Errors - types and sources of errors (definitions and examples), Systematic error, Random error, Ambiguity error, Dynamic error, with example of Slide calipers, Screw-gauge, Carrey Foster bridge. Study of different types of unit cells with model system,
Any 7 to be performed from the following experiments

Experiments on Classical Mechanics:
1. Study of torsional oscillation of torsional pendulum & determination of time period using various load of the oscillator.
2. Experiments on Lissajous figure (using CRO).
3. Experiments on LCR circuit.

Experiments on Optics:
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Fresnel's bi-prism method.
6. Determination of wavelength of light by Laser diffraction method.
7. Determination of numerical aperture and the energy losses related to optical fibre experiment
8. Study of Hydrogen/ Helium spectrum using transmission grating and measurement of Rydberg Constant.
9. Inspection of Laser beam profile-to find beam divergence.
10. Study of half-wave and quarter wave plates.
11. Measurement of specific rotation of an optically active solution by polarimeter

Experiments on Electromagnetic theory:
12. Measurement of nodal and antinodal points along a transmission wire and measurement of wave length.

Experiments on Quantum Mechanics I
13. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
14. Measurement of stopping potential using a photocell and determination of Planck's Constant.

Workshop Practice
Code: ME 293, Contacts: 3P, Credits: 2

Course Objective:

1. To develop a knowledge of appropriate parameters to be used for various machining operations.
2. To develop a knowledge of workshop practice and basic use of machine tools and workshop equipment.
3. To introduce students to the role of manufacturing in an economy and to show the relationship between design and manufacturing.
4. To make students aware of the necessity to manage manufacturing processes and systems for the best use of material and human resources with particular emphasis on product safety and environmental considerations.
5. To introduce students to the scientific principles underlying material behavior
6. To impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
7. To educate students of Safe handling of machines and tools

Course Outcome:
After successful completion of the course, the student will be able to:

1. Demonstrate and produce different types of fitting models.
2. Gain knowledge of development of sheet metal models with an understanding of their applications.
3. Perform welding of different welded joints.
4. Understand the Basics of Workshop practices

A. THEORETICAL PART

1. INTRODUCTION TO MANUFACTURING; Socio-economic role, Definition, Major grouping and Examples. - 1L

2. ENGINEERING MATERIALS; Classification / Major grouping, Physical, Chemical and Mechanical properties, Applications - 1L

3. DIFFERENT CONVENTIONAL MANUFACTURING PROCESSES MAINLY COVERING BASIC PRINCIPLES, DIFFERENT METHODS AND GENERAL APPLICATIONS; Manufacturing by forming /shaping from solid (input) to solid (product); Forging, Rolling, Drawing, Extrusion; Press tool work- Bending, Shearing, Drawing and Coining. - 3L

4. FORMING / SHAPING FROM LIQUID TO SOLID- CASTING; General principles, General classification or Types of casting; Sand mould casting- procedural steps and requirements; Pattern, Mould, Melting, Pouring, Solidification, Extracting and Fettling. Other casting processes (for larger volume and quality); Centrifugal casting, Investment casting, Die casting. -3L

5. JOINING PROCESSES; Welding (Permanent Joining)- General classification and basis; Gas welding, Arc welding, Friction welding and Resistance welding, w.r.t. Principle, Requirements, Relative Advantages and Applications; Brazing and soldering.
- 2L

6. REMOVAL (MACHINING) PROCESS; Principle and purpose of machining, Machining requirements, Machine tools- Definition, General classification w.r.t, functional principles and applications; Major machining parameters (and responses)- Speed, Feed and Depth of cut; Tool geometry (Rake, Clearance and Cutting angles), Cutting fluid application; Elementary machining operations- Facing, Centering, Turning, Threading, Drilling, Boring, Shaping and Milling.
-2L

B. SCHEDULE OF PRACTICAL CLASSES

Suggested apportionment / weigtage:

- Machining (and fitting)- 50% (6 days) 18 hrs
- Casting (including pattern making molding and preparation) - 25% (3 days 9hrs)
- Welding (gas, arc and resistance) (2 days 6hrs) and Sheet Metal Working (1 day 3hr)- 25% (3 days 9hrs)

FEASIBLE TYPES / MODELS OF ASSIGNMENTS

i) FITTING (in 2 days or 6 hours); Making a gauge from MS plate as shown in Fig.1.

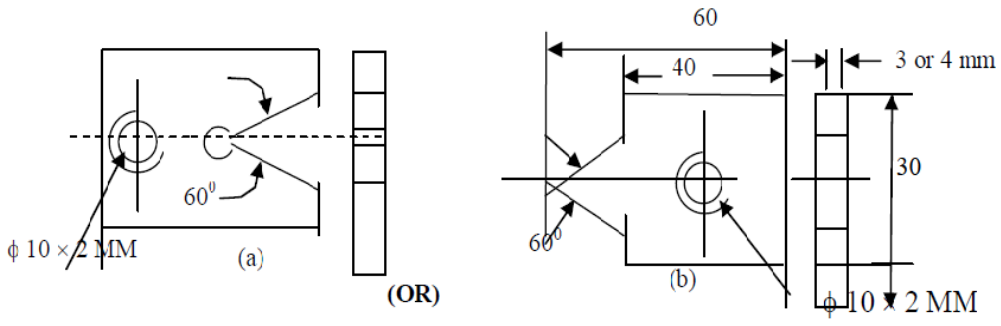

Fig.1: Job for fitting practice

Operations required:

11. Squaring and finishing of the blank by filing
12. Making the Vee-portion by sawing and filing
13. Drilling (in machine) and tapping (hand)

ii) MACHINING (in 3 days or 9 hours); To make a pin as shown in Fig.2 from a 20mm mild steel rod in a lathe.

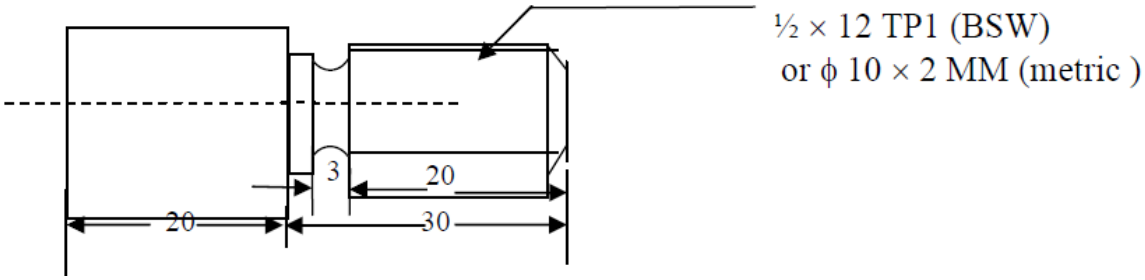

Fig.2: Job for practice on a lathe

iii) MACHINING (in 1 day or 3 hours); To make a MS prism as shown in Fig.3 from a □20mm mild steel rod in a shaping and / or milling machine.

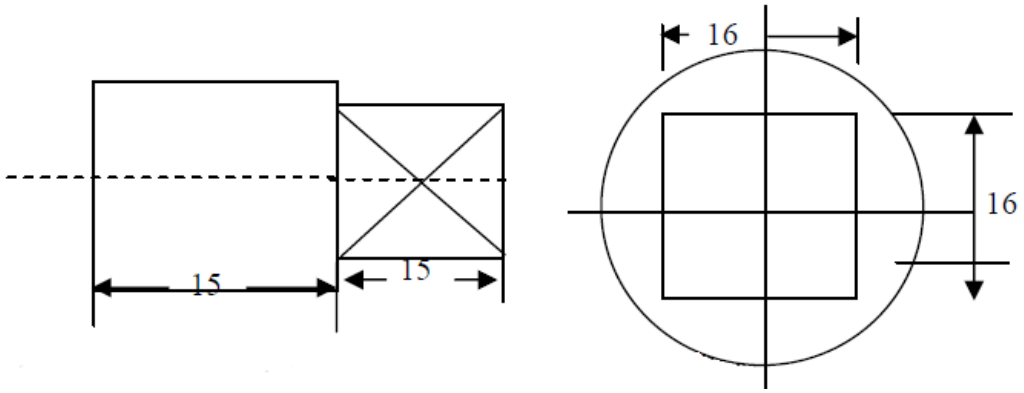

Fig.3: Job for practice on a shaping and/or milling machine

iv) PATTERN MAKING, SAND MOULDING AND CASTING (in 3 classes or 9 hours); To make a wooden pattern and a sand mould with that pattern for casting a cast iron block as shown in Fig.4.

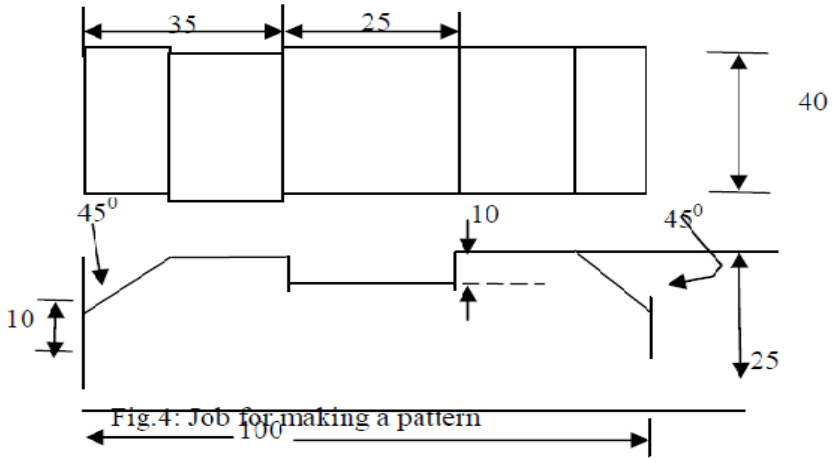

Fig.4: Job for making a pattern

v) WELDING (GAS WELDING) (in 1 class or 3 hours); To join two thin mild steel plates or sheets (1 to 3 mm thick) as shown in Fig. 5 by gas welding.

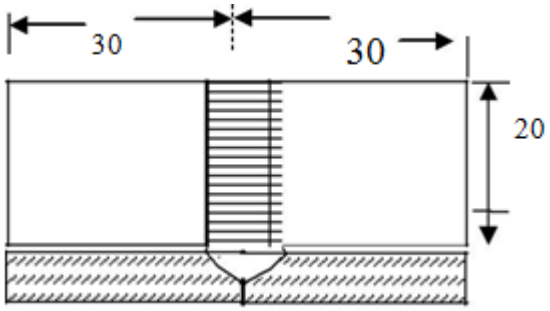

Fig.5: Welding specimen for practice

vi) WELDING (ARC WELDING) (in 1 day or 3 hours); To join two thick (6mm) MS plate as shown in Fig. 5 by arc welding.

vii) SHEET METAL WORK (in 1 day or 3 hours); forming a cone, for example.

Introduction to Programming Laboratory
Code: CS (BME) 291, Contacts: 3P, Credits: 2

Course Objective:

1. Analyze problems and develop computer algorithms to solve novel problems.
2. Write, document, test and debug programs, making use of variables, expressions, selection and looping statements.
3. Organize program code into modules using methods following the software engineering principles of modularity and abstraction.
4. Assemble data and methods into classes at an introductory level following the software engineering principles of encapsulation and data hiding.
5. Make use of arrays to store and process lists of data.
6. Read, interpret, analyze and explain programs.
7. Use editors to compose programming code and compilers to produce executable software

Course Outcome:
After completion of this course the students will be able to

1. Understand the basic concept of C Programming, and its different modules that includes conditional and looping expressions, Arrays, Strings, Functions, Pointers, Structures and File programming
2. Acquire knowledge about the basic concept of writing a program.
3. Acquire knowledge about role of constants, variables, identifiers, operators, type conversion and other building blocks of C Language.
4. Use of conditional expressions and looping statements to solve problems associated with conditions and repetitions.
5. Acquire knowledge about role of Functions involving the idea of modularity.
6. Achieve concept of Array and pointers dealing with memory management.
7. Acquire knowledge about structures and unions through which derived data types can be formed
8. Achieve concept of File Handling for permanent storage of data or record.
9. Achieve concept of Near & Huge pointers.

Exercises should include but not limited to:

1. Simple Programs: simple and compound interest. To check whether a given number is a palindrome or not,
2. Evaluate summation series, factorial of a number , generate Pascal's triangle, find roots of a quadratic equation
3. Programs to demonstrate control structure: text processing, use of break and continue, etc.
4. Programs involving functions and recursion
5. Programs involving the use of arrays with subscripts and pointers
6. Programs using structures and files.

Elements of Electronics Engineering Laboratory
Code: EC 291, Contacts: 3P, Credits: 2

Prerequisites: Knowledge in High School Physics, Chemistry and Mathematics

Course Objective:

- To make students familiar with behavioural characteristics of well known electronic components.
- Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
- Familiarization with measuring and testing equipment like CRO, Signal generators etc.
- Study of I-V characteristics of Junction diodes.
- Study of I-V characteristics of Zener diodes.
- Study of Half and Full wave rectifiers with Regulation and Ripple factors.
- Study of I-V characteristics of BJTs.
- Innovative experiments (Basic Logic gate design using DTL logic)

Course Outcome:

The students will be able

- To learn the basics of electronics and perform experiments;
- To study the behaviour of different active components like Diodes, Transistors, FETs etc;

List of Experiments:

1. Familiarisation with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multimeters etc.
2. Familiarisation with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs.

B.Tech-2nd Year, 3rd Semester

THEORY PAPERS

Biomathematics & Biostatistics
Code: M (BME) 301, Contacts: 3L+1T, Credit: 4

Course Objectives:

The objectives of offering this course are

1. To develop the ability to solve problems using probability.
2. To introduce students to some of the basic methods of statistics and prepare them for further study in statistics.
3. To develop abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to basic probability.
4. To study the basic concepts and definitions of partial differential equations.
5. To apply the basic series and transform for solution to partial differential equations.
6. To provide an application oriented computation for solving wave equation, heat equation and steady state two dimensional heat flow.
7. To make students familiar with complex variable.
8. To create zeal of working with higher mathematics in the widespread field of Biomedical engineering.
9. To introduce the basic statistical data analysis.

Course Outcomes:

On the successful completion of this course; student shall be able to

1. Use a statistical package, both for numerical work and to help to analyze the data required for Biomedical engineering.
2. Demonstrate an understanding of basic principles of probability, and sample spaces.
3. Know how to calculate fundamental concepts such as the cumulative distribution function, expectations, and distributions for functions of random variables.
4. Know how to describe distributions using graphs and numerical descriptors.
5. Evaluate estimators, construct confidence intervals, and perform hypothesis tests in the context of a single population sample.
6. Set up probability models for a range of random phenomena, both discrete and continuous.
7. Solve partial differential equations corresponding to vibration and radiation phenomena.
8. Understand analytic function of a complex variable and able to apply Cauchy integral theorem and residue theorem to solve contour integrations.
9. Find the sample regression line.
10. Apply partial differential equations to Biomedical engineering problems.
11. Solve ordinary differential equations using series solutions; describe special functions as solutions to differential equations.

Topic	No of Periods
Module-I **Calculus of Complex Variable**: Functions, Limit and Continuity, Analytic functions, Cauchy-Riemann equations , Complex integration and Cauchy's theorem, Cauchy's integral formula, Taylor's and Laurent series, Zeros of an analytic function, Poles, Essential singularities, Residue theorem.	10L
Module-II **Probability**: Axiomatic definition of probability, Conditional probability, Baye's theorem (Statement only) & its application. Random variable, Discrete and Continuous distributions, Expectation, Binomial, Poisson, Uniform, Exponential and Normal distribution, Problems on Binomial, Poisson and Normal distribution	10L
Module-III **Statistics:** Sampling theory , Mean, Median ,Mode, Variance and Standard Deviation, Correlation and Regression analysis , Testing of Hypothesis, ANOVA **Numerical Integration**: Trapezoidal rule, Simpson's $1/3^{rd}$ rule	10L
Module-IV **Partial Differential Equations**: Solution of one dimensional wave equation, One dimensional heat-conduction equation, Laplace equation in two dimension by the methods of 1: Separation of variables	5L

2:Integral Transforms (Laplace and Fourier Transforms).	
Module- V **Series Solution of Ordinary Differential Equation**: Introduction, validity of series solution of an ordinary differential equation, general method to solve equation of the type: $P_0(x)y'' + P_1(x)y' + P_2(x)y = 0$, Bessel's equation, properties of Bessel's function, Recurrence formula for Bessel's function of first kind, Legendre's equation, Legendre function; Recurrence formula for Legendre function ($P_n(x)$); Orthogonality relation.	5L
TOTAL	40L

Suggested Text / Reference Books:

1. Lipschutz & Lipson,Schaum's Outline in Probability (2ndEd).
2. Colburn, Fundamentals of Probability and Statistics.
3. Advanced Ordinary & Partial Diff.Equation by M D Raisinghania.
4. Complex Variables and Applications (Brown and Churchill).
5. Probability and Statistics by N.G. Das.

Physics-II
Code: PH (BME) 301, Contacts: 3L, Credit: 3

Course Objective: The aim of courses in Physics is to provide an adequate exposure and develop insight about the basic principles of physics along with the possible applications. The acquaintance of basic physics principles would help engineers to understand the tools and techniques used in the industry and provide the necessary foundations for inculcating innovative approaches. This would create awareness about the vital role played by science and engineering in the development of new technologies. The courses would provide the necessary exposure to the practical aspects, which is an essential component for learning science. **This could be achieved by primarily introducing a course clarifying some of the basics of physical sciences attached to engineering curriculum in general, and an advanced course explaining the scientific details of some of the material properties e.g. electric, magnetic semiconducting and acoustic properties which are connected to the 4yr Biomedical Engineering course. The advanced courses will also give an insight into the new-age science & technology to the budding engineers though the introduction of topic such as elementary Nanomaterials. .**

Course Outcome: Through the 1st year basic physics courses, **s**tudents will be equipped with basic physical laws, principles and formalism to apply them in their core curriculum. After going through the 2nd year course (advanced course), students will be exposed to the physics of materials that are allied to the syllabi of Biomedical engineering only as well develop knowledge about ultrasonics, vacuum pump and gauges as well as fundamentals of frontier technologies such as elementary nanoscience.

Topic	No of Lectures
Module 1: Acoustics, Modern Optics & Radioactivity:	
1.01: Ultrasonics: Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering & Medical applications of Ultrasonics (Non-destructive testing, cavitation, measurement of gauge).	**3L**
1.02: LASER-II: Recap of earlier course of laser (Population inversion, Optical resonator and Condition necessary for active Laser action) Principles and characteristics – CO_2 laser, excimer (ultraviolet laser) , NdYAG laser, GaAs laser, free electron laser–biomedical applications.	**3L**
1.03: Holography & Photoelasticity: Theory of Holography, viewing the hologram, mass storage, biomedical applications. Photo-elasticity-Theory and applications	**2L**
1.04 X-ray-Origin of X ray, X-ray spectra (Continuous & Characteristics), Hard and soft X-rays.	**2L**
1.05 Radioactivity-Basic concepts, units, doses, applications of radio isotopes.	**2L**
Module 2: PHYSICS OF SEMICONDUCTORS & OPTOELECTRONIC DEVICES	
2.01: Band Theory of solids: Introduction to Band theory (mention qualitatively improvement over free electron theory) - Energy bands of metal, insulator, semiconductor, magneto-resistance, Piezoelectric effect, Hall Effect (qualitative)-applications.	**3L**
2.02: Optoelectronic devices: Basic background of photonic devices, Photoconductivity, Photo conducting materials, Optical devices, Importance of reverse current in optical detectors, photo voltaic effects (solar cells), Light Emitting Diode (as direct band gap material), LDR-operation & applications, Biomedical applications (Endoscopy)	**4L**
2.03: Liquid crystal and phases-Introduction, classification, production, applications. Nonlinear optical materials (elementary ideas) and their applications (LCD).	**2L**

2.04: Sensors & Display devices: Basic idea about sensors, Thermo electric sensors, Thermocouple, Thermopile, LDR, Optical Pyrometer, Bolometer, photodiode-area of applications. Operation and application of CRT, LCD, LED, Plasma display, thin film transistor display.	**4L**
Module 3: Electron optics, Optical Instruments & Storage devices: **3.01: Electron Optics:** Motion of charge particle in a electro-magnetic field. Electrostatic & magneto static focusing system, construction and working of CRT, CRO and its applications. **3.02: Optical Instruments:** Imaging-Types of imaging (PET, CT), electron microscope. **3.03: Storage devices:** Magnetic field and Magnetization; Magnetic susceptibility, Paramagnetism, Concept of magnetic moment, Bohr Magneton, Curie's Law; Ferromagnetism, phenomenon of hysteresis-hysteresis loss, Hard ferromagnets, applications of permanent magnets; Comparison and applications of Soft ferromagnets (Permalloys, Ferrites). Magnetic resonance, NMR and MRI (qualitative discussions related to applications).	**2L** **2L** **4L**
Module 4: Vacuum Technology, Cryogenics & Introduction to Nanomaterials **4.01 Vacuum technique:** Basic definition, units, low, high and ultra high vacuum, methods of production, conductance and pumping speed, vacuum pump-rotary, diffusion. Vacuum gauges-Pirani, Penning, thermocouple. **4.02 Cryogenics:** Methods of liquefaction of gases (cascade process, Linde's process, and adiabatic demagnetization process) – Measurement of cryogenic temperatures **4.03: Introduction to Nanomaterials:** Reduction of dimensionality, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Nanoclusters, nanocrystals; Some special nanomaterials e.g. grapheme sheet- properties and applications.	**3L** **2L** **2L**
TOTAL	**40L**

List of recommended Books:

Module 1: Acoustics & Modern Optics

1. Sound-N. K. Bajaj (TMH)
2. Advanced Acoustics-D. P. Roy Chowdhury (Chayan Publisher)
3. Principles of Acoustics-B.Ghosh (Sridhar Publisher)
4. A text book of sound-M. Ghosh (S. Chand publishers)
5. Optics-Ajay Ghatak (TMH)
6. Atomic & Molecular Physics Vol I-S. N. Ghoshal, S. Chand Publishers
7. Nonlinear optics-Ghatak, Tayagrajan, TMH
8. Nonlinear optics-B.B. Laud, TMH
9. Optics & Atomic Physics-Khandelwal, Himalya Publishers

Module 2: PHYSICS OF SEMICONDUCTORS & ENERGY BAND THEORY

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde Singh (S. Chand Publishers)
3. Perspective of Quantum Mechanics-S. P. Kuilla (New Central Book Agency)
3. Solid state physics- S. O. Pillai
4. Introduction to solid state physics-Kittel (TMH)
5. Solid State Physics- Ali Omar (Pearson Eduction)
6. Integrated Electronics-Millman Halkias (TMH)
7. Solid State Physics-A. J. Dekker (Prentice-Hall India)
8. Solid state physics-Gupta Kumar (K. Nath publishers)

Module 3: OPTICAL INSTRUMENTS & OPTICAL DEVICES

1. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
2. A text book of Light-Brijlal & Subhramanium, (S. Chand publishers)
3. Modern Optics-A. B. Gupta (Book & Allied Publisher)
4. Optics-Ajay Ghatak (TMH)
5. Optics-R. Kar, Books Applied Publishers
6. Integrated Electronics-Millman Halkias (TMH)
7. Electricity Magnetism-Fewkes and Yardwood (Oxford University Press)

Module 4: Magnetic properties of materials, Electron optics & Optical Instruments:

1 Introduction to solid state physics-Kittel (TMH)
2. Solid State Physics- Ali Omar (Pearson Eduction)
3. Solid state physics- S. O. Pillai

4. Solid State Physics-A. J. Dekker (Prentice-Hall India)

Module 5: Vacuum Technology, Cryogenics & Introduction to Nanomaterials
1. Physics-III-Avijit Lahiri (Grantha Bharati)
2. College Physics Vol-I- D. B. Sinha & J. Das Sarma (Modern Book House)
3. Introduction to application of Physics-P.N. Ghosh (editor), University of Calcutta

Engineering Physiology & Anatomy
Code: BME 301, Contacts: 3L+1T, Credit: 4

Course Objective:

- Students will be able to get an in-depth understanding of anatomy and physiology of the cardiovascular system (heart and blood vessel), the pulmonary system (lung), the renal system, the digestive system, the nervous system, the muscular system and the skeletal system.
- The discussion of these physiological systems will cover the levels of cell, tissue and organ.
- Students will be able to understand the corresponding structure function relationship of these physiological systems.
- Students will be able to relate the structure and function of the cardiovascular, circulatory, respiratory, excretory, nervous and digestive systems in humans.
- Make measurements on and interpret data of physiological processes in living systems.
- Explain mechanisms of communication, integration and homeostasis involved in physiological parameters and energy balance.
- Extend students' vocabulary of anatomical concepts and terms.
- Students will understand and postulate physiological concepts based on anatomical information
- Enable students to develop their critical reasoning skills in the field of Engineering Physiology & anatomy.

Course Outcome:

- Students will be able to get an in-depth understanding of anatomy and physiology of the cardiovascular system (heart and blood vessel), the pulmonary system (lung), the renal system, the digestive system, the nervous system, the muscular system and the skeletal system
- The discussion of these physiological systems will cover the levels of cell, tissue and organ
- Students will be able to understand the corresponding structure function relationship of these physiological systems
- Students will be able to relate the structure and function of the cardiovascular, circulatory, respiratory, excretory, nervous and digestive systems in humans
- Make measurements on and interpret data of physiological processes in living systems
- Explain mechanisms of communication, integration and homeostasis involved in physiological parameters and energy balance
- Extend students' vocabulary of anatomical concepts and terms
- Students will understand and postulate physiological concepts based on anatomical information
- Enable students to develop their critical reasoning skills in the field of Engineering Physiology & anatomy
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Module No	Topic	No of Periods
1	**Blood Vascular system** Composition and functions of blood. Plasma proteins – normal values, origin and functions. Brief idea on Bone marrow. Formed elements of blood – origin, formation, functions and fate. Hemoglobin – functions, compounds and derivatives. Abnormal hemoglobin-overview. Erythrocyte sedimentation rate (ESR) and its significance. Hematocrit. PCV, MCV, MCH, MCHC. Blood coagulation –factors, process, anticoagulants, Prothrombin time. Clotting time. Bleeding time. Blood groups – ABO systems and Rh factors. Blood transfusion. Ultra structure & functions of blood vessels (artery, vein, capillary). Differences between artery & vein.	**8L**
2	**Cardio Vascular System** Structure & function of Heart, Anatomical position, chambers of heart, Blood circulation through heart. Special junctional tissue of heart. Cardiac cycle. Heart Sound. Systemic & pulmonary circulation. Cardiac output. Blood Pressure-regulation & controlling factors.	**6L**

3	**Muscular & Skeletal System:** Microscopic and electron microscopic structure of skeletal, smooth and cardiac muscles. Difference between skeletal, smooth and cardiac muscles. The sarcotubular system. Red and white striated muscle fibers. Properties of muscle: excitability and contractility, all or none law, summation of stimuli, summation of contractions, effects of repeated stimuli, genesis of tetanus, onset of fatigue, refractory period. Muscle contraction – E C Coupling, Muscle fatigue, Rigor mortis, Sliding filament theory, Slow & fast muscle fibers, Isotonic & Isometric contraction. Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial Joint, Cartilage, Tendon, Ligament.	**8L**
4	**Renal System** Function of kidney, Anatomy & Histology of Nephron & collecting duet. Urine formation (Filtration, reabsorption and secretion) Counter – current system of urine concentration, Anomalies in urine concentration.	**4L**
5	**Digestive System** Organization of GI system, Digestion and Absorption, Movement of GI tract, Liver, Intestine, Pancreas, Role of Enzymes in Digestion.	**3L**
6	**Respiratory System** Respiratory Pathways, Mechanism of Respiration, Respiratory membrane and gaseous exchange, Lungs, Role of Lungs in Respiration and Thermoregulation.	**3L**
7	**Neuro Physiology** Electron microscopic structure of nerve cell or neurons. Neuroglia. Myelinated and nonmyelinated nerve fibers. The resting membrane potential. The action potential. Propagation of nerve impulse in different types of nerve fibers. Compound action potentials. Conduction velocity of nerve impulse in relation to myelination and diameter of nerve fibers. Synapses – types, structure, synaptic transmission of the impulse, synaptic potentials, neurotransmitters. Autonomic nervous system – Introduction. Structure of sympathetic and parasympathetic division. Neuromuscular Junction – structure, events in transmission, end-plate potential, post titanic potential. CNS- Brain and Spinal cord.	**8L**
	Total	**40**

Reference Books:

1. Essential of Medical Physiology - Anil Baran Singha Mahapatra, Current Books International
2. Human Physiology - C.C.Chatterjee, Medical Allied Agency
3. Text book of Medical Physiology- Guyton
4. Concise Medical Physiology - Chauduri
5. Anatomy and Physiology – Ross & Wilson, Churchill Livigstone publications.
6. Modern Physiology & Anatomy for Nurses - J Gibson, Black-well Scientific Publishers

Circuit Theory & Networks
Code: BME (EE) 302, Contacts: 3L, Credit: 3
Prerequisite:

1. Ability in identifying passive and active circuit elements/components and basic knowledge on their operation and application.
2. In depth knowledge in Integral & Differential Calculus and fundamental knowledge on Laplace Theorem & its inverse.

Course Objective

1. To familiarize students with Resonance in Circuits and relevant parameters and methods for evaluating the same.
2. To introduce students the methods of Mesh Current and Node Voltage analysis and their application.
3. To describe Network Theorems and their applications.
4. To illustrate graph theory and its application in estimating electrical parameters in the circuit.
5. To introduce students with coupled circuits and their methods of analysis..
6. To introduce students with transient circuits and describe the methodology to evaluate relevant electrical parameters.
7. To highlight the application of Laplace & Inverse Laplace transform in analyzing circuits.

Course Outcome

After completion of this course the students will be able to

1. Understand, Describe, Analyze and Design series and parallel RLC circuits and solve related problems
2. Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks and solve related problems.
3. Apply and Analyze Network Theorems to electrical networks to evaluate network parameters in simplified ways.
4. Understand, Describe, Analyze and Design Graph and Trees for a given network and build network matrices and solve related problems
5. Understand Describe, Analyze and Design Coupled (Magnetic and Electromagnetic) Circuits and solve related problems
6. Understand, Describe and Analyze the Transients in electrical networks and solve related problems
7. Apply Laplace Transform and form Transfer Function for different kinds of electrical networks for analyzing them and solve related problems

Module	Topic	No of Periods
1	**Resonant Circuits**: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems	4L
2	**Mesh Current Network Analysis**: Kirchoff's Voltage Law, Formulation of Mesh Equations, Solution of mesh equations by Cramer's rule and matrix method, Driving point impedance, Transfer impedance, Solutions of Problems with DC and AC sources	6L
3	**Node Voltage Network Analysis**: Kirchoff's Current Law, Formulation of node equations and solutions, Driving point admittance, Transfer admittance, Solutions of Problems with DC and AC sources	4L
4	**Network Theorems**: Definition and implications of Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta transformations, Solutions and Problems with DC and AC sources	6L
5	**Graph of Network**: Concept of Tree Branch, Tree link, junctions, Incident matrix, Tie-set matrix, Cut-set matrix, determination of loop current and node voltages.	5L
6	**Coupled Circuits**: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems	2L
7	**Circuit Transients**: DC Transient in R-L & R-C circuits with and without initial charge, R-L-C circuits, AC transients in sinusoidal RL, R-C, & R-L-C circuits, solution of problems	5L
8	**Laplace Transform**: Concept of complex frequency, transformation of f(t) into F(s), transformation of step, exponential, over-damped surge, critically damped surge, damped sine, und-amped sine functions, properties of Laplace Transform, linearity, real-differentiation, real integration, Initial Value Theorem and Final Value Theorem, Inverse Laplace Transform, applications in circuit analysis, Partial Fractions expansion, Heaviside's Expansion Theorem, solution of problems	8L
	Total	**40**

Recommended Books:

1. Valkenburg M. E. Van, Network Analysis, Prentice Hall./Pearson Education
2. Hayt"Engg Circuit Analysis 6/e Tata McGraw-Hill
3. D.A.Bell- Electrical Circuits- Oxford
4. A.B.Carlson-Circuits- Cenage Learning
5. John Bird- Electrical Circuit Theory and Technology- 3/e- Elsevier (Indian Reprint)
6. Skilling H.H.: "Electrical Engineering Circuits", John Wiley & Sons.
7. Edminister J.A.: "Theory & Problems of Electric Circuits", McGraw-Hill Co.
8. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.
9. R.A.DeCarlo & P.M.Lin- Linear Circuit Analysis- Oxford
10. P.Ramesh Babu- Electrical Circuit Analysis- Scitech
11. Sudhakar: "Circuits & Networks:Analysis & Synthesis" 2/e TMH
12. M.S.Sukhija & T.K.NagSarkar- Circuits and Networks-Oxford
13. Sivandam- "Electric Circuits and Analysis", Vikas
14. V.K. Chandna, "A Text Book of Network Theory & Circuit Analysis",Cyber Tech
15. Reza F. M. and Seely S., "Modern Network Analysis", Mc.Graw Hill .

16. M. H. Rashid:Introduction to PSpice using OrCAD for circuits and electronics, Pearson
17. Roy Choudhury D., "Networks and Systems", New Age International Publishers.
18. D.Chattopadhyay and P.C.Rakshit: "Electrical Circuits" New Age

Analog Electronic Circuits
Code: BME (EC) 303, Contacts: 3L, Credit: 3

Course Objective

- To familiarize about the working principle and, method of connection application of Electronic devices
- To know about the working of circuits using advanced semiconductor devices and about the practical applications of Electronic devices.

Course Outcome

Student can analyze practical circuits and come out with the necessary solutions and corrections to be incorporated. One could design the circuits with these electronic components used in day to day life.They will also know regarding the development of the Analog Electronics

Module no.	TOPIC	No. of Lecture
1	**Filters and Regulators**: Capacitor filter, π-section filter, ripple factor, series and shunt voltage regulator, percentage regulation, 78xx and 79xx series, concept of SMPS.	4
	Transistor Biasing and Stability: Q-point, Self Bias-CE, Compensation techniques, h-model of transistors. Expression for voltage gain, current gain, input and output impedance,	3
2	**Transistor Amplifiers**: RC coupled amplifier, functions of all components, equivalent circuit, derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, lower and upper half frequencies, bandwidth, and concept of wide band amplifier.	3
	Power amplifiers – Class A, B, AB, C, Conversion efficiency, Tuned amplifier	3
3	**Multivibrator:** Monostable, Bistable,Astable multivibrators; Monostable and astable operation using 555 timer.	3
	Feedback Amplifiers & Oscillators: Feedback concept, negative & positive feedback, voltage/ current, series/shunt feedback, Berkhausen criterion, Colpitts, Hartley's, Phase shift, Wein bridge and crystal oscillators.	5
4	**Operational Amplifier**: Ideal OPAMP, Differential Amplifier, CMRR, Open & Closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers, voltage follower/buffer circuit.	4
	Applications of Operational Amplifiers: adder, integrator & differentiator, comparator, Schmitt Trigger. Instrumentation Amplifier, Log & Anti-log amplifiers, Precision Rectifier, voltage to current and current to voltage converter, free running oscillator.	5
	TOTAL	30

Reference Books:

1. Sedra & Smith-Microelectronic Circuits- Oxford UP
2. Franco—Design with Operational Amplifiers & Analog Integrated Circuits,3/e,McGraw Hill
3. Boylested & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
1. Millman & Halkias – Integrated El;ectronics, McGraw Hill.
2. Rashid-Microelectronic Circuits-Analysis and Design- Thomson (Cenage Learning)
3. Schilling & Belove—Electronic Circuit:Discrete & Integrated , 3/e , McGraw Hill
4. Razavi- Fundamentals of Microelectronic s- Wiley
5. Malvino—Electronic Principles, 6/e, McGraw Hill
6. Horowitz & Hill- The Art of Electronics; Cambridge University Press.
7. Bell- Operational Amplifiers and Linear ICs- Oxford UP
8. Tobey & Grame – Operational Amplifier: Design and Applications, Mc GrawHill.
9. Gayakwad R.A -- OpAmps and Linear IC's, PHI
10. Coughlin and Driscol–Operational Amplifier and Linear Integrated Circuits–Pearson Edn

PRACTICAL/SESSIONAL PAPERS

Physics-II Laboratory
Code: PH (BME) 391, Contacts: 3P, Credit: 2

Course Objective:
This course is objected to train students with experimental techniques in the domain of Acoustics, Modern Optics & Radioactivity, Semiconductors & Optoelectronic Devices, Electron optics, Optical Instruments & Storage devices

Course Outcome:
After completion of this course the students will be able to

1. Understand, perform and show their experimental skills in the domain of Acoustics
2. Understand, perform and show their experimental skills in the domain of Modern Optics & Radioactivity
3. Understand, perform and show their experimental skills in the domain of Semiconductors & Optoelectronic Devices
4. Understand, perform and show their experimental skills in the domain of Electron optics, Optical Instruments & Storage devices

Any 7 to be performed from the following experiments

Experiments on Acoustics, Modern Optics & Radioactivity
1. Determination of velocity of ultrasonic wave using piezoelectric crystal.
2. To study variation of acoustics pressure

Experiments on PHYSICS OF SEMICONDUCTORS & OPTOELECTRONIC DEVICES
3. Determination of band gap of a semiconductors/thermistor/four probe method.
4. Determination of Hall co-efficient of a semiconductor.
5. Measurement of Magnetoresistance of a semiconductor.
6. Study of a temperature sensor characteristics.
7. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.
8. Study of characteristics LED.
9. Study of LDR characteristics.

Experiments on Electron optics, Optical Instruments & Storage devices:
10. Study of hysteresis curve of a ferromagnetic material using CRO.
11. Use of paramagnetic resonance and determination of lande-g factor using esr setup.
12. Determination of specific charge (e/m) of electron by J.J. Thomson's method.

Engineering Physiology & Anatomy Laboratory
Code: BME 391, Contacts: 3P, Credit: 2

Objectives:

1. The objective of Engineering Physiology & Anatomy Laboratory class is to understand the practical aspects of the body's internal organs and how they function.
2. Provide an active learning environment to teach the basic principles of human physiology & anatomy.
3. Teach students the principles of experimental documentation in a laboratory notebook.
4. Provide students with a hands on opportunity to use commonly used physiological variables measuring equipments.
5. Promote and encourage team work and collaboration among students in the lab.
6. Students are encouraged to create additional test conditions and run additional experiments during the lab time that extend from the guided lesson plan.

Outcome:

1. Develop a visual knowledge of body structure at the cellular, tissue, organ, & system levels.
2. Understand the gross & microscopic approach to Anatomy & Physiology.
3. Provide the students with all necessary lab tools such as anatomical models, histology slides as well as experimental & physiological problems that promote the critical understanding of the human body.
4. Familiarize the students with a variety of lab assignments, help visualize most of the anatomical models of all the body systems that have been covered in the Anatomy & Physiology course.

Experiments:

1. Study on Compound Microscope.
2. Identification of fixed histological slides: Cerebellum, Cerebral cortex, Spinal cord, Renal tissues, Blood vessels (artery & vein), Skin, Tongue, Liver.
3. Hemoglobin estimation.
4. Determination of blood pressure.
5. Blood film making & identification of different blood corpuscle.
6. ECG wave identification.
7. DC of WBC.
8. Determination of Blood Group (ABO; Rh).
9. Measurement of Bleeding Time (BT) & Clotting Time (CT).

Circuits & Networks Laboratory
Code: BME (EE) 392, Contacts: 3P, Credit: 2

Course Objective

1. To familiarize students MATLAB Software and its application in circuit analysis.
2. To introduce students in evaluating electrical parameters in resonant circuits using MATLAB.
3. To implement MATLAB in verification of Network theorems.
4. To familiarize students in measuring electrical parameters in transient circuits using MATLAB.
5. To introduce students with the generation of various waveforms using MATLAB.
6. To apply MATAB in evaluating impedance and admittance parameters in a circuit.
7. To familiarize students with poles & zeros concepts and the techniques in evaluating the same.
8. To enumerate application of Laplace transform and its inverse in analysis of circuits.

Course Outcome

After completion of this course the students will be able to

1. Describe Analyze and Design series and parallel RLC circuits using MATLAB.
2. Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks using MATLAB.
3. Verify and analyze Network Theorems to electrical networks using MATLAB.
4. Understand Describe, Analyze and Design Graph and Trees for a given network and solve related problems using MATLAB.
5. Understand Analyze and Design Coupled Circuits and solve related problem using MATLAB.
6. Understand, Describe and Analyze the Transients in electrical networks and solve related problems using MATLAB
7. Implement Laplace Transform and its Inverse transform on various waveforms using MATLAB

Implementation of Following Experiments using Software (e.g. MATLAB/Pspice) or Hardware

1. Characteristics of Series & Parallel Resonant circuits
2. Verification of Network Theorems
3. Transient Response in R-L & R-C Networks ; simulation / hardware
4. Transient Response in RLC Series & Parallel Circuits & Networks; simulation / hardware
5. Determination of Impedance (Z), and Admittance (Y) parameters of Two-port networks
6. Generation of periodic, exponential, sinusoidal, damped sinusoidal, step, impulse, and ramp signals.
7. Representation of Poles and Zeros in s-plane, determination of partial fraction expansion in s-domain.
8. Determination of Laplace Transform, different time domain functions, and Inverse Laplace Transformation.

Analog Electronic Circuits Laboratory
Code: BME (EC) 393, Contacts: 3P, Credit: 2

Course Objective:
1. To understand application of p-n junction Diode, Zener diode , Rectifier etc
2. To analyze the performance of multistage amplifier and power amplifier
3. To study and analyze the performance of multivibrators
4. To understand application of OP AMP

Course Outcome:
After learning this subject, students will be able to
1. Design voltage regulator using Zener Diode
2. Design a DC voltage supply circuit
3. Design and analyze amplifier circuit using transistor
4. Design different Wave Form generator circuit
5. Design and analyze different circuits using OP AMP
6. Design different filter circuits and study their performance

List of Experiments:
1. Study of Diode as clipper & clamper
2. Study of Zener diode as a voltage regulator
3. Study of ripple and regulation characteristics of full wave rectifier without and with capacitor filter
4. Study of characteristics curves of B.J.T
5. Construction of a two-stage R-C coupled amplifier & study of it's gain .
6. Study of class A & class B power amplifiers.
7. Study of timer circuit using NE555 & configuration for monostable & astable multivibrator.
10. Construction & study of RC phase shift oscillator.
11. Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip.
12. Construction of a simple function generator using IC.

Personality Development Laboratory
Code: HU 381, Contacts: 3P, Credit: 2

Guidelines for Course Execution:

Course Objectives:
This course has been designed
1. To inculcate a sense of confidence in the students.
2. To help them become good communicators both socially and professionally.
3. To assist them to enhance their power of Technical Communication.

Course Outcome:
After learning this subject, students will be able to
1. Comprehend conversations and speeches.
2. Speak with clarity and confidence, thereby enhancing their employability skills.
3. Identify his/her creative self, and express effectively the same in writing.
4. Explain the advantages of teamwork and how the tasks could be completed effectively when done as a cohesive unit.
5. Realize that selecting goal is a fundamental component to long-term success of an individual.
6. Enable students to understand different aspects of leadership and evaluate in their own strengths.
7. Be more organized and disciplined.

Detailed Course Outlines:
A. ***Technical Report Writing:*** 2L+6P
1. Report Types (Organizational / Commercial / Business / Project)
2. Report Format & Organization of Writing Materials
3. Report Writing (Practice Sessions & Workshops)
B. ***Language Laboratory Practice***

I. Introductory Lecture to help the students get a clear idea of Technical Communication & the need of Language Laboratory Practice Sessions: 2L
2. Conversation Practice Sessions: (To be done as real life interactions) 2L+4P
a) Training the students by using Language Lab Device/Recommended Texts/cassettes /cd's to get their
Listening Skill & Speaking Skill honed
b) Introducing Role Play & honing over all Communicative Competence
3. Group Discussion Sessions: 2L+6P
a) Teaching Strategies of Group Discussion
b) Introducing Different Models & Topics of Group Discussion
c) Exploring Live /Recorded GD Sessions for mending students' attitude/approach & for taking remedial measure Interview Sessions; 2L+6P
a) Training students to face Job Interviews confidently and successfully
b) Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking
Skill in a formal situation for effective communication
4. Presentation: 2L+6P
a) Teaching Presentation as a skill
b) Strategies and Standard Practices of Individual /Group Presentation
c) Media & Means of Presentation: OHP/POWER POINT/ Other Audio-Visual Aids
5. Competitive Examination: 2L+2P
a) Making the students aware of Provincial /National/International Competitive Examinations
b) Strategies/Tactics for success in Competitive Examinations
c) SWOT Analysis and its Application in fixing Target

Books – Recommended:

1. Nira Konar: English Language Laboratory: A Comprehensive Manual PHI Learning, 2011
2. D. Sudharani: Advanced Manual for Communication Laboratories & Technical Report Writing,Pearson Education (W.B. edition), 2011

References:

Adrian Duff et. al. (ed.): Cambridge Skills for Fluency
A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)
B) Listening (Levels 1-4 Audio Cassettes/Handbooks)
Cambridge University Press 1998
Mark Hancock: English Pronunciation in Use
4 Audio Cassettes/CD'S OUP 2004

2nd Year-4th Semester

THEORY PAPERS

Biomechanics
Code: BME 401, Contacts: 3L, Credit: 3

Course Objective:

1. To describe the fundamental of biomechanics.
2. To Study the deformability, strength, visco elasticity of bone and flexible tissues, modes of loading and failure.
3. To describe the types and mechanics of skeletal joints.
4. To describe movement precisely, using well defined terms (*kinematics*) and also to consider the role of force in movement (*kinetics*).
5. To teach students the unique features of biological flows, especially constitutive laws and boundaries.
6. To teach students approximation methods in fluid mechanics and their constraints.
7. To consider the mechanics of orthopedic implants and joint replacement , mechanical properties of blood vessels and Alveoli mechanics

Course Outcomes:
After completion of the course student will be able to

1. Understand and describe the properties of blood , bone and soft tissues like articular cartilage tendons and ligaments.
2. Gain broad knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement of the human body.
3. Be able to computionally analyze the dynamics of human movement from the most commonly used measurement devices in the field, such as motion capture and force platform systems.
4. Use knowledge gained to competently interpret the current understanding of human movement and present recommendations for further study.

TOPIC	No of Lectures
UNIT I: Introduction to Biomechanics Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.	**4L**
UNIT II: Tissue Biomechanics **Hard Tissues:** Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Electrical properties of bone, type of fractures, biomechanics of fracture healing. **Soft Tissues:** Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling: Cartilage, Tendon, Ligament, and Muscle.	**7L**
UNIT-III: Joints Biomechanics: Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, hip, knee and ankle.	**6L**
UNIT IV: Cardiac & Respiratory Mechanics Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. artificial heart valves, biological and mechanical valves development, testing of valves. Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, Airway resistance, Physics of lung diseases.	**5L**
UNIT V: Movement Biomechanics Gait analysis, body & limbs: mass & motion characteristics actions, forces transmitted by joints. Joints forces results in the normal & disable human body, normal & fast gait on the level. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw - like motions.	**4L**
UNIT VI: Biofluid Mechanics Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, Non- Newtonian fluid, viscoelastic fluids, Vascular tree. Relationship between diameters, Velocity and pressure of blood flow, Resistance against flow.	**4L**
UNIT VII: Implant Mechanics: General concepts of Implants, classification of implants, Soft tissues	

replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.	**6L**
Total	**40L**

Text Books

1. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
2. Richard Shalak&ShuChien, Handbook of Bioengineering,
3. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones & Bartlett Publishers, 2013
4. Y. C. Fung, Yuan-Cheng Fung,Biomechanics: mechanical Proparty of living Tissue, Springer, 1996.
5. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010
6. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones & Bartlett Publishers, 2013.

Reference Books

1. Prof. Ghista,Biomechanics, Private Publication UAF, 2009
2. White &Puyator, Biomechanics, Private publication UAE, 2010

Biophysical Signals & Systems
Code: BME 402, Contacts: 3L, Credit: 3

Course Objective:

Biomedical engineers must have knowledge about various biosignals and systems. This course with develop the fundamental basis of signals and systems for biomedical engineering along with characterization and understanding of bio-signals and physiological systems. Various signal processing tools are dealt in this course with an emphasis on their application in bio-systems. Control systems along with their analogy with biological systems are also included.

Course Outcome:

The subject provides the student the exposure to the fundamentals in digital bio-signal processing. At the end of the course the students will have clear knowledge of tools and techniques of digital signal processing along with firm understanding of physiological signals and systems.

Module	Content	No of Lectures
1	**Signals and systems:** Continuous time (CT) signals, Discrete time (DT) signals, periodic, aperiodic, random, energy and power signals, step, ramp, impulse and exponential function, Transformation in independent variable of signals: time scaling, time shifting and time inverting, Introduction to systems, system properties, interconnection of system, LTI systems- linear and circular convolution, correlation, auto-correlation, direct form-I and direct form-II representations, parallel and cascade representations, s, physiological signals and their properties.	8
2	**Signal analysis**: Basic concepts of the Fourier Series, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), Discrete Fourier transform (DFT) and its inverse (IDFT), Introduction to Fast Fourier transform (FFT), ECG signal analysis.	7
3	**Sampling Theorem, Laplace Transforms and Z-Transforms**: Representation of continuous time signals by its sample, Sampling theorem, Reconstruction of a Signal from its samples, aliasing, Laplace transform: basics, properties, inverse; z-transform: definition, properties, Poles and Zeros, inverse z-transform; Region of convergence (ROC), Representation of systems by differential equations and transfer functions.	7
4	**Noise and Feed Back System:**: Sources and types of noise, Basic Feedback concept, Positive and Negative Feedback, Control system, Open loop Control System, Control system With Feed Back, Application of feed back in physiological systems and its importance.	4
5	**Filtering Techniques:** Types of filter (Active and Passive), General idea of L.P.F, H.P.F, B.P.F and N.F. Passive and Active Filters (L.P, H.P, B.P & N.F), use of filter for biomedical signal analysis, design of filter suitable for Bio-medical signal analysis.	4
6	**Physiological System**: Block diagram representation of cardio vascular system, Electrical analog of blood vessels and its transfer function. Characteristics of ECG, EEG and EMG signals, signal conditioning of these bio-potential signals	4
	Total	**34**

Reference Books:

1. Oppenheim, Wilskey and Nawab-Signal & System, Prentice Hall India.
2. Hayken & Van Veen- Signal & System,Willey
3. Taub & Schilling-Principles of Communication System, Tata McGraw Hill.
4. Kennedy & Devis-Electronic Communication System, Tata McGraw Hill
5. R.M. Rangayyan, Biomedical Signal Analysis, Wiley
6. A.K.Sawhney-Electrical & Electronic Measurement & Instrumentation, Dhanpat Rai & Co. (P) Ltd
7. J.G.Prokis & D.G.Manolakis, "Digital Signal Processing: Principles, Algorithm and Applications", PHI/Pearson Education.
8. I.J. Nagrath, Control Systems Engineering, New Age International.
9. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.

Digital Electronics & Integrated Circuits
Code: BME (EC) 403, Contacts: 3L+1T, Credit: 4

Prerequisite:
Knowledge of analog electronics

Course Objective:

1. To introduce students with different number systems & their inter-conversion techniques.
2. To introduce students with codes & code conversion techniques.
3. To familiarize students with different logic families & technologies of circuit integration
4. To introduce basic postulates of Boolean algebra and its application in digital electronics.
5. To introduce the methods for simplifying Boolean expressions
6. To describe the procedures for the analysis and design of combinational circuits and sequential circuits
7. To introduce the concept of memories, programmable logic devices and digital ICs.

Course Objective:
After completion of this course the students will be able to

8. Understand and describe different number systems and their conversions, signed binary number representation and binary arithmetic and solve relevant numerical.
9. Understand and explain Boolean algebra and logic gates and solve relevant numerical.
10. Describe, analyze, formulate and construct combinational networks.
11. Understand and explain memory systems.
12. Describe, analyze, formulate and construct sequential networks.
13. Understand, describe, analyze and construct basic analog-to-digital and digital-to-analog circuits.
14. Understand and explain different kinds of logic families.

Module	Topic	No of Periods
1	Data and number systems; Binary, Octal and Hexadecimal representation and their conversions; BCD,ASCII, EBDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic.	5
2	Boolean algebra; Various Logic gates- their truth tables and circuits; Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, K-map method	6
3	Combinational circuits- Adder and Subtractor circuits; Applications and circuits of Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator.	5
4	Memory Systems: RAM, ROM, EPROM, EEROM, Programming logic devices and gate arrays.(PLAs and PLDs)	6
5	Sequential Circuits- Basic memory element-S-R, J-K, D and T Flip Flops, various types of Registers and counters and their design, Irregular counter, State table and state transition diagram, sequential circuits design methodology.	8
6	Different types of A/D and D/A conversion techniques.	4
7	Logic families- Basics TTL, MOS and CMOS, their operation and specifications	6
	Total	**40**

Text Books:

1. S.Salivahanan, S.Aribazhagan, Digital Circuit & Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
2. Anand Kumar, Fundamentals of Digital Circuits- PHI
3. A.K.Maini- Digital Electronics- Wiley-India
4. Kharate- Digital Electronics- Oxford

References:

1. Morries Mano- Digital Logic Design- PHI
2. Leach & Malvino—Digital Principles & Application, 5/e, Mc Graw Hill
3. Floyed & Jain- Digital Fundamentals-Pearson.
4. Tocci, Widmer, Moss- Digital Systems,9/e- Pearson
5. R.P.Jain—Modern Digital Electronics, 2/e , Mc Graw Hill
6. H.Taub & D.Shilling, Digital Integrated Electronics- Mc Graw Hill.
7. D.Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers
8. Givone—Digital Principles & Design, Mc Graw Hill
9. S.K.Mandal, Digital Electronics Principles and Applications- Mc Graw Hill.
10. J.Bignell & R.Donovan-Digital Electronics-5/e- Cenage Learning.
11. P.Raja- Digital Electronics- Scitech Publications

Object Oriented Programming using C++
Code: BME(CS)404, Contacts: 3L, Credit: 3

Course Objective:

1. Be able to explain the difference between object oriented programming and procedural programming.
2. Be able to program using more advanced C++ features such as→ composition of objects, operator overloads, dynamic memory allocation, inheritance and polymorphism, file I/O, exception handling, etc.
3. Be able to build C++ classes using appropriate encapsulation and design→ principles.

Course Outcome:

After the completion of the course the students will be able to

1. Develop, design and implement simple computer programs.
2. Understand functions and parameter passing.
3. Perform numeric (algebraic) and string-based computation.
4. Understand object-oriented design and programming.
5. Understand dynamic memory allocation and pointers.
6. Design, implement, and test relatively large C++ programs.

Topic	No of Lectures
Introduction Programming paradigms, Language translator, Basics of OOP, Structure of C++ program, Class and object, Abstraction and encapsulation, Polymorphism, Inheritance, Static and dynamic binding.	**3L**
Declaration, Expression and statements Data types, Variables, Constants, Operator and expression, Operator precedence and associativity. Statements: Labelled, Expression, Compound, Control, Jump, Declaration, Try-throw-catch. Control, Jump, Declaration, Try-throw-catch.	**4L**
Array, pointer and function Array, Addresses, Pointer. Function: Declaration, Definition and call, Inline function, Main function argument, Reference variable, Function overloading, Default argument, Parameter passing, Recursion, Scope of variable, Return-by-value and Return-by-reference, Pointer to function	**4L**
Data abstraction through classes and user defined data types Class, Members, Constructor and destructor, Copy constructor. Dynamic memory management: Operators new and delete, Malloc and free, Static member, Scope of class names, Scope of variables.	**6L**
Operator Overloading Overloading unary and binary operator, Overloaded function calls, Subscripting, class member access, Non-member operator, New and delete, Cast operator.	**5L**

Class relationships Introduction, Polymorphism, Coercion, Overloading, Parametric and inclusion polymorphism, Inheritance: direct and indirect super classes, Multiple inheritance, Virtual base class, Friend, Virtual function, Abstract class, Overriding and hiding, Dynamic binding of functions, Virtual destructor and operators.	**6L**
Template and Exception Handling Class template, Member function inclusion, Function template, Specialization, Inheritance, Namespace. Concept of exception handling, Catch block, Nested try-catch block, Condition expression in throw expression, Constructor & destructor, Runtime standard exception	**5L**
Standard Library in C++ Standard library function, Input and output, Iostream class hierarchy, Class ios, Other stream classes.	**3L**
Object oriented design and modelling [4L] Software development, Qualities of software system, Software architecture, Process life cycle, phases, Modularity, OOmethodology, Modeling, UML overview, Object oriented design patterns.	**4L**
TOTAL	**40L**

Textbooks/References: Textbooks/References:

1. Objected Oriented Programming with C++- E. Balaguruswamy
2. Schildt, H., The Complete Reference C++, McGraw – Hill.
3. C++ object oriented programming paradigm, Debasish Jana, PHI
4. Pooley, R and P. Stevens, Using UML , Addison-Wesley.
5. Programming In C++, Y.I. Shah and M.H. Thaker, ISTE/EXCEL BOOKS
6. Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
7. Rajaram: Object Oriented Programming and C++, New Age International

Biomaterials
Code: BME 405, Contacts: 3L+1T, Credit: 4

Course Objectives:

- The student would be able to learn characteristics and classification of Biomaterials.
- Understand the characteristics of different metals and ceramics used as biomaterials.
- Understand polymeric materials, composites and combinations that could be used as a tissue replacement implants.
- Students should be able to understand how to develop artificial organ using these materials.
- Instill a fundamental understanding of the properties and applications of biomaterials, both natural and synthetic that are used in contact with biological systems in the area of various tissues and organ replacement.
- To acquaint students with the interactions between biomaterials and the human body that lead to failure of devices.
- This course presents a balanced perspective on the evolving discipline of Biomaterials Science by including information on hard biomaterials and soft biomaterials, orthopedic ideas, cardiovascular concepts, ophthalmologic ideas, and dental issues.
- Demonstrate in-depth knowledge of the mechanical and biological properties of both natural and synthetic biomaterials used in implant design and artificial tissue or organ making.
- Describe the role of adsorbed proteins and cells in the tissue response to biomaterials.
- Demonstrate an understanding of the host response to implant biomaterials and be able to compare the responses to different materials.
- Describe the methods of testing for biomaterials biocompatibility.
- Distinguish the events that lead to the degradation of materials in the biological environment.
- Demonstrate an in-depth knowledge of the application of biomaterials, both natural and synthetic, in implant design and artificial tissue or organ making.
- Demonstrate an understanding of implant failure from a biological perspective.
- Appreciate the complex mechanical and biological interactions between biomaterials and biological systems.
- Gain a solid appreciation for the special significance of the word biomaterial as well as the rapid and exciting evolution and expansion of biomaterials science and its applications in health care.

Course Outcome:

- Identify and understand the main terms largely used in biomaterials literature, basic properties of various biomaterials, correctly associate terms with processes/phenomena, and be able to correlate related events.
- Able to design basic tissue or organ replacement implants using clear understanding of Biomaterials as tools of Biomedical Implant Engineering.
- They will be able to apply knowledge in the design of various biocompatible implants and artificial organ to develop and improve Health Care Service and will be able to serve mankind and society.
- Include a balance of fundamental biological concepts, materials science background, medical/clinical concerns, as well as coverage of biomaterials past, present, and future.
- Develop an ability to identify, formulate, and solve engineering problems, particularly in the context of biomaterials selection and design.
- An ability to understand environmental considerations and sustainable engineering solutions in the field of Biomaterials.
- Develop an ability to understand professional ethics and legal issues related to Biomaterials, Implant design and artificial tissue grafting.
- Develop an ability to function effectively as an individual and a member in diverse team.

Topic	**No of Lectures**
Introduction: Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.	**6L**
Metallic implant materials: Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with biometal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.	**6L**
Polymeric implant materials: Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: creep-recovery, stressrelaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.	**6L**
Ceramic implant materials: Definition of bioceramics. Common types of bioceramics: Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).	**4L**
Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g.hydroxyapatite). Host tissue reactions.	**4L**
Biocompatibility & toxicological screening of biomaterials: Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests.	**5L**
Sterilisation techniques: ETO, gamma radiation, autoclaving. Effects of sterilization on material properties.	**3L**
Testing of biomaterials/Implants: In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In-vivo testing (animals): biological performance of implants. Ex-vivo testing: in vitro testing simulating the in vivo conditions. Standards of implant materials.	**6L**

Test books

1. J B Park, *Biomaterials - Science and Engineering*, Plenum Press , 1984.
2. Sujata V. Bhat, *Biomaterials*, Narosa Publishing House, 2002.
3. Bronzino JD, ed. The Biomedical Engineering Handbook, Second Edition, Vol-II, CRC Press

References

1. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
2. C.P.Sharma & M.Szycher, *Blood compatible materials and devices*, Tech.Pub.Co. Ltd., 1991.
3. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers.
4. Eugene D. Goldbera , *Biomedical Ploymers*, Akio Nakajima.
5. L. Hench & E. C. Ethridge, *Biomaterials - An Interfacial approach*.
6. Buddy D.Ratner, Allan S. Hoffman, Biomaterial Sciences – Int. to Materials in Medicine

7. Frederick H. Silver, Biomaterials, Medical devices and Tissue Engineering, Chapman & Hall

Engineering Economics & Management
Code: HU 401, Contacts: 3L, Credit: 3

Course Objective:
The course is intended to provide basic understanding of Economics and Management to engineering students with following aspects:

1. To impart knowledge, with respect to concepts, principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.
2. To help the students to understand the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

Course Objective:
After completion of the course the students will be able to

1. Furnish their concepts & knowledge on the principles and practical applications of Economics, which govern the functioning of a firm/organization under different market conditions.
2. Understand & describe the fundamental concepts and principles of management; the basic roles, skills, functions of management, various organizational structures and basic knowledge of marketing.

Topic	No of Lectures
Module1: Economic Decisions Making – Overview, Steps, Problems.	3L
Module2: Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs,; Types Of Estimate, Estimating Models - Per-Unit Model, Benefits ,C-V-P.	5L
Module3: Investment Decision: Concept of time value of money, Cost of Capital, Cash Flow, present value of annuity, Future value of annuity, Investment decision with considering time value of money and without considering time value of money- Multiple Alternatives. Replacement Analysis - Replacement Analysis with time value of money.	7L
Module4: Decision making process under uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return.	5L
Module5: Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis	5L
Module6: Accounting –Definition, Concepts, Double entry System, Journal , Ledger, Trial Balance, Trading A/C,Profit & Loss A/C and Balance Sheet.	5L
Module7: Interpretation of financial statements with Financial Ratios like Revenue Ratios, Balance sheet Ratios and Combined ratios.	5L
Module8: Inventory Management: Levels of stock, Wilson model of EOQ,EOQ with quantity discount.	5L
TOTAL	40L

Reference Books:
1. Engineering Economics, R.Paneerselvam, PHI publication
2. Fundamentals of Management: Essential Concepts and Applications, Pearson Education, Robbins S.P. and Decenzo David A.
3. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning
4. Principles and Practices of Management by L.M.Prasad

5. Principles of Management by Tripathy and Reddy
6. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications

PRACTICAL/SESSIONAL PAPERS

Biomaterials & Biomechanics Laboratory
Code: BME 491, Contacts: 3P, Credit: 2

Course Objective:
This course will provide basic hands on laboratory experiments in Biomaterials & Biomechanics

Course Outcomes:
After completion of the course student will be able to

1. Perform Mechanical characterization & Hardness testing of biomaterials
2. Measure Surface roughness & haemocompatibility of biomaterials
3. Stress Strain analysis of hip prosthesis
4. Determine moment of inertia of human limb & human bone
5. Perform Ultrasonic characterization of biomaterials-NDE
6. Perform Conductivity measurement of body fluid

List of Experiments:
1. Mechanical characterization of biomaterials
2. Hardness testing of biomaterials
3. Surface roughness measurement of biomaterials
4. Estimation of haemocompatibility of biomaterials by hemolysis studies
5. Measurement of torque required to tap and screwing in jaw bone.
6. Determination of moment of inertia of human limb using dynamometer.
7. Determination of moment of inertia of human bone using compound pendulum method.
8. Stress-strain analysis of hip prosthesis
9. Ultrasonic characterization of biomaterials-NDE
10. Conductivity measurement of body fluid.

Biophysical Signals & Systems Laboratory
Code: BME 492, Contacts: 3P, Credit: 2

Course Objective:
This course is objected to impart the fundamental knowledge and application of versatile types of signals in experimental point

Course Outcomes:
After completion of the course student will be able to

1. Gain knowledge on the application of MATLAB software in analyzing biophysical signals
2. Generate versatile Signal waveform using MATLAB
3. Generate various types of noise waveforms using MATLAB
4. Apply MATLAB in evaluating Fourier Transform, Z-transform and Laplace Transform of mathematical functions
5. Apply MATLAB in studying filters and ECG signal analysis

The following simulation exercise should be carried out in MATLAB or C programming.
1. Familiarization with MATLAB and generation of various types of waveforms (sine, cosine, square, triangular etc.).
2. Generation of different functions (unit impulse, unit step, RAMP, etc.)
3. Generation of various types of noise (uniform white, Gaussian, coloured etc.).
4. Fourier transform of the signals
5. To study Z- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
6. To study Laplace- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
7. To study LPF &HPF, band-pass and reject filters using RC circuits
8. ECG signal analysis / Equivalent electrical circuit analysis of blood vessels

Digital Electronics & Integrated Circuits Laboratory
Code: BME (EC) 493, Contacts: 3P, Credit: 2

Course Objective:

1. To familiarize students with different Digital ICs corresponding to different logic gates
2. To show the working operation of basic logic gates & Universal logic gates.
3. To familiarize students with the design of combinational circuits.
4. To introduce students with basic components of sequential circuits.
5. To familiarize students with the design of sequential circuits.

Course Outcome:

1. Understand and describe Digital ICs of different logic gates.
2. Describe, design and analyze combinational circuits.
3. Describe, design and analyze sequential circuits.

List of Experiments
1. Familiarization with different digital ICs.
2. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR and EX-NOR.
3. Realization of basic gates using universal logic gates.
4. Gray Code to Binary Code Conversion and Vice Versa.
5. Code Conversion between BCD and Excess-3
6. Four-bit parity generator and comparator circuits.
7. Construction of simple Decoder and Multiplexer circuits using logic gates.
8. Construction of simple arithmetic circuits-Adder, Subtractor.
9. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.
10. Realization of RS-JK and D flip-flops using Universal logic gates.
11. Realization of Universal Register using JK flip-flops and logic gates.
12. Realization of Universal Register using multiplexer and flip-flops..
13. Realization of Asynchronous Up/Down counter.

Programming Practices Laboratory
Code: BME (CS) 494, Contacts: 3P, Credit: 2

Course Objective:
This course is directed to train students with programming practices using C++

Course Outcomes:
After completion of the course student will be able to

1. Understand the principles and practice of object oriented analysis and design in the construction of robust, maintainable programs which satisfy their requirements;
2. Design, write, compile, test and execute straightforward programs using C++;
3. Realize the professional approach to design and the importance of good documentation to the finished programs.
4. Implement, compile, test and run C++ programs comprising more than one class, to address a particular software problem.
5. Demonstrate the ability to use simple data structures like arrays in a C++ program.

List of Experiments:

1. Write a C++ program to display any message.
2. Write a C++ program to illustrate the example of Inline Function.
3. Write a C++ program to show Default Arguments.
4. Write a C++ program to show Function Overloading.
5. Write a C++ program to illustrate the example of for loop, while loop, do-while loop, switch case.
6. Write a C++ program to show the example of Static Variable and Static Member function.

7. Write a C++ program to illustrate the example of Implicit and Explicit type casting.
8. Write a C++ program to show the example of scope resolution operator and private member function.
9. Write a C++ program to illustrate the example of object as function argument.
10. Write a C++ program to show the example of friend function.
11. Write a C++ program to illustrate the example of function returning object.
12. Write a C++ program to illustrate the example of Constructor overloading.
13. Write a C++ program to illustrate the example of copy operator and default operator.
14. Write a C++ program to illustrate the example of overloading of unary operator.
15. Write a C++ program to illustrate the example of overloading of binary operator.
16. Write a C++ program to show the example of overloading of binary operator and friend function.
17. Write a C++ program to illustrate the example of overloading of binary operator and friend function.
18. Write a C++ program to compare two strings using operator overloading.
19. Write a C++ program to illustrate the example of multilevel, multiple, hierarchical and hybrid inheritance.
20. Write a C++ program to illustrate the example of array of pointer and array of pointers to objects.
21. Write a C++ program to illustrate the example of this pointer.
22. Use a try block to throw it and use catch block to handle it properly and demonstrate the concept of re-throwing an exception.
23. Write a C++ program to illustrate a function template for finding the maximum value in an array.
24. Write a C++ program to illustrate the example of virtual function.
25. Write a C++ program to implement the virtual base classes.
26. Write a C++ program to show the example of class templates and function template.
27. Consider a class network, the class master derives information from both account and admin classes which in turn derive information from the class person. Define all the four classes and write a program to create, update and display the information contained in master objects.
28. Write a C++ program to create a file and store the employee record in the file and display all the record and update the contact number and address of the employee whenever it has required.
29. Write a C++ program to implement the handle the exception. Use a try block to throw it and use catch block to handle it properly and demonstrate the concept of re-throwing an exception.
30. Related Problems based on the above concepts.

3rd Year-5th Semester

THEORY PAPERS

Biomedical Instrumentation
Code: BME 501, Contacts: 3L+1T, Credit: 4

Prerequisite:
Knowledge of analog & digital electronics

Course Objective

1. To familiarize students with various aspects of measuring electrical parameters from living body.
2. To introduce students with the characteristics of medical instruments and related errors.
3. To illustrate various types of amplifiers used in biomedical instruments.
4. To familiarize students with biomedical recorders.
5. To introduce students with patient monitoring system & its characteristics.

Course Outcome

After completion of this course the students will be able to

1. Describe and characterize the sources of biomedical signals and needs of using biomedical instruments & their limitations.
2. Understand & describe pc based medical instrumentation & regulation of medical devices.
3. Describe and characterize medical instruments as per their specifications, static & dynamic characteristics and understand data acquisition system.
4. Describe, analyze, characterize and design Bio-amplifiers.
5. Understand, describe, characterize and design various medical recording systems & their components.
6. Understand and describe patient monitoring systems and its necessity in healthcare system.

Topic	**No of Lectures**
Medical Instrumentation: Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors in medical instruments, PC based medical Instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.	**6L**
Measurement systems: Specifications of instruments, Static & Dynamic characteristics of medical instruments, Classification of errors, Statistical analysis, Reliability, Accuracy, Fidelity, Speed of response, Linearization of technique, Data Acquisition System.	**6L**
Bioelectric signals and Bioelectric amplifiers: Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Instrumentation amplifiers, Special features of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector.	**8L**
Biomedical recording systems: Basic Recording systems, General consideration for signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electrocardiograph, Vectorcardiograph, Phonocardiograph, Electroencephalograph, Electromyography, Other biomedical recorders, Biofeedback instrumentation, Electrostatic and Electromagnetic coupling to AC signals, Proper grounding, Patient isolation and accident prevention.	**12L**
Patient Monitoring Systems: System concepts, Cardiac monitor, selection of system parameters, Bedside monitors, Central monitors, Heart rate meter, Pulse rate meter, Holter monitor and Cardiac stress test, Cardiac cauterization instrumentation, Organization and equipments used in ICCU & ITU.	**8L**
Total	**40L**

Text Books:
1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.

3. Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India

References:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
2. J.Webster, "Bioinstrumentation", Wiley & Sons.
3. Joseph D.Bronzino, "The Biomedical Engineering handbook", CRC Press.

Biosensors & Transducers
Code: BME 502, Contacts: 3L+1T, Credit: 4

Objective: This subject aims to impart an understanding of the physical principles which govern the measurement of a biological variable or system, using a transducer which converts the variable into an electrical signal. This course will principally focus on biosensors and transducers associated with measurement of physiological phenomena, including pressure, displacement, flow, volume and biochemistry.

Outcome: On completion of this course, the student should:

i) Have a broad understanding of the applications of various sensors and transducers available for physiological and cellular measurements
ii) Understand fundamental transduction and biosensing principles
iii) Get the clear domain knowledge about various measurement systems includes different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters.
iv) Understand various measurement devices and techniques, including the underlying biological processes that generate the quantities to be measured or controlled
v) Be capable of critically reviewing the literature in the application area and apply knowledge gained from the course to analyse simple biosensing and transduction problems.

Topic	No of Lectures
Module-I: Transducers principles and Medical applications - Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, p-n junction, chemical thermometry, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer:variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo-emissive tubes, photovoltaic cell, photoconductive cell, photodiodes, Flow transducers: magnetic, resistive and ultrasonic	
Module–II: Biopotential Electrodes - Electrode electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal , micropipette (metal filled glass and glass micropipette electrodes), microelectronic, properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG & EEG)	
Module-III: Chemical Biosensors Blood gas and Acid-Base Physiology, Electrochemical sensors, reference electrode, pH, pO2, pCO2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors. Transcuteneous arterial oxygen tension & carbon dioxide tension monitoring enzyme electrode.	
Module-IV: Optical Sensor and Radiation Detectors: Principles of optical sensors, optical fiber sensors, indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionisation chamber, Geiger counters, Scintillation detectors.	
Module-V: Biological sensors: Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors, Basic principles of MOSFET biosensors & BIOMEMS, basic idea about Smart sensors.	
TOTAL	

Reference Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.
3. Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.
4. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.
5. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.
6. Iberall & Guyton, Regulation & Control in Physiological System, Instruments Soc.USA.
7. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.
8. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
9. D. L. Wise, "Applied Bio Sensors", Butterworth, London.

Biomedical Digital Signal Processing
Code: BME 503, Contacts: 3L, Credit: 3

Course Objectives

1. To build a strong base for developing algorithms for signal processing systems.
2. To develop competency in terms of logical thinking, programming and application skills.
3. To train and motivate students for pursuing higher education and research for developing cutting edge technologies.

Course Outcomes

After completion students will be able to

1. Understand the fundamental techniques and applications of digital signal Processing with emphasis on biomedical signals.
2. Implement algorithms based on discrete time signals.
3. Understand Circular and linear convolution and their implementation using DFT analyse signals using discrete Fourier transform.
4. Understand efficient computation techniques such as DIT and DIF FFT Algorithms.
5. Design FIR filters using window method, digital IIR filters by designing prototype analog filters and then applying analog to digital conversion

Introduction: Concept of discrete-time signal, Basic idea of sampling and reconstruction of signal, Sampling theorem, Simple signal conversion systems, Frequency domain representation, Spectral analysis, Cepstral analysis, Linear filtering, adaptive filters-general structure, LMS adaptive filter, Noise cancellation, Feature extraction and pattern recognition, Brief idea about - Short Time Fourier Transform (STFT) and Wavelet	**9L**
Digital Filters Realizations: Characteristics of FIR filters, frequency response, Design of FIR filters using Windowing Techniques, Analog filter approximations-Butterworth and Chebychev, Design of IIR filters-Bilinear transformation method, Step and Impulse invariance techniques, Spectral transformations, Comparison of FIR and IIR filters.	**7L**
Cardiological and Electromuscular signal processing: Basic Electrocardiography, ECG Data Acquisition, QRS detection, Rhythm analysis, Arrhythmia detection algorithms, Automated ECG analysis, ECG pattern recognition, Basic electromyography, EMG data acquisition, Rectification and averaging.	**9L**
Neurological signal processing: The EEG Signals and its characteristics, EEG Analysis-Time frequency domain method, Linear prediction theory and Autoregressive (A.R.) method, Detection of spikes and spindles, Detection of alpha, beta and gamma waves. Least squares and polynomial modelling-Markov Model and Markov Chain, Dynamics of Sleep-Wake Transition, Hypnogram Model Parameters, Analysis of evoked potential using Prony's method.	**9L**
Data compression techniques: Data reduction algorithms-TP, AZTEC, CORTES and KL transform with special example to ECG signal.	**4L**
Total	**34 L**

Text Books:

1. D.C.Reddy, " Biomedical signal processing – Principles and Technique", Tata McGraw-Hill.
2. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.
3. Digital biosignal processing. Weitkunat R, Elsevier.
4. Computer technique in medicine. Macfarlane P.W. Butter Worth
5. L.R.Rabiner & B.Gold, "Theory and application of Digital Signal Processing".
6. S.K.Mitra, "Digital Signal Processing : A computer based approach", TMH.
7. J.G.Prokis & D.G.Manolakis, "Digital Signal Processing: Principles, Algorithm and Applications", PHI/Pearson Education.
8. S.Salivahanan et al, "Digital Signal Processing", TMH.

Reference:

1. Oppenheim & Ronald W Schafer," Digital Signal Processing", Prentice Hall India.
2. Andreas Antonion , "Digital Filters Analysis & Design", Prentice Hall India.
3. R Rabiner & B. Gold , "Theory & Application of Digital Signal processing", PHI.

Medical Imaging Techniques
Code: BME 504, Contacts: 3L, Credit: 3

Course Objective

1. To study the production of x-rays and its application to different medical Imaging techniques.
2. To study the different types of Radio diagnostic techniques.
3. To study the special imaging techniques used for visualizing the cross sections of the body.
4. To study the imaging of soft tissues using ultrasound technique

Course Outcome:

After completion of this course students will be able to

1. Understand and describe the basics of X-ray imaging modality and its biological effects.
2. Understand and describe the fundamentals of CT imaging
3. Understand and explain the principles of Fluoroscopy and angiography.
4. Understand and explain the principles of Infra red imaging.

X-ray Machine: Physics and production of X-ray, Stationary and rotating anode tube, tube enclosure, rating charts of X-ray tubes, Conventional electrical circuit of X-ray machine, High voltage generation, High frequency generators, Control circuits-high voltage control, filament control and tube current, starter, exposure timing, Automatic exposure control, Collimators and Grids, mammographic and dental X-ray machines, portable and mobile X-ray units.	**10L**
X-ray image and radiotherapy: X-ray film, Film sensitometry, Radiographic film image formation, dark room accessories-developer and fixer, image quality factors, detector quantum efficiency, MTF, Image intensifier, Digital radiography, safety protocol and doses, Dose equivalent and REM, Radiotherapy principles, dose measurement and treatment planning.	**7L**
Fluoroscopy and angiography: Fluoroscopic imaging system, Digital fluoroscopy-c-arm system, Digital subtraction angiography (DSA), digital subtraction programming, angioplasty.	**5L**
Infra red Imaging: Physics of thermography, Infrared detectors, Imaging systems, clinical themography, liquid crystal thermography, modern application.	**3L**
Computed tomography: Principles of computed tomography, Scanning system, Detectors, Processing / data acquisition system, viewing system, storing & documentation, gantry geometry, Different informations from gantry, CT numbers, image reconstruction techniques: back projection, iterative and analytical methods, image quality and artifacts, Dose in CT, Spiral CT.	**9L**
Total	**34L**

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey & Meredith , "Fundamental Physics of Radiology", John Wright & Sons.
4. S. Webb, "The Physics of Medical Imaging", Ada m Hilger, Bristol.
5. Sybil M Stockley, "A Manual of Radiographic Equipments", Churchill Livingstones.
6. Chistrmis , "Physics of Diagnostic Radiology"

Electives (PE)

Control Engineering
Code: BME 505A, Contacts: 3L, Credit: 3

Course Objectives:
This course is objected to impart knowledge on the fundamentals of Control systems engineering, its components and applications.

Course Outcomes:
After completion of the course the students will be able to

1. To teach the fundamental concepts of Control systems and mathematical modeling of the system
2. To study the concept of time response and frequency response of the system
3. To teach the basics of stability analysis of the system
4. To study the state variable analysis
5. To teach the problem solving technique and designing aspect of control system.

Topic	No of Lectures
Module 1: **Introduction to Control Systems:** Classification of control systems with examples. Properties of Control Systems: Stability, disturbance rejection, insensitivity and robustness.	**2L**
Module 2: **Control system components:** Position and velocity sensors and encoders, servomotors and voice coil actuators.	**2L**
Module 3: **Basic Control actions:** Proportional, integral, derivative, and their combinations.	**2L**
Module 4: **Review of Matrix Algebra:** Rank of matrix, Generalised matrix inverse, eigenvalues, eigenvector, computation of function of matrix.	**3L**
Module 5: **State variable analysis:** Concept of state, state variable, state model. State variable formulation of control system, diagonalization, Relating transfer function with state model. Time response of state model of linear time-invariant system. Alternative representations in state space (cascade form, parallel form, controllable canonical form, observable canonical form). Elementary concept of controllability & observability.	**9L**
Module 6: **Block diagram representation of control systems:** block diagram reduction and signal flow graph analysis.	**4L**
Module 7: **Stability of linear systems:** Routh-Hurwitz criterion, Nyquist criterion. Stability margins. Root locus analysis. Effects of system gain and additional pole-zeros on stability.	**8L**
Module 8: **Review of frequency domain methods:** Nichols plots. Frequency Domain Specifications in open loop and	**3L**

closed loop and their significance, Concept of Bandwidth (3 dB BW & 90 degree BW) and Cut-off frequency, Effect of addition of poles and zeros on Bandwidth.	
Module 9: **Design and compensation of control systems in frequency domain:** Lag compensator, lead compensator, lead-lag compensator and lag-lead compensator.	**2L**
Module 10: **Case Studies:** Performance analysis of remote position control system and generator voltage regulation.	**1L**
Total	**36L**

Books :

1. Nagrath I. J. and Gopal M.,"Control Systems Engineering", New Age International (P) Ltd.
2. Ogata K, "Modern Control Systems", Prentice Hall, Englewood Cliffs.
3. Benjamin C. Kuo, "Automatic Control Systems", PHI
4. Gopal: Modern Control System, New Age International

Biophysics & Biochemistry
Code: BME 505B, Contacts: 3L, Credit: 3

Course Objective:

- The course aims to provide an advanced understanding of the core principles and topics of Biophysics & Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a branch lecture series.
- Students will be able to learn the vocabulary and conceptually understand the biochemical & biophysical processes.
- Students will be able to learn the theoretical and technical basis for biophysical & biochemical definition and determination of macromolecular structure.
- This course focuses on the phenomena related to the interaction and communication between living cells and their molecular constituents, drawing on research methods used within the fields of molecular and cellular biochemistry and biophysics.

Course Outcome:

- The students will get broad and deep understanding of the ways that life functions are explained in terms of the principles of chemistry and physics.
- The ability to utilize computational tools as appropriate to the biochemistry, biophysics, and molecular biology disciplines, including research, data analysis, and communication.
- The students will get knowledge necessary for students, according to their career goals, to attain acceptance into advanced degree programs.
- The students will be exposed to familiarity with the complexity of issues facing professionals in the biochemistry, biophysics, and molecular biology disciplines, including scientific and moral ethics, cultural diversity, and environmental concerns.
- The students will be exposed to familiarity with the types of contributions that this course can provide to society, including improvements in the human condition, and economic stimulation at the local, national, and international levels.
- Learn how to design and interpret experiments, thereby contributing to the creation of new knowledge in the fields of biochemistry and biophysics.
- Develop an awareness of ethical responsibilities when conducting and reporting research in the biochemistry, biophysics, and molecular biology disciplines.

MODULE	CONTENT	HOURS
1	**Biological Principles:** Composition and properties of cell membrane, membrane transport, body fluid, electrolytes, filtration, diffusion, osmosis, electrophoresis, plasmapheresis, radioimmunoassay, Photochemical reaction, laws of photochemistry, fluorescence, phosphorescence.	5
2	**Bioelectricity:** Membrane potential, Action potential, Electrical properties of	4

	membrane, capacitance, resistance, conductance, dielectric properties of membrane.	
3	**Electrical stimulus and biophysical activity:** Patient safety, electrical shock and hazards, leakage current, Electrical activity of heart (ECG), Electrical activity of brain(EEG), Electroretinogram (ERG), Electro-occologram (EOG), Electromyogram(EMG).	**5**
4	**Radioactivity:** Ionizing radiation, U-V & IR radiations, Production of radioisotopes, Radioactive decay, Half life period.	**4**
5	**Macromolecules:** Classification & functions of carbohydrates, glycolysis, TCA cycle, ATP synthesis. Classification & functions of proteins, architecture of protein, Classification of amino acid, oxidative and non oxidative deamination, transamination. Classification & functions of lipids, biosynthesis of long chain fatty acid, oxidation and degradation of fatty acid.	**8**
6	**Enzymes and Nucleic acid:** Chemical nature &broad classification of enzymes, M-M kinetics, Isozymes and Allosteric enzymes. Structure of DNA, DNA Replication, Transcription, Translation.	**8**

Reference Books:

1. Radiation Biophysics, Second Edition - by Edward L. Alpen - Academic Press; 2 edition
2. Bio-Physics – Roland Glaser- Springer; 2nd printing edition (November 23, 2004)
3. Text book of Medical Physiology- Guyton
4. The Biomedical Engineering Hand Book- 3rd Ed- (Biomedical Engineering Fundamentals) - Joseph D. Bronzino – CRC –Tylor-Francis – 2006 (Section- III – Bio-Electrical Phenomena)
5. Lehninger Principles of Biochemistry, Fourth Edition - by David L. Nelson & Michael M.Cox , - W. H. Freeman; 4 edition (April 23, 2004)
6. Fundamentals of Biochemistry: Life at the Molecular Level - by Donald J. Voet , Judith G. Voet & Charlotte W. Pratt. - Wiley; 2 edition (March 31, 2005)

Modelling of Physiological Systems
Code: BME 505C, Contacts: 3L, Credit: 3

Course Objectives:
The course provides a detailed insight in the modeling approaches to describe and reconstruct physiological properties and physiology of the cardiovascular muscular and neurological systems. The course will provide the students with a guide to mathematical modeling techniques and tools for simulation of physiological systems.

Course Outcomes:

After Completion of the course, students will be able to

1. Understand the requirements for the development of mathematical and computational models in the analysis of physiological process/ biological systems
2. Articulate the difference between theory and model
3. Choose and apply appropriate analytical and numerical tools to solve ordinary differential equation models of biological problems.
4. Understand, predict and interpret the biological significance of linear and nonlinear control systems.
5. Classify modeling approaches and select appropriate models as research and development tools.
6. Students will be able to demonstrate their understanding of cellular force development and tissue mechanics.
7. Students will be able to integrate electrical, electrochemical, physiological and mechanical phenomena into the design of models to assess their inter-dependencies.

Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Purpose of physiological modeling and signal analysis, linearization of nonlinear models. Time invariant and time varying systems for physiological modeling.	**8L**
Equivalent circuit model: Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis. **Physiological modeling**: Electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop, *and Linearized model of the immune response:* Germ, Plasma cell, Antibody, system equation and stability criteria.	**12L** **10L**
Total	**30L**

Text/ Reference books:

1. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engg. , Academic press.
2. Suresh.R.Devasahayam, Signals & Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.
3. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.
4. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.
5. L.Stark, Neurological Control System, Plenum Press.
6. R.B. Stein, Nerve and Muscle, Plenum Press.

Electives (OE)

Data Structure & Algorithm
Code: BME (CS) 506A, Contacts: 3L, Credit: 3

Course Objectives:
The course provides a detailed insight in the data structure using object oriented programming & relevant algorithm formation and their application.

Course Outcomes:

1. Understand the need of Object oriented programming and its relevance in the context of Structures and Functions
2. Learn the concepts and relevance of Classes & Objects
3. Understand the concept of Operator Overloading and inheritance for effective programming.
4. Understand advanced concepts about functions and programming techniques for working with files.
5. Understand different types of Data structures

Topic	**No of Lectures**
Overview of C language, Time and Space analysis of Algorithms - Order Notations.	5L
Linear Data Structures: Sequential representations - Arrays and Link Lists, Stacks, Queues and Dequeues, Strings, Application. Linear Data Structures, Link Representation - Linear linked lists, Circularly linked lists. Doubly linked lists,application.	7L
Recursion: Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.	4L
Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Graphs - Representations,Breadth-first and Depth-first Search.	6L
Hashing: Hashing Functions, collision Resolution Techniques.	4L
Sorting and Searching Algorithms- Bubble sort, Selection Sort, Insertion Sort, Quicksort, Merge Sort, Heapsort and Radix Sort.	4L
File Structures: Sequential and Direct Access. Relative Files, Indexed Files - B+ tree as index. Multi-indexed	6L

Files, Inverted Files, Hashed Files.	
Total	**36L**

Text books:
Data Structure Through C-Bandyopadhyay & De,Pearson Education
Data Structure Using C-Berman,OUP
Ajay Agarwal- Data Structure Through C, Cyber Tech
Data Structures and Algorithms – O.G. Kakde and U.A. Deshpande, ISTE/EXCEL BOOKS.
Aho Alfred V., Hopperoft John E., UIIman Jeffrey D., "Data Structures and Algorithms", Addison Wesley.
Drozdek A –Data Structures and Algorithms.
Pujari A.K. – Data Mining & Techniques, Universities Press.

References:
1. Heileman: Data structures, algorithms & OOP- Tata McGraw Hill
2. Data Structures Using C – M.Radhakrishnan and V.Srinivasan, ISTE/EXCEL BOOKS
3. Weiss Mark Allen, Algorithms, Data Structures, and Problem Solving with C++, Addison Wesley.
4. Horowitz Ellis & Sartaj Sahni, Fundamentals of Data Structures, Galgotia Pub.
5. Tanenbaum A. S., Data Structures using 'C'

Soft-computing
Code: BME(CS)506B, Contacts: 3L, Credit: 3

AIM:
To give an overall understanding on the theories those are available to solve hard real world Problems

OBJECTIVES:
1. To give the students an overall knowledge of soft computing theories and fundamentals
2. To give an understanding on the fundamentals of non-traditional technologies and approaches to solving hard real-world problems
3. Fundamentals of artificial neural networks, fuzzy sets and fuzzy logic and genetic algorithms.
4. Use of ANN, Fuzzy sets to solve hard real-world problems
5. To give an overview of Genetic algorithms and machine learning techniques to solving hard real-world problems
6. To study about the applications of these areas

Topic	**No of Lectures**
UNIT I **INTRODUCTION** Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence – Neural Networks - Scope and Evolution – Models of Neural Networks – Feed forward Networks – Supervised Learning Neural Networks – Associative memory networks – Unsupervised learning networks – Special Networks	**6L**
UNIT II **FUZZY SETS AND FUZZY LOGIC** Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations - Fuzzy Rules Non –interactive fuzzy sets – Fuzzification– Intuition , inference, Rank ordering –Defuzzification – Max-membership principle, centroid method, center of sums, center of largest area.	**7L**
UNIT III **FUZZY MEASURES AND REASONING** Fuzzy arithmetic and measures – Fuzzy reasoning – approximate reasoning –categorical, qualitative, syllogistic, dispositional – Fuzzy inference systems – fuzzy decision making – individual, multiperson, multi objective, Bayesian – fuzzy logic control system – architecture, model and application	**7L**
UNIT IV **MACHINE LEARNING AND GENETIC ALGORITHM** Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA) – Simple and General GA – Classification of Genetic Algorithm – Messy, Adaptive, Hybrid, Parallel – Holland Classifier System	**8L**
UNIT V **APPLICATION AND IMPLEMENTATION SOFT COMPUTING** Genetic algorithms -. Traveling Salesperson Problem, Internet Search Techniques –Fuzzy Controllers – Bayesian	**8L**

Belief networks for Rocket Engine Control – Neural Network, Genetic algorithm and Fuzzy logic implementation in C++ and Matlab	
Total	**36L**

TEXT BOOK:

1. S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing", Wiley India Ltd., First Indian Edition, 2007

REFERENCES:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2003.
2. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edn., 2003.
3. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1995.
4. Amit Konar, "Artificial Intelligence and Soft Computing", First Edition,CRC Press, 2000.
5. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Second Edition Prentice Hall, 1999.
6. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998.
7. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley, 1997.

VLSI & Embedded System
Code: BME(EC)506C, Contacts: 3L, Credit: 3

PO(Program Objective):

1 Describe MOS transistor structure and operation
2 . State VLSI design flow and design hierarchy
3. Design NAND, NOR, half adder, full adder transmission gate
4. describe different inverters(Resistive load,CMOS etc)
5. Design MOS based sequential circuit
6. Design dynamic logic circuits
7. Understand the fundamentals of the embedded systems
8. Basic programming concepts of for embedded systems
9. Describe the Basic OS fundamentals and the RTOS for embedded systems

Learning Outcome:

Outcome of this course is:

Students will be able to apply the theoretical VLSI circuits knowledge and embedded systems fundamentals for designing circuits in the domain of VLSI and can have a basic platform for embedded systems. Getting a strong foundation on the theoretical knowledge on VLSI as well as embedded systems will help them to get into the field of VLSI circuits design and the embedded systems and RTOS fields which in turn helps the society to have chips for simplifying /helping everyday life either in form of knowledge sharing or in the form of product development.

Topic	**No of Lectures**
Introduction to MOSFETs: MOS-transistor structure, operation,characteristics.VLSI design flow and design hierarchy. Brief overview of circuit design techniques (Hierarchical design, Design abstraction, computer aided design).	**2L**
MOS Inverter: Simple inverter structure, VTC, Critical voltages, different types of inverter, Noise margin.	**2L**
CMOS combinational circuit:: NAND gate, NOR gate, Half adder, Full adder, Other complex logic circuts, CMOS transmission gates, Simple circuits design with CMOS transmission gate.	**5L**
Sequential MOS Logic Circuits: SR Latch, JK Latch,D latch,Edge triggered Flipflops.	**5L**
Dynamic Logic Circuits: Dynamic logic circuits basics, Precharge and evaluate logic,cascading problem, Domino Logic.	**4L**

Introduction to Embedded systems: Embedded Systems –Definition, Difference between Embedded system and General Computing Systems, Importance of Embedded Systems , Hardware architecture of the real time systems,Different hardware units & processor overview for embedded systems.	**4L**
Programming Concepts for Embedded systems: ALP and High level language, Macros, functions, data types, data structures, modifiers, statements ,loops, pointers Queue, stack, Lists and ordered lists, compilres and cross compilers.	**4L**
Real Time Operating Systems : Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, Multiple tasks scheduling in real time systems by RTOS	**10L**
Total	**36L**

Text books:

1. Neil H.E Weste, Kim Haase, David Harris, A.Banerjee, "CMOS VLSI Design: A circuits & Systems Perspective", Pearson Education
2. Wayne Wolf," Modern VLSI Design – System-on-chip Design", Prentice Hall India/Pearson Education
3. Sung-Mo Kang & Yusuf Lablebici, "CMOS Digital Integrated Circuits, Analysis & Design", Tata McGraw-Hill Edition
4 .Introduction to Embedded System: Shibu K. V. (TMH)
5. Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley)
6. Embedded Systems: Rajkamal (TMH)

References:

1. David Hodges, Horace G Jackson, & Resve A Saleh, " Analysis & Design of Digital Integrated Circuits", Tata McGraw-Hill Edition
2. Ken Martin," Digital Integrated Circuits", Oxford University Press
3.Embedded Systems : L. B. Das (Pearson)
4. Embedded System design: S. Heath (Elsevier)
5. Embedded microcontroller and processor design: G. Osborn (Pearson)

PRACTICAL/SESSIONAL PAPERS

Biomedical Instrumentation Laboratory
Code: BME 591, Contacts: 3P, Credit: 2

Course Objective

1. To familiarize students with the operation of DC to DC converter & its application.
2. To introduce students with timer circuits & heart-rate meter.
3. To emphasis on the study of EMG, ECG, EEG & PCG waveform & analysis.
4. To familiarize students with the design of biopotential amplifiers.
5. To introduce students with basic operation of X-ray system.
6. To introduce students on the study of isolation of biosignals.

Course Outcome

After completion of this course the students will be able to

1. Understand and implement isolation techniques in designing biomedical instruments.
2. Measure and Analyze EMG, ECG, EEG and PCG waveforms in diagnostic point of views
3. Measure and Analyze QRS components from diagnostic point of view.
4. Design and analyze the characteristics of Biopotential amplifiers.
5. Understand & describe the basic operation of an X-ray system.
6. Measure heart rate meter using F-V Converter.
7. Measure ON-Time & OFF-Time delay of a waveform using Timer circuit.

List of experiments:
1. Power isolation: isolation transformer and DC-DC converters
2. Timer circuits: ON delay and OFF delay study
3. Measurement of heart rate using F-V converter
4. ECG processing and analysis
5. EMG processing and analysis
6. EEG processing and analysis
7. Detection of QRS component from ECG signals
8. Study on Instrumentation Amplifier-Design
9. Study on X-ray radiography systems / X-ray simulator
10. Characterization of biopotential amplifier for ECG & EMG signals
11. PCG processing and analysis / electronic stethoscope
12. Isolation of bio-signal (EMG / ECG)

Biosensors & Transducers Laboratory
Code: BME 592, Contacts: 3P, Credit: 2

Course Objectives:
1. To study and analyze the theory and practical characteristics of the various transducers for the measurement of the vital physiological signals
2. To get familiar with the various types of transducers and to study the compatibility for any clinical measurements

Course Outcomes:
After completion of this course the students will be able to

1. Perform temperature, pressure & displacement measurement using relevant sensors/transducers
2. Study the characteristics of an LDR, load cell & pH electrodes
3. Perform torque measurement with strain gauge
4. Study the characteristics of biotransducers and bioelectrodes

List of Experiments:

1. Temperature measurement using AD590 IC sensor
2. Displacement measurement by using a capacitive transducer
3. Study of the characteristics of a LDR
4. Pressure and displacement measurement by using LVDT
5. Study of a load cell with tensile and compressive load
6. Torque measurement Strain gauge transducer
7. Study & characterization of Biotransducers – Pressure, Temparature, Humidity
8. Study & characterization of Bioelectrodes – ECG, EMG, EEG
9. Study & Characterization of pH electrodes.

Biomedical Digital Signal Processing Laboratory
Code: BME 593, Contacts: 3P, Credit: 2

Course Objective:
Examining the full scope of digital signal processing in the biomedical field, this course provides the basics of digital signal processing as well as programming in MATLAB for designing and implementing digital filers for biomedical application. It provides a set of laboratory experiments that can be done using either an actual analog-to-digital converter, or taking the available data base to process the biomedical signals. The course emphasizes on feature extraction and classification of normal and abnormal features using different modeling techniques.

Course Outcome:
After completion of the course the students, using MATLAB software, will be able to

1. Perform DFT of a step response
2. Estimate Power spectral density of waveform
3. Determine frequency response, phase response & magnitude response of FIR & IIR filters
4. DCT, IDCT, FFT, IFFT, correlation, autocorrelation and cross-correlation of ECG signals

List of experiments:

1. Find out DFT of a Step Sequence.
2. Power Spectral Density of any sequence.
3. Estimation of Power Spectral Density.
4. Frequency Response, Phase Response & Magnitude Response of all types of FIR filter.
5. Frequency Response, Phase Response & Magnitude Response of all types of IIR filter.
6. Auto-Correlation and Cross-Correlation of ECG signals.
7. Correlation of ECG Signal & Noise Signal.
8. Convolution of ECG Signal & Noise Signal.
9. DCT and IDCT of ECG signal.
10. FFT and IFFT of ECG signals
11. 60-Hz adaptive filter
12. Reduction of ECG signal

Data Structure & Algorithm Laboratory
Code: BME(CS) 596A, Contacts: 3P, Credit: 2

Course Objective:

This course provides the student with the fundamental means to approach the design and analysis of algorithms in an effective and methodologically correct manner. The student will acquire knowledge of general techniques for the design and analysis of algorithms and will be provided with a collection of significant examples of representative problems. Furthermore, the student will have the opportunity to supplement the theoretical concepts with programming in the C language during laboratory sessions.

Course Outcome:
After completion of the course the students will be able to

1. Able to understand the importance of structure and abstract data type, and their basic usability in different applications through different programming languages
2. Able to analyze and differentiate different algorithms based on their time complexity.
3. Able to understand the linked implementation, and its uses both in linear and non-linear data structure
4. Able to understand various data structure such as stacks, queues, trees, graphs, etc. to solve various computing problems
5. Able to implement various kinds of searching and sorting techniques, and know when to choose which technique
6. Able to decide a suitable data structure and algorithm to solve a real world problem

List of Experiments:
1. Implementation of array operations.
2. Implementation of linked lists: inserting, deleting, and inverting a linked list.
3. Stacks and Queues: adding, deleting elements of Circular Queue: Adding & deleting elements.
4. Merging Problem: evaluation of expressions/operations on multiple stacks & queues.
5. Implementation of stacks & queues using linked lists.
6. Polynomial addition, Polynomial multiplication.
7. Sparse Matrices: Multiplication, addition.
8. Recursive and Non-recursive traversal of Trees
9. Threaded binary tree traversal. AVL tree implementation.
10. Application of Trees, Application of sorting and searching algorithms.
11. Hash tables implementation: searching, inserting and deleting, searching & sorting techniques

Soft-computing Laboratory
Code: BME (CS) 596B, Contacts: 3P, Credit: 2

Course Objective:
To implement neural network techniques, fuzzy logic approaches, genetic algorithms to solve different type of practical problems

Course Outcome:
After completion of the course the students will be able to

1. To know about the basics of soft computing techniques and also their use in some real life situations.
2. To solve the problems using neural networks techniques.
3. To find the solution using different fuzzy logic techniques
4. To use the genetic algorithms for different modelling
5. To integrate the various soft computing techniques

List of experiments:

1. To perform Union, Intersection and Complement operations.
2. To implement De-Morgan's Law.
3. To plot various membership functions.
4. Use Fuzzy toolbox to model tip value that is given after a dinner based on quality and service.
5. To implement FIS Editor.
6. Generate ANDNOT function using McCulloch-Pitts neural net.
7. Generate XOR function using McCulloch-Pitts neural net.
8. Hebb Net to classify two dimensional input patterns in bipolar with given targets.
9. Perceptron net for an AND function with bipolar inputs and targets.
10. To calculate the weights for given patterns using hetero-associative neural net.
11. To store vector in an auto-associative net, find weight matrix & test the net with input
12. To store the vector, find the weight matrix with no self-connection.
13. Test this using a discrete Hopfield net.

VLSI & Embedded System Laboratory
Code: BME(EC)596C, Contacts: 3P, Credit: 2

Course Objective:
This lab course is to provide an introduction to the characteristics of digital logic and the design, construction, testing and debugging of simple digital circuits using Verilog HDL. And also provide an introduction to the development of application using microcontrollers.

Course Outcome:

1. An understanding of digital logic
2. An ability to implement basic synchronous sequential circuits with flip-flops
3. An understanding of the operation of logic gates
4. An understanding of the operation of SR, T, JK, and D flip-flops
5. An understanding of the operation of counters and registers an understanding of the operation of multiplexers, decoders.
6. To have a wide knowledge in the architecture 8051 microcontroller
7. Being able to design small software/hardware systems

List of experiments:

1. Introduction to modelsim & Design of Logic gates
2. Design of Binary Adders & Subtractor
3. Design of Multiplexers & Demultiplexers
4. Design of Encoders & Decoders
5. Design of Flip Flops
6. Design of Counters & Shift Registers
7. Switch level modeling
8. Bit manipulation
9. Verifying Arithmetic function
10. Interrupts &Timer control

3rd Year-6th Semester

THEORY PAPERS

Analytical & Diagnostic Equipments
BME 601, Contacts: 3L, Credit: 3

Course Objective:

This course is intended to impart the fundamental knowledge of versatile analytical & diagnostic equipments used in the healthcare system

Course Outcome:

After completion of this course the students will be able to

Identify, understand and explain the working principle of basicdanalytical & diagnostic equipments used in biomedical engineering domain

1. Understand and explain the working principle of Blood gas analyzers and Oximeters
2. Understand and explain the working principle of Blood cell counters and Blood pressure apparatus
3. Understand and explain the working principle of Blood Flow meters
4. Understand and explain the working principle of Pulmonary function analyzers
5. Understand and explain the working principle of Endoscopy

Topic	No of Lectures
Module I: Clinical equipments Principles of photometric measurement, Radiation sources, Optical filters, Colorimeter, Spectrometer , Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer- Auto analyzer, Electromechanical analyzer – Chromatographs, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-principles and applications.	**8L**
Module II: Blood gas analyzers and Oximeters Blood pH measurement, Blood pCO2 measurement, Blood pO2 measurement, a complete blood gas analyzer, Fiber optic based blood gas sensors, Oximetry, Principles of oximetric measurements, Ear oximeter, Pulse oximeter, Intravascular oximeter.	**6L**
Module III: Blood cell counters and Blood pressure apparatus Methods of cell counting, Flow cytometry, Coulter Counters, automatic recognition and differential counting of cells, Sphygmomanometer, Automated indirect and specific direct method of B.P. monitor.	**7L**
Module IV: Blood Flow meters Electromagnetic blood flow meter, Ultrasonic blood flow meter-Transit time and Doppler blood flow meter, Cardiac output measurement-Dye dilution method and Impedance technique.	**6L**
Module V: Pulmonary function analyzers Respiratory volumes and capacities, Compliance and related pressure, Spirometer, Pneumotachometer, impedance pneumograph / plethysmograph, apnea detector.	**6L**
Module VI: Endoscopy Basic endoscopic equipments, Fibreoptic instruments and video-endoscopes, Accessories-illumination, instrument tips, instrument channels, tissue sampling devices, suction traps and fluid-flushing devices, Various endoscopic applications. Maintenance and Storage	**7L**
TOTAL	**40L**

Text Books:

1. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.

3. Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India

References:

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
2. J.Webster, "Bioinstrumentation", Wiley & Sons.
3. Joseph D.Bronzino, "The Biomedical Engineering handbook", CRC Press.

Microprocessors & Microcontrollers

BME 602, Contacts: 3L+1T, Credit: 4

Objective:

The Microprocessor is a general purpose programmable logic device. A thorough understanding of the Microprocessor demands, concepts & skill from two different aspects - hardware concepts and programming skills. The syllabus presents an integrated approach to hardware and software in the concept of 8085 Microprocessor. The syllabus has been updated on the Microprocessor architecture, introduces programming and integrates hardware and software concepts, with interfaces and peripherals.

However 8086 microprocessor provides better and faster performance that contains a set of 16 bit ALU, a rich instruction set and provides segmented memory addressing scheme. It also has a powerful instruction set along with the architectural developments which imparts substantial programming sensibility. The microcontroller 8051 for the approach for designing embedded systems. The course is intended to acquire the knowledge for design and development of microprocessor based systems as well as microcontroller based systems.

Outcome:

After completion of this course students will be able to

1. Familiar with the 8085 and 8086 microprocessor and 8051 microcontroller
2. Explain the application of microprocessor & microcontroller
3. Interface external device like sensors, memory, keyboard etc with the microprocessor as well as microcontroller.
4. Design embedded system.
5. They will be able to write program in assembly language and C language.
6. Study the advanced microcontroller.
7. Control the different physical parameters.

Topics	**No. of Periods**
Module -1	
Introduction to Microcomputer based system. History of evolution of Microprocessor and Microcontrollers and their advantages and disadvantages, Architecture of 8085 Microprocessor. Address/data bus De multiplexing, status Signals and the control signal generation. Instruction set of 8085 microprocessor, Classification of instruction, addressing modes, timing diagram of the instructions (a few examples).	6
Assembly language programming with examples, Interrupts of 8085 processor, programming using interrupts, Stack and Stack Handling, Call and subroutine, DMA, Memory interfacing with 8085	6
Module 2:	
The 8086 microprocessor- Architecture, pin details, addressing modes, instruction set, Assembly language programming interrupts	6
Memory interfacing with 8086	2
Module -3	
Introduction to MCS-51 microcontroller –Architecture, pin details, memory organization, Hardware features of MCS-51, external memory interfacing, timers, interrupts, serial port, addressing modes, assembly language programming, ADC and DAC interfacing with microcontroller 8051	11
Module -4:	
Support IC chips- 8255, 8253, 8259, 8251 and their interfacing techniques	6
Brief introduction to PIC microcontroller (16F877)	1
Total	**40**
Module -5:	
Introduction to PLC and Mechatronics	2
Total	**40**

Textbooks :

1. Microprocessors and microcontrollers - N. Senthil Kumar, M. Saravanan and Jeevananthan (Oxford univ.press)
2. 8051 Microcontroller – K. Ayala (Cengage learning)
3. MICROPROCESSOR architecture, programming and Application with 8085 - R.Gaonkar (Penram International Publishing LTD.)
4. 8051 Microprocessor –V. Udayashankara and M.S Mallikarjunaswami (TMH).
5. Microprocessor 8085 and its Interfacing—S Mathur (PHI)
6. An Introduction to Microprocessor and Applications –Krishna Kant (Macmillan)
7. Mechatronics: W. Bolton, Pearson Education
8. Mechatronics : N.P. Mahalik, Tata McGraw Hill Publication
9. Introduction to Programmable Logic Controllers, Thomson/Delmar Learning; 3rd edition, 2005
10. Programmable Logic Controllers, McGraw-Hill Higher Education; 4 edition, 2010

Reference:

1. 8086 Microprocessor –K Ayala (Cengage learning)
2. The 8085 Microprocessor,Architecture,Programming and Interfacing- K Uday Kumar,B .S Umashankar (Pearson)
3. The X-86 PC Assembly language, Design and Interfacing - Mazidi, Mazidi and Causey (PEARSON)
4. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley (PEARSON)
5. Microprocessors – The 8086/8088, 80186/80386/80486 and the Pentium family – N. B. Bahadure (PHI).
6. The 8051 microcontrollers – Uma Rao and Andhe Pallavi (PEARSON).

Advanced Imaging Systems
BME 603, Contacts: 3L, Credit: 3

Course Objective:

This course is intended to impart the versatile advanced imaging techniques, their operating principle, applications & related modalities in healthcare system.

Course Outcome:

After completion of this course the students will be able to

1. Understand, explain & analyze the principles of ultrasound imaging and its biological effects.
2. Understand, explain & analyze the principles of PET & SPECT imaging.
3. Understand, explain & analyze the fundamentals of Magnetic resonance imaging

Topic	No of Lectures
Module I: Ultrasound Imaging Physics of ultrasound and Production of ultrasound, Medical ultrasound, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe design, Principles of image formation, capture and display - Principles of A Mode, B Mode and M Mode. Real-time ultrasonic imaging systems, electronic scanners, image artifacts, Doppler ultra sound and Colour velocity mapping, duplex ultrasound, bio-effects and safety levels. Scan converters, Frame grabbers, Single line and multi line monitoring of ultrasound displays - US artifacts	**10L**
Module II: Magnetic Resonance Imaging (MRI) Principles of nuclear magnetism, RF magnetic field and resonance, magnetic resonance (MR) signal, nuclear spin relaxations, gradient pulse, slice selection, phase encoding, frequency encoding, spin echoes, gradient echoes, K-space data acquisition and image reconstruction. MRI scan ner hardware: magnet, gradient coil, RF pulse transmission and RF signal reception. Diagnostic utility and clinical MRI, functional MRI, magnetic resonance angiography (MRA), magnetic resonance spectroscopy (MRS), diffusion MRI, bio-effects and safety levels.	**12L**

Module III: PET and SPECT Imaging Introduction to emission tomography, basic physics of radioisotope imaging Compton cameras for nuclear imaging, Radio nuclides for imaging, nuclear decay and energy emissions, brief of radionuclide production and detectors, pulse height analyzer, uptake monitoring equipments, Rectilinear scanners, Gamma Camera PET scanner principles, SPECT, Computer techniques in fast acquisition Analytic image reconstruction techniques, Attenuation, scatter compensation in SPECT spatial compensation in SPECT.	**10L**
Module IV - Other Imaging Techniques & Archiving: Infrared (IR) imaging: Thermography - Clinical applications of thermography, liquid crystal thermography. Optical coherence tomography (OCT): Introduction and its medical applications - Advances in image resolutions and speed in picture archiving and communication systems (PACS) in medical imaging.	**8L**
TOTAL	

Text Books:

1. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey & Meredith , "Fundamental Physics of Radiology", John Wright & Sons.
4. S. Webb, "The Physics of Medical Imaging", Ada m Hilger, Bristol.
5. Sybil M Stockley, "A Manual of Radiographic Equipments", Churchill Livingstones.
6. Chistrmis , "Physics of Diagnostic Radiology"

Electives (PE)

Communication Systems
BME 604A, Contacts: 3L, Credit: 3

Pre-Requisite: Mathematics, Signal Theory.

Course Objective: This curriculum is designed for enabling the students to assimilate the principles of electronic communication. Theory of traditional communication systems, digital communication, wireless communication, information theory, Source coding, error correction strategies and their working methodology would be stressed.

Course Outcome: On course completion, the students would be exposed to the methods of modulating amplitude and phase/frequency of the electromagnetic wave, transmission and receptions of binary streams and voice signals, constraints of designing communication systems namely noise, power. Also idea of information as measurable quantity. Methods of probabilistic source coding and error correction techniques are ingrained quantitatively.

Topic	No. of Lectures
ANALOG COMMUNICATION **Noise:** Source of Noise - External Noise- Internal Noise - Noise Calculation. Introduction to Communication Systems: Modulation – Types - Need for Modulation. Theory of Amplitude Modulation - Evolution and Description of SSB Techniques - Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).	8L
DIGITAL COMMUNICATION	

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) – Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK - Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK– FSK – PSK – QAM).	8L
DATA AND PULSE COMMUNICATION **Data Communication:** History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes - Error Detection and Correction Techniques - Data communication Hardware - serial and parallel interfaces. Pulse Communication**:** Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM)	7L
SOURCE AND ERROR CONTROL CODING Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes, convolution codes, viterbi decoding algorithm	7L
MULTI-USER RADIO COMMUNICATION Advanced Mobile Phone System (AMPS) - Global System for Mobile Communications (GSM) – Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Hand off - Overview of Multiple Access Schemes - Satellite Communication - Bluetooth.	6L
Total	**36L**

TEXT BOOK:

1. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2009.

REFERENCES:

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

Bionanotechnology

BME 604B, Contacts: 3L, Credit: 3

Course Objective:

This course is aimed to provide the knowledge on fundamental aspects of bionanotechnology

Course Outcome:

After completion of this course the students will be able to understand the basics of bionanotechnology and its application

Topic	No. of Lectures
UNIT - I BIONANOMACHINES AND THEIR BASICS Negligible gravity and inertia, atomic granularity, thermal motion, water environment and their importance in bionanomachines. The role of proteins- amino acids- nucleic acids- lipids and polysaccharides in modern biomaterials. Overview of natural Bionanomachines: Thymidylate Sythetase , ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen.	**5**
UNIT - II SYNTHESIS OF BIOMOLECULES & INTERPHASE SYSTEMS	**8**

Recombinant Technology, Site-directed mutagenesis, Fusion Proteins. Quantum Dot structures and their integration with biological structures. Molecular modeling tools: Graphic visualization, structure and functional prediction, Protein folding prediction and the homology modeling, Docking simulation and Computer assisted molecular design. Interphase systems of devices for medical implants – Microfluidic systems – Microelectronic silicon substrates – Nano-biometrics – Introduction – Lipids as nano-bricks and mortar: self assembled nanolayers**.**	
UNIT - III FUNCTIONAL PRINCIPLES OF NANOBIOTECHNOLOGY Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials, Bimolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels,ABC Transporters and Bactreriorhodapsin, Bimolecular sensing, Self replication, Machine-Phase Bionanotechnology Protein folding; Self assembly, Self-organization, Molecular recognition and Flexibility of biomaterials.	**7**
UNIT - IV PROTEIN AND DNA BASED NANOSTRUCTURES Protein based nanostructures building blocks and templates – Proteins as transducers and amplifiers of biomolecular recognition events – Nanobioelectronic devices and polymer nanocontainers – Microbial production of inorganic nanoparticles – Magnetosomes .DNA based nanostructures – Topographic and Electrostatic properties of DNA and proteins – Hybrid conjugates of gold nanoparticles – DNA oligomers – Use of DNA molecules in nanomechanics and Computing.	**8**
UNIT - V APPLICATIONS OF NANOBIOTECHNOLOGY Semiconductor (metal) nanoparticles and nucleic acid and protein based recognition groups – Application in optical detection methods – Nanoparticles as carrier for genetic material – Nanotechnology in agriculture – Fertilizer and pesticides. Designer proteins, Peptide nucleic acids, Nanomedicine, Drug delivery, DNA computing, Molecular design using biological selection, Harnessing molecular motors, Artificial life, Hybrid materials, Biosensors, Future of Bionanotechnology	**8**
Total	**36L**

TEXT BOOKS & REFERENCES:

1. C. M. Niemeyer, C. A. Mirkin, ―Nanobiotechnology: Concepts, Applications and Perspectives‖, Wiley – VCH, (2004).
2 T. Pradeep, ―Nano: The Essentials‖, McGraw – Hill education, (2007).
3. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, ‖Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖, Wiley – VCH, (2005).
4. Nicholas A. Kotov, ―Nanoparticle Assemblies and Superstructures‖, CRC, (2006).
5. David S Goodsell, "Bionanotechnology‖, John Wiley & Sons, (2004).

Tissue Engineering
BME 604C, Contacts: 3L, Credit: 3

Course Objective:

This course will provide an overview of cell biology fundamentals, an extensive review on extracellular matrix and basics of receptors, followed by topics on cell-cell and cell-matrix interactions at both the theoretical and experimental levels. Subsequent lectures will cover the effects of physical (shear, stress, strain), chemical (cytokins, growth factors), and electrical stimuli on cell function, emphasizing topics on gene regulation and signal transduction processes. Tissue engineering will be introduced by reviewing tissue structure and function and the clinical need for tissue repair. An overview of scaffold design and processing for tissue engineering will be reviewed and the application of tissue engineering to specialized tissues and organs will then be addressed in depth. Specific organ systems include skin, muscular skeletal system (vascular grafts, blood substitutions, cardiac patch, and heart valve), nervous system (peripheral and central nervous systems), liver, pancreas, and kidney.

Course Outcome:

After completion of this course the students will be able to

1. Demonstrate knowledge of the difference between cells and tissues and understand how complex structures can arise from simpler components.
2. Demonstrate the ability to predict single component fluid properties and changes in thermodynamic variables associated with intercellular processes associated with tissues.
3. Demonstrate understanding of common tissue engineering strategies and known solutions for organ replication.
4. Apply the combined knowledge of tissue organization and common tissue engineering strategies to design a unique, plausible tissue engineering solution.

Topic	No. of Lectures
UNIT I– INTRODUCTION TO TISSUE ENGINEERING Introduction – definitions - basic principles - structure-function relationships –Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies –Tissue Morphogenesis and Dynamics- Stem Cells and Lineages - Cell-Cell Communication	6
UNIT II– TISSUE CULTURE BASICS Primary cells vs. cell lines - sterile techniques – plastics – enzymes - reactors and cryopreservation - Synthetic Biomaterial Scaffolds- Graft Rejection – Immune Responses-Cell Migration-Controlled Drug Delivery- Micro technology Tools	7
UNIT III– SCAFFOLD FORMATION Oxygen transport - Diffusion - Michalies-Menten kinetics - oxygen uptake rates -limits of diffusion - Principals of self assembly - Cell migration - 3D organization and angiogenesis - Skin tissue engineering –Introduction - scar vs. regeneration - split skin graft -apligraft. Engineered Disease Models- Tissue Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring	8
UNIT IV– CARDIOVASCULAR TISSUE ENGINEERING Blood vessels structure - vascular grafts - Liver tissue engineering – Bioartificial liver assist device - shear forces - oxygen transport - plasma effects – Liver tissue engineering - Self-assembled organoids - decelluarized whole livers – Stem cells - basic principle - embryonic stem cells - Induced pluripotent stem cells -Material Biocompatibility - Cell Mechanics - Vascularization- Stem Cell Therapies	7
UNIT V– PATTERNING OF BIOMIMETIC SUBSTRATES Patterning of biomimetic substrates with AFM lithography primarily focusing on DPN-Nanotemplating polymer melts - Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments - Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications -Nanotopography techniques for tissue-engineered scaffolds	8
Total	**36L**

TEXT BOOKS

1. KetulPopat *"Nanotechnology in Tissue Engineering and Regenerative Medicine"* CRC Press Taylor and Francis 2011.
2. Cato T. Laurencin, Lakshmi S *"Nanotechnology and Tissue Engineering: The Scaffold* "CRC Press Taylor and Francis 2008.

REFERENCES

1. Kun Zhou, David Nisbet, George Thouas, Claude Bernard and John Forsythe "*Bio-nanotechnology Approaches to Neural Tissue Engineering*", NC-SA 2010.
2. Nair "*Biologically Responsive Biomaterials for Tissue Engineering",* Springer Series in Biomaterials Science and Engineering, Vol. 1 Antoniac, Iulian (Ed.) 2012.

Electives (OE)

Electrical & Electronic Measurement and Instrumentation

BME (EE) 605A, Contacts: 3L, Credit: 3

Prerequisite:

Knowledge of analog & digital electronics

Course Objective:

1. To familiarize students with basic measurement system & its components
2. To introduce students with characteristics of measuring instruments & errors in measurement
3. To familiarize students with basic electrical measuring instruments
4. To familiarize students basic and advanced electronic measuring instruments
5. To introduce students with PC based instrumentation system and data acquisition system
6. To introduce students with basic optical power measurement system

Course Outcome:

Upon successful completion of this course, the student will be able to:

1. Understand & describe basic measurement systems and their components.
2. Describe the characteristics of instruments and different measurement errors.
3. Describe construction & operation of basic electrical instruments & analyze AC bridge circuits.
4. Understand and describe the configuration & working principle of different electronic instruments for the used in laboratories.
5. Distinguish between analog and digital instruments.
6. Understand and describe the working theory of basic data acquisition system & PC based instrumentation system.
7. Realize the construction & working principle of Optical Power Measurement.

Topic	No. of Lectures
Module1: **General Features:** Measurement systems – Static and Dynamic Characteristics – Units and Standards of measurements, –errors analysis, –moving iron meters, dynamometer, wattmeter– multimeter, – True rms meters– Bridge measurements, Wheatstone Bridge, Kelvin, Wein, Maxwell, Hay, Schering and Anderson Bridges.	8
Module2: **Basic Measurement Concepts:** Electronic Multimeter Current measurement with analog electronic instruments. Chopper stabilized amplifier for measurement of very low voltage and currents. Cathode Ray Oscilloscopes- Block Schematic, Principles and applications. Dual Trace and Dual Beam Oscilloscopes, Digital Storage Oscilloscopes	7
Module3: **Signal Generator and Analysis:** Function Generators- RF Signal Generators- Sweep Generators – Frequency Synthesizer-Wave Analyzer-Harmonic Distortion Analyzer – Spectrum Analyzer	7
Module4: **Digital Instruments:** Comparison of analog & digital techniques- digital voltmeter- mutlimeter – frequency counters-measurement of frequency and time interval – extension of frequency range-measurement errors.	7
Module5: **Data Acquisition Systems:** Elements of digital data acquisition system- interfacing of transducers – multiplexing – computer controlled instrumentation: IEEE 488 BUS. Optical Power Measurement, Optical Time Domain Reflectometer.	7
Total	**36L**

Books:

1. Electronic Instrumentation by H. S. Kalsi. 3rd Ed. Tata McGraw-Hill Education
2. A Course in Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Puneet Sawhney. Dhanpat Rai Publications.
3. Modern Electronic Instrumentation & Measurement Techniques – Albert D. Helfrick & William D. Copper,Prentice Hall of India, 2003
4. Elements of Electornics Instrumentation & Measurement, Pearson Education 2003
5. Measurement System- Application & Design – Ernest O.Doeblin, Tata McGraw Hill 2004

Fuzzy Control & Systems
BME (EE) 605B, Contacts: 3P, Credit: 3

Course Objective:

This course presents some fundamental knowledge of fuzzy sets, fuzzy logic, fuzzy decision making and fuzzy control systems. The aim is to equip graduate students with some state-of-the-art fuzzy-logic technology and fuzzy system design methodologies, thereby better preparing them for the rapidly evolving high-tech information-based financial market and modern industry.

Course Outcome:

After completion of this course the students will be able to

1. Understand basic knowledge of fuzzy sets and fuzzy logic
2. Apply basic knowledge of fuzzy information representation and processing
3. Apply basic fuzzy inference and approximate reasoning
4. Understand the basic notion of fuzzy rule base
5. Apply basic fuzzy system modelling methods
6. Apply basic fuzzy PID control systems
7. Uunderstand the basic notion of computational verb controllers

Topic	No. of Lectures
FUZZY SYSTEMS Classical sets – Fuzzy sets – Fuzzy relations – Fuzzification – Defuzzification – Fuzzy rules-Fuzzy Implications and Approximate Reasoning	8
FUZZY LOGIC AND ITS APPLICATIONS Fuzzy Logic and Its Applications in Artificial Intelligence, Database and Information Systems, Pattern Recognition	10
FUZZY LOGIC CONTROL Membership function – Knowledge base – Decision-making logic – Optimisation of membership function using neural networks – Adaptive fuzzy system – Introduction to genetic algorithm.	8
APPLICATION OF FLC Fuzzy logic control – Inverted pendulum – Image processing – Home heating system – Blood pressure during anesthesia – Introduction to neuro fuzzy controller.	10
Total	**36L**

Text Books

1. Timothy J. Ross, 'Fuzzy Logic with Engineering Applications', Tata McGraw Hill, 1997.
3. John Yen & Reza Langari, 'Fuzzy Logic – Intelligence Control & Information', Pearson Education, New Delhi, 2003.

Reference Books

1. H.J. Zimmermann, 'Fuzzy Set Theory & its Applications', Allied Publication Ltd., 1996.
2. Hao Ying, *Fuzzy Control and Modeling: Analytical Foundations and Applications*, IEEE Press, 2000.
3. Laurance Fausett, Englewood cliffs, N.J., 'Fundamentals of Neural Networks', Pearson Education, 1992.
4. Jacek M. Zurada, 'Introduction to Artificial Neural Systems', Jaico Publishing home, 2002.
5. Simon Haykin, 'Neural Networks', Pearson Education, 2003.

Software Engineering

BME (IT) 605C, Contacts: 3L, Credit: 3

Course Objective:

1. This course helps to understand theories, methods, and technologies applied for professional software development.
2. To define software engineering and
3. Explain its importance
4. To discuss the concepts of software products and software processes

Course Outcome:

After completion of this course the students will be able to

1. The students understands the process to be followed in the software development life cycle
2. Find practical solutions to the problems
3. Solve specific problems alone or in teams
4. Manage a project from beginning to end
5. Work independently as well as in teams
6. Define, formulate and analyze a problem

Topic	No. of Lectures
Introduction 1.1 Software Engineering Process Paradigms 1.2 Process Models – Incremental and Evolutionary models, 1.3 Typical Application for each model, 1.4 Agile methodology 1.5 Process and Project Metrics.	4
Software project scheduling, Control & Monitoring 2.1 Software estimation – Empirical estimation models – Cost/Effort estimation 2.2 Planning – Work breakdown Structure, Gantt Chart. Discuss schedule and cost slippage.	4
Risk Management 3.1 Risk Identification, Risk Assessment, Risk Projection, RMMM	2
Software Configuration Management 4.1 Software Configuration items, SCM process, Identification of objects in software configuration, version and change control, configuration audit , status reporting, SCM standards and SCM issues.	3
Software Design Specification 5.1 Software Design – Abstraction , Modularity 5.1 Software Architecture – Effective modular design, Cohesion and Coupling, Example of code for cohesion and coupling. 5.2 User Interface Design – Human Factors, Interface standards, Design Issues – User Interface Design Process.	6
Software Quality 6.1 Software Quality Assurance – Software standards , Quality metrics Software Reliability ,Quality Measurement and Metrics	3
Software Testing 7.1 Basic concept and terminology, Verification & validation, White Box Testing- Path Testing, Control Structures Testing , DEF-USE testing, 7.2 Black Box Testing –BVA Integration, Validation and system testing. 7.3 OO testing methods-Class Testing, Interclass testing, testing architecture, Behavioral testing. 7.4 Software Maintenance	8
Web Engineering 8.1 For web based applications – attributes, analysis and design, testing. 8.2 Security Engineering, 8.3 Service-Oriented Software Engineering. 8.4 Test Driven Development 8.5 Software engineering with aspects	6
Total	**36L**

Text Books:

1. Roger Pressman, Software Engineering: A Practitioners Approach, (6th Edition), McGraw Hill, 2010

2. Ian Somerville, Software Engineering, 9th edition, Addison Wesley, 2011

Reference Books:

1. Eric J. Braude and Micheal E. Bernstein, Software Engineering Modern Approach, 2nd edition, Wiley, 2011.
2. Ali Behforooz Fredrick Hudson, Software Engineering Fundamentals, Oxford University Press, 2006.
3. James F. Peters and Witold Pedrycz, " Software Engineering – An Engineering Approach", Wiley.
4. Mouratidis and Giorgini. "Integrating Security and Software Engineering – Advances and Future", IGP. ISBN – 1-59904-148-0

PRACTICAL/SESSIONAL PAPERS

Biomedical Equipments Laboratory
BME 691, Contacts: 3P, Credit: 2

Course Objectives:
To provide practice on recording and analysis of different bio potentials, study the function of different therapeutic equipments.

Course Outcomes:
After successful completion of this course the students will be able to

1. Perform and study experiments on Lead selection circuits & pulse rate meter
2. Perform and study experiments on colorimeter/spectrophotometer & flame photometer
3. Perform and study experiments on electronic BP and calibration procedure
4. Perform and study experiments on ultrasonic transmitter and detector
5. Perform and study experiments on pulmonary function analyzer, respiratory rate meter & apnea detection
6. Perform and study experiments on blood flow velocity measurement
7. Perform and study experiments on diathermy unit (ultrasound & short-wave)
8. Perform and study experiments on Pacemaker Circuits / Pacemaker simulator, nerve conduction velocity measuring system

List of experiments:
1. Lead selection circuits
2. Study on pulse rate meter
3. Study on colorimeter/spectrophotometer
4. Study on flame photometer
5. Study on electronic BP and calibration procedure
6. Study of ultrasonic devices - transmitter and detector
7. Study on pulmonary function analyzer - spirometer
8. Study on respiratory rate meter & apnea detection
9. Study on blood flow velocity measurement - ultrasonic method
10. Study on diathermy unit (ultrasound & short-wave)
11. Pacemaker Circuits / Pacemaker simulator
12. Study on nerve conduction velocity measuring system

Microprocessors & Microcontrollers Laboratory
BME 692, Contacts: 3P, Credit: 2
Course Objectives:

To provide practice of programming in assembly language in 8085 microprocessor, 8086 microprocessor as well as 8051 microcontroller. Objective of this course to be familiar with the trainer kit of microprocessor as well as the interfacing with the external peripherals & sensors

Course Outcome
Upon successful completion of this course, the student will be able to:
1. Write the program in assembly language.
2. Familiar with the trainer kit of 8085, 8086 microprocessor kit.
3. Familiar with the simulator of 8085, 8086 microprocessor kit.

4. Interface peripherals and sensors with microprocessor & microcontroller.

List of experiments:

1. Write a program in 8085 microprocessor to swap the content of two register B and C containing the values 08H and 06H respectively.
2. Write a program in 8085 microprocessor to add two number 09H and 08H and store the result in 9085H location and draw the flow chart.
3. Write a program in 8085 microprocessor to subtract 05H from 09H and store the result in 8072H. and draw the flow chart.
4. Write a program in 8085 microprocessor to add five (5) numbers and store the result in memory location 9071H. The numbers are stored from 9061H to 9065H location. The numbers are stored in 5 consecutive memory locations given below and draw the flow chart.
5. Write a program in 8085 microprocessor to multiply 08H with 03H and store the result in 9065H location. and draw the flow chart.
6. Write a program in 8085 microprocessor to multiply FEH with 0FH and store the result in 9074H &9075H memory location and draw the flow chart.
7. Write a program in 8085 microprocessor to divide 07H by 03H and store the quotient in 9075H and reminder in 9076H memory location and draw the flow chart.
8. Write a program in 8085 microprocessor to add six (6) numbers and store the result in memory location 9071H and 9061H.The numbers are stored from 9050H to 9055H location. The numbers are stored in 6 consecutive memory locations given below and draw the flow chart.
9. Write a program in 8085 microprocessor of shifting block of five (5) data from 9055H location to 9080H location and draw the flow chart.
10. Write a program in 8085 microprocessor to count ones (1) in 8 bit data. The 8 bit no. is store in memory location 9070H.Store the counting result in memory location 9080H and draw the flow chart.
11. Write a program in 8085 microprocessor to interchange the nibble of a 8 bit number stored in memory location 9006H and store the interchanged number into memory location 9060H.[for example 78H will be 87H]. 1 nibble= 4 bits
12. In 8086 microprocessor write a program to add two numbers 0465H and 2010H and store the result at different registers and draw the flow chart
13. In 8086 microprocessor write a program to subtract two numbers 0006H from 0009H and store the result at different registers and draw the flow chart

14. In 8086 microprocessor write a program to multiply between 24H and 45H and store the result at different registers and draw the flow chart

15. In 8086 microprocessor write a program to divide 0009H by 0002H and store the quotient and remainder at different registers.

16. Configure 8255 A such that port A and port B as output port. Display the value of 45H through port A and 56H through port B. Execute the program at 8000H and draw the flow chart.

    Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H

17. Configure 8255 A such that port A as an output and port B as input port. Take the input value through DIP switch of Port B. Display the input value though port A. Execute the program at 8000H, and draw the flow chart. Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H

18. Configure 8255 A such that port A as an input and port B as output port. Take the input value through DIP switch of Port A. Display the input value though port B. Execute the program at 8000H, and draw the flow chart. Port A Equ. 80H, Port B Equ. 81H, Control Register Equ. 83H

19. Write a program in 8051 microcontroller to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.
20. Write a program in 8051 microcontroller to send 55h to port 1 and port 2 and check the value of ports and draw the flow chart.
21. Write a program in 8051 microcontroller to multiply 06H by 05H and store the result in RAM address 46H and draw the flow chart.
22. Write a program in 8051 microcontroller to divide 07H by 02H and store the quotient and remainder in two suitable RAM address.

Communication Systems Laboratory
BME 693A, Contacts: 3P, Credit: 2

Course Objective:

To impart the practical knowledge on different analog and digital modulation techniques, multiplexing techniques and their applications

Course Outcome:
After completion of this course the students will be able to

1. Able to Formulate and interpret the presentation and processing of signals in communication systems.
2. Understand the basic concepts of AM, FM, and PM transmission and reception.
3. Assess and evaluate different modulation and demodulation techniques.
4. Evaluate the influence of noise on communications signals.

List of experiments:

1. Measurement of MI of an AM signal
2. Study of SSB modulation and demodulation technique
3. Study of DSB modulation and demodulation technique
4. Measurement of bandwidth of a FM signal
5. Study of phase locked Loop (PLL)
6. Study process of PAM and demodulation technique
7. Study of PCM coder and decoder
8. Study of PSK modulation and demodulation technique
9. Study of FSK modulation and demodulation technique
10. Study of Time Division Multiplexing (TDM) and Demultiplexing

Bionanotechnology Laboratory
BME 693B, Contacts: 3P, Credit: 2

Course Objective:

This course is aimed to provide knowledge on experimental aspects of bionanotechnology

Course Outcome:
After completion of this course the students will be able to

1. Develop nanostructed DNA templates
2. Learn to probe DNA structure with nanoparticles
3. Form fluoro-immoassays using Antibody- conjugated quantum dots
4. Perform surface- functionalization of nanoparticles for controlled drug delivery
5. Develop quantum dot- encoded beads
6. Detect DNA sequence detection using nanoscale ZnO sensor arrays
7. Detect pesticides using electrochemical biosensors membrane-based electrochemical nanobiosensor for Escherichia coli detection

List of experiments:

1. Nanostructed DNA Templates
2. Probing DNA structure with Nanoparticles
3. Fluoro-immoassays using Antibody- conjugated Quantum Dots
4 .Surface- Functionalized Nanoparticles for controlled Drug Delivery
5. Quantum Dot- encoded Beads
6. Ultrasensitive DNA sequence detection using nanoscale ZnO sensor arrays
7. Electrochemical Biosensors for the Detection of Pesticides
8. Membrane-Based Electrochemical Nanobiosensor for Escherichia coli Detection and Analysis of Cells Viability

Tissue Engineering Laboratory
BME 693C, Contacts: 3P, Credit: 2

Course Objective:

This course will train students in advanced cellular and tissue engineering methods that apply physical, mechanical and chemical manipulation of materials in order to direct cell and tissue function. Students will learn the techniques and equipment of bench research including cell culture, immunofluorescent imaging, soft lithography, variable stiffness substrates, application/measurement of forces and other methods. Students will integrate classroom lectures and lab skills by applying the scientific method to develop a unique project while working in a team environment, keeping a detailed lab notebook and meeting mandated milestones.

Course Outcome:
After completion of this course the students will be able to

1. Use of conventional microscopy for the understanding of tissue structure
2. Understand microscopic organization of Tissues into Organs and system
3. Tissue observation and image capture
4. Histology as a diagnostic tool
5. Use of Immunohistochemical techniques

List of Experiments:
Module 1 –
Scaffold Formation and Characterization; Preparation of 2D Collagen Films;
Preparation of 3D Scaffolds;
Preparation of Silk Fibroin scaffold by Salt Leaching Method;
Preparation of Silk Fibroin scaffold by Phase Separation Method;
Preparation of Silk Fibroin scaffold by Electrospinning; Design of 3D scaffold by rapid proto typing technique.;
Characterization of biopolymers and scaffold; Mechanical Strength;
Contact angle measurement;
Pore size & Porosity;
Module 2 –
Cells and Cell Culture; Introduction to Cell Culture lab and aseptic skill;
Use of Biosafety cabinet, CO2 incubators, Microscopes, Sterile Conditions;
Preparation of Cell Culture Media and other supplements & Additives;
Isolation and Culturing of MNCs from Peripheral blood;
Cell counting & cell morphology
Module 3 –
Bioreactors and Integration;
Introduction to type of bioreactors & their operation; (Spinner Flask, Rotating vessel, Perfused Column and Perfused Chamber);
MNC seeding on 2D films and 3D scaffolds;
MNC seeding on 2D & 3D polymer scaffolds by static method;
MNC seeding on 2D & 3D polymer scaffolds by dynamic method;
Culture and cell growth study inbioreactor;
Module-4 –
Cell Survival & Function; Live/Dead Fluorescence Assay;
MTT Viability Test;
Cell Viability Test by Trypan Blue staining method

Group Discussion & Seminar
BME 694, Contacts: 2P, Credit: 1

Hospital Training

4th Year-7th Semester

THEORY PAPERS

Therapeutic Equipments
BME 701, Contacts: 3L, Credit: 3

Pre-requisite knowledge and/or skills: This course requires basic chemistry and physics, physiology, differential equations, control systems, bioinstrumentation knowledge.

Course Objectives:

1. This course will provide to students brief review of physiology and common pathology from an engineering point of view for understanding of therapeutic medical devices.
2. The lectures will focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.
3. To study the concept of various assist devices so as to enable the students to develop new assist devices.
4. To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.
4. To introduce the recent trends in field of diagnostic and therapeutic equipments.
5. This course is also focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.

Course Outcome:

After successful completion of the course the students will be able to

1. Understand and explain the working principle of cardiac pacemakers & defibrillators
2. Understand and explain the working principle of ventilators & anaesthetic system
3. Understand and explain the working principle of physiotherapy & electrotherapy equipments
4. Understand and explain the working principle of surgical diathermy & LASER
5. Understand and explain the working principle of neonatal care & drug delivery systems

Cardiac Pacemakers & Defibrillators:. Effects of electric field on cardiac muscles and laws of stimulation, Need for pacemaker, External pacemakers, Implantable pacemakers and types, codes for pacemakers, Pulse generator and Power sources, Electrodes and leads system, Pacing system analyzers, Programmable pacemakers, Rate-responsive and ventricular synchronous pacemakers, Microprocessor based modern pacemakers, Need for defibrillators, DC defibrillator, Synchronous operation, Implantable defibrillators, defibrillator analyzers and safety.	10L
Ventilators & Anaesthetic system: Artificial ventilations, Ventilators and types, Terminology of ventilators, Classification of ventilators and modern ventilators, Need for anaesthesia, Anaesthesia gases and vapors, Anaesthesia delivery system, Humidifiers, Nebulizers and Aspirators.	6L
Physiotherapy & Electrotherapy Equipments: IR diathermy, UV diathermy, Short wave diathermy, Microwave diathermy, Ultrasonic diathermy, Electrotherapy and different waveforms, Electrode system, Electrical stimulators and types, Nerve-muscle stimulators, Ultrasonic stimulators, Pain relief through electrical stimulators.	7L
Surgical Diathermy & LASER: Principles and applications of surgical diathermy, Electrosurgery machine, electrosurgery circuits, Different electrodes, Electrosurgery techniques, solid state electrosurgery, generator circuits, Testing of Electrosurgery units, electrosurgery safety, Basic principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter, Principle operation of LASER, various application of CO_2, Ar,, He -Ne, Nd – YAG & pulsed ruby LASER, Application of LASER in surgery.	8L
Neonatal Care and Drug Delivery Systems: Baby incubator, radiant warmer and phototherapy unit, Suction apparatus, Infusion pumps, Syringe pumps, Peristaltic pumps, Implantable infusion pumps, Programmable volumetric pumps.	3L
Total	**34L**

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J.Webster, "Bioinstrumentation", Wiley & Sons

References:

1. Joseph Bronzino, " Biomedical Engineering and Instrumentation", PWS Engg . , Boston.
2. Willard Van Nostrand, ".Instrumental Methods of Analysis"-
3. Sharms, "Instrumental Methods", S Chand & Co.
4. Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
5. Jacobson & Websler, " Medicine & Clinical Engg"
6. Leslie Cromwell, " Biomedical Instrumentation and Measurements"

Medical Image Processing
BME 702, Contacts: 3L, Credit: 3

Medical Image Processing

Course Objectives:

1. To introduce the learners the basic theory of digital image processing.
2. To expose learners to various available techniques and possibilities of this field.
3. To understand the basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms.
4. To prepare learners to formulate solutions to general image processing problems.
5. To develop hands-on experience in using computers to process images.
6. To familiarize with MATLAB / C/ Labview/ similar software for processing digital images.

Course Outcomes:
A learners will be able to

1. Acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description.
2. Analyze images in the spatial domain.
3. Analyze images in the frequency domain through the Fourier transform.
4. Design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing.

Digital image fundamentals: Image digitization, sampling and quantization, neighbour of pixels, connectivity, relations, equivalence and transitive closure, distance measures, arithmetic / logic operations, discrete transform, fast Fourier transform, 2-D Fourier transform, inverse Fourier transform.	**8L**
Image enhancement fundamentals: Spatial domain method, frequency domain method, contrast enhancement, histogram processing, image smoothing, image averaging, masking, image sharpening, removing of blur caused by uniform linear motion, enhancement in the frequency domain – low pass, high pass, mean and band-pass filtering.	**10L**
Image restoration fundamentals: Degradation model, discrete formulation, algebraic approach to restoration – unconstrained & constrained.	**4L**
Image compression and segmentation fundamentals: Fidelity criteria, image compression models, lossy and lossless compression technique. Image segmentation: point detection, line detection, edge detection, edge linking and boundary detection.	**10L**
Algorithms used in medical image processing: Brief of reconstruction techniques – algebraic, simultaneous iterative and simultaneous algebraic. Reconstruction algorithm for parallel projections, fan beam projection and back projection. Introduction to various approaches of pattern recognition.	**8L**
Total	**40L**

Text books:

1. Digital image processing by Gonzalez and Woods, 2nd ed., Pearson
2. Digital image processing and analysis by Chanda & Majumdar, PHI
3. Fundamental of digital image processing by Jain, PHI
4. Pattern recognition by Tou and Gonzalez

Artificial Organ & Rehabilitation Engineering
BME 703, Contacts: 3L, Credit: 3

Course Objective

1. To know about various types of assist devices
2. To give a basic idea of the artificial organs that can aid a human to live a normal life.
3. To provide the awareness of how a help can be rendered to a differently abled person

Course Outcome

1. Have knowledge about various types of assist devices.
2. Students will have the ability to choose which type of assist device is suitable for various disorders and legal aspects related to rehabilitation.
3. Students will have the urge to develop new devices based on the basic knowledge gained in different assisting devices

Introduction to artificial organs: Biomaterials used in artificial organs and prostheses, inflammation, rejection, correction. Rheological properties of blood, blood viscosity variation: effect of shear rate, hematocrit, temperature and protein contents. Casson equation, flow properties of blood through the blood vessels, problems associated with extracorporeal blood flow.	**6L**
Artificial kidney: Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney and middle molecule hypothesis. Hemodialysers: flat plate type, coil type and hollow fiber. Analysis of mass transfer in dialyers (cross current & cocurrent flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, separation of antigens from blood in ESRD patients.	**10L**
Artificial 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.	**6L**
Audiometry: air conduction, bone conduction, masking, functional diagram of an audiometer. Hearing aids: different types, receiver amplifiers. Opthalmoscope, retinoscope, I.A.B.P principle and application.	**4L**
Rehabilitation Engineering: Impairments, disabilities and handicaps, Measurement and assessment. Characterizing engineering concepts in sensory and motor rehabilitation. Engineering concept in communication disorders. Rehabs for locomotion, visual, speech & hearing. Artificial limb and hands, prosthetic heart valves. Externally powered and controlled orthotics and prosthetics. Myoelectric hand and arm prostheses. The marcus intelligent hand prostheses, gait study, spinal rehabilitation	**10L**
Total	**36L**

Text / Reference Books:

Hand book of biomedical engineering. Bronzino. Joseph
Hand book of biomedical instrumentation. R.S.Khandpur
Artificial Organs. Erie.D.Blom, Howard.B.Rotham.
Biomedical Engineering Principles (Volume – II). David O. Cooney., Marcel Dekker Inc.
Robbinson C.J., Rehabilitation Engineering. CRC press 1995
Ballabio E.etal, Rehabilitation Engineering. IOS press 1993.

Electives (PE)

Biological Control Systems
BME 704A, Contacts: 3L, Credit: 3

COURSE OBJECTIVE:

- To introduce students to the various biological control systems.
- To equip the students with necessary knowledge on analysis and design parameters of biological control system.
- To impart Knowledge about the application of various regulatory processes in designing a bio control system.
- Develop ability to create simple models of the biological control system.
- The students will get knowledge necessary for students, according to their career goals, to attain acceptance into advanced degree programs.
- Students will be able to develop an ability to apply knowledge of mathematics, science and engineering fundamentals for appropriate solutions to Biological control system.
- Students will be able to develop an ability to identify, analyze a problem, and formulate the requirements appropriate to its solution.
- Develop an ability to design, implement and evaluate a biological control based system to meet desired needs in healthcare.
- Develop an ability to design experiments, as well as to analyze and interpret Biological control system data.
- An ability to use current techniques and modern tools necessary for practice leading to improvised health care.
- An ability to understand health and safety issues through biological control concepts.

COURSE OUTCOME:

- The students will be exposed to familiarity with the types of contributions that this course can provide to society, including improvements in the human condition, and economic stimulation at the local, national, and international levels.
- Learn how to design and interpret experiments, thereby contributing to the creation of new knowledge in the fields of biological control system.
- Develop an awareness of ethical responsibilities when conducting and reporting research in the biological control system and biological regulatory processes.
- An ability to understand environmental considerations and sustainable engineering solutions in Biological Control System.
- Develop an ability to understand professional ethics and legal issues related to Biological Control System and Healthcare Technologies.
- Develop an ability to function effectively as an individual and a member in diverse team.
- Develop an ability to communicate effectively with a range of audiences.
- Develop an ability to understand management principles and apply these to manage projects and finance.
- Develop an ability to engage in continuing professional development for lifelong learning.

Module	Topic	No. of Lectures
Module1	**Introduction:** Technological Control System, Mathematical approaches, System stability, Differences & similarities between biological and engineering control system, Linearization of nonlinear model, Time invariant and time varying systems of Biological control processes.	**10**
Module2	**Process regulation:** Acid – base balance, Extra cellular water and electrolyte balance, Interstitial fluid volume, Blood pressure, Blood glucose, Thermal regulatory system.	**12**
Module3	**Biological control:** Cardiac rate, Respiratory rate, Mass balancing of lungs, Oxygen uptake by RBC and pulmonary capillaries, Oxygen and carbondioxide transport in blood and tissues, Urine formation and control, skeletal muscle servo mechanism and semicircular canal, Endocrine control system.	**12**

	TOTAL	**34**

Text/ Reference Books:

1. Ogata Katsuhika, Modern Control Engineering. 2nd Edition, Prentice Hall of India.
2. Ibrell and Guyton, Regulation and control in physiological system.
3. Milsum Jhon H., Biological control system analysis, Tata McGrow-Hill.
4. Milhom T.H. Saunder. Application of control theory to physiological systems, The University of Chicago Press.

Biotelemetry & Telemedicine
BME 704B, Contacts: 3L, Credit: 3

Course Objective

1. To familiarize students with basic concepts of Biotelemetry & Telemedicine
2. To teach students the application of Biotelemetry & Telemedicine

Course Outcome

After completion of the course the students will be able to

1. Describe basic Telemetry, Biotelemetry & Telemedicine system/ subsystems
2. Explain the application of Biotelemetry & Telemedicine in modern healthcare technology
3. Identify and describe modern telemedical technologies

Module	Topic	No. of Lectures
Module1	**BASICS OF TELEMETRY** Introduction, fundamental of RF telemetry, basic telemetry, system components of coding resolution, pulse code modulation, PCM multiplexing and conversion, PCM data transmission, PCM PSD system. Theoretical comparison of telemetry systems, sub modulation methods, power efficiency of combined systems, practical constraint of telemetry methods optimized power efficiency.	**6**
Module2	**BIOTELEMETRY** Measurement of Blood pressure – Direct Methods and Indirect Methods -Temperature - Respiration rate - Heart rate measurement - Apnea detectors -Oximetry -Pulse oximeter, Ear oximeter - Computerized patient monitoring system– Bedside, Central Monitoring system – Biotelemetry: Basics components, and its different types.	**5**
Module3	**TELEMEDICINE AND HEALTH** History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.	**5**
Module4	**TELEMEDICAL TECHNOLOGY** Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN,POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data – local and centralized.	**4**
Module5	**TELEMEDICAL APPLICATIONS** Telemedicine access to health care services – health education and self care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.	**4**
	TOTAL	**34**

Text Books & References

1. Fundamentals of Remote Sensing – by George Joseph, second Edition, Universities press, 2005
2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003.

3. Rajarao C and Guha S.K. “Principles of Medical Electronics and Bio-medicalInstrumentation”, Universities press (India) Ltd, First Edition, Orient LongmanLtd, 2001.
4. Wootton, R., Craig, J., Patterson, V. (Eds.), “Introduction to Telemedicine. Royal Society of Medicine” Press Ltd, Taylor & Francis 2006
5. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), “Public Health Informatics and Information Systems”, Springer, 2003.
6. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.
7. Simpson, W. Video over IP. A practical guide to technology and applications. Focal Press Elsevier, 2006.
8. Bemmel, J.H. van, Musen, M.A. (Eds.) Handbook of Medical Informatics. Heidelberg, Germany: Springer, 1997.
9. Mohan Bansal, “Medical Informatics”, Tata McGraw-Hill, 2004.

BioMEMs
BME 704C, Contacts: 3L, Credit: 3

Course Objective
This course introduces students to the techniques and applications of microfabrication technology for biomedical applications

Course Outcome
After completion of the course the students will be able to

1. Critically read a scientific paper
2. Manufacture a microdevice by photolithography and micromolding
3. Create protein and cellular micropatterns with a microfluidic device
4. Interface microdevices with cells and tissue
5. Tailor the microenvironment of single cells
6. Manipulate or measure biomolecules on the micron scale

Module	Topic	No. of Lectures
Module1	Introduction to BioMEMS and microfluidics Introduction to Bio nano technology, Biosensors, fluidics. Introduction to device fabrication (Silicon and Polymers) Introduction to device fabrication (Silicon and Polymers) continued. Sensors, Transduction and Performance factors. Sensors, Transduction and Performance factors continued	**4**
Module2	Important materials for fabrication of BioMEMS platforms Introduction to silicon device fabrication Some Fabrication Methods for soft materials Transduction Methods. About cell potential and SHEs Cell reaction, Nernst equation, Construction of Ion selective electrodes Measurement and calibration of electrodes, ion-solvent interaction	**5**
Module3	Design of ISE. Finding selectivity coefficient for a mixed ion system. ISE continued.. Gas sensing electrodes Applications for biosensors in Diagnostics, Zeta potential and the model for electrode. Flow between two fixed plates. Comparison between plug like flow of electro-osmosis Vs parabolic flow. Electro-kinetic flow in silicon channels. Design of electro-kinetic network. Design of electro-kinetic network. Flow rate calculations. Selection of good materials, Streaming potential.	**5**
Module4	Introduction to Cell biology, Basic structure of DNA DNA hybridization, , DNA polymerization, PCR Thermal cycle , Real Time PCR.PCR design Electrophoresis, Gel and Capillary electrophoresis, Agarose DNA microarrays (concepts, and utility). Affymetrix and Nanogen approaches in realization of micro-arrays. DNA sequencing (Sanger’s reaction). DNA nano-pores. DNA detection using Mechanical Cantilevers. Basics of Protein structure.	**4**
Module5	Protein charging at different pH range, Amino acids, protein polymerization, Transcription , Translation Antibody, Microencapsulation, Cyclic voltametry Microfluidics, Similarity of Streamlines, Pathlines, Sreaklines and Timelines for a steady flowStress tensor. Viscosity. Newtonian, non- Newtonian fluids, Pseudoplastic, Dilatant, Bingham Plastic materials, Thixotropic fluids. Flow over infinite plates, laminar and turbulent flow, Compressible and Incompressible flows Flow over an infinite plate. Types of flows. Types of Fluids. Kinematics of fluids	**4**
Module6	Micromixers: Design and mixing principles Microvalves : Designing of pneumatic	**4**

	and thermo pneumatic valves. Hydrogel based valves. Electrochemical valves. Micropumps Microelectronic-fabrication processes: Review of basic fabrication processes for silicon Introduction to microelectronic fabrication, Optical lithography, photo-resists	
Module7	Etching techniques, evaporation and sputtering. Vacuum science and plasmas, Theory of plasma Review of basic fabrication processes for polymers Polymer materials for microsystems, Polymeric micromachining technology. Bulk and surface micro machining, Replication technologies, laser machining, micro-stereo lithography, micro-molding, Assembly and packaging.	**4**
Module8	Photolithography techniques Functionality of Polymer PDMS used in micro technology Additive techniques, Thermal oxidation Single crystalline silicon, Subtractive technique. Overview of Lab-on-chip technology/ biomedical and chemical sensors, specific cases: Integrated gene analysis systems Chip technology (Integrated analysis of pathogenic bacteria), Electrochemical and optical (labeled and unlabeled).	**4**
	TOTAL	**34**

Text Books & References

1. Fundamentals of BioMEMS and Medical Microdevices by Steven S. Saliterman
2. Mauro Ferrari (editor), BioMEMS and Biomedical Nanotechnology: I:Prospectus, Biological and Biomedical Nanotechnology (A. Lee, L. Lee);II: Micro and Nano-Technologies for Genomics and Proteomics (M.Ozkan and M. Heller); III: Therapeutic Micro/Nanotechnology (T. Desaiand S. Bhatia); IV: Biomolecular Sensing, Processing and Analysis (R.Bashid and S. Wereley), Springer, 1st edition, Nov. 30, 2006, ISBN:0387255613
3. Gerald Urban, BioMEMS (Microsystems), Springer, 1st edition, May 5,2006, ISBN: 0387287310.
4. Wanjun Wang, Steven A. Soper, Bio-MEMS: Technologies andApplications, CRC Press, 1st edition, Dec. 15, 2006, ISBN: 0849335329.
5. Ville Kaajakari, Practical MEMS: Design of microsystems, accelerometers,gyroscopes, RF MEMS, optical MEMS, and microfluidic systems, Small Gear Publishing, Mar. 17, 2009, ISBN: 0982299109.
6. Marc J. Madou, From MEMS to Bio-MEMS and Bio-NEMS:Manufacturing Techniques and Applications, CRC Press, 1st edition, Jun.16, 2010, ISBN: 142005516X.
7. Ellis Meng, Biomedical Microsystems, CRC Press, 1st edition, ISBN:1420051229, Sept. 17, 2010.

Electives (OE)

Engineering System Modeling & Simulation
BME(ME) 705A, **Contacts: 3L, Credit: 3**

Course Objectives:
Present concepts of computer-based modeling and simulation applicable to various domains of engineering and science. Provide theoretical concepts, methods, and hands-on experience with object oriented modeling and simulation. Students are expected to gain a solid foundation and associated experience for computer-based tool set for constructing, simulating and analyzing models of complex systems.

Course Outcome:
After completion of the course the students will be able to

1. Understand the major capabilities and commonly encountered limitations of discrete-event simulation for modeling systems that industrial engineers commonly encounter.
2. Formulate a real world problem and select an appropriate analytical technique for modeling and ultimately solving this problem.
3. Use simulation software for model development and analysis.
4. Develop experience with application of statistical data analysis methods for arriving at and supporting design and operations decisions.
5. Build and run simple discrete-event simulation models in practical situations; understand the main assumptions underlying these models; and understand what can happen when these assumptions do not hold.

6. Communicate the results of the modeling process to management and other non-specialist users of engineering analysis.
7. Recognize and deploy methods for influencing and managing project outcomes. Demonstrate how to apply effective project stats using and utilize key performance indicators.

Module	Topic	No. of Lectures
Module1	Introduction to system dynamics; Solution methods for dynamic models; Spring and damper elements in mechanical systems; State-variable models and simulation method	**5**
Module2	Electric and electromechanical systems; System analysis in the frequency domain; Transient response and block diagram models	**6**
Module3	Principles of Modeling and Simulation Modeling and Simulation of Mixed Systems Block Diagram Modeling	**6**
Module4	MIMO: State-Space System Models	**5**
Module5	Constructing and Analyzing First Order Math Models Practical Applications of First Order Math Models	**6**
Module6	Constructing and Analyzing Second Order Math Models Practical Applications of Second Order Math Models	**6**
	TOTAL	**34**

Textbook

1. William J. Palm. System Dynamics. McGraw-Hill, 2ndEdition,2010
2. Mechatronic Systems: Modeling and Simulation with HDL by George Pelz. 2003
3. Mechatronic Systems Design by Shetty 2011
4. Feedback Systems: An Introduction to Scientists and Engineers by Astrom and Muray 2009
5. Automatic Control Systems by Golnaraghi and Kao 2010
6. Modeling of Engineering Systems: PC-based Techniques and Design Tools by Jack Lewis. 2000
7. Mechatronics Handbook Edited by Robert Bishop. 2002
8. Digital Control Systems: Design, Identification and Implementation by Landau and Zito 2006

Recommended References

Katsuhiko Ogata. System Dynamics. Prentice Hall, 2003.

Medical Robotics & Automation
BME(ME) 705B, Contacts: 3L, Credit: 3

Course Objective

1. To introduce the basic concepts, parts of robots and types of robots.
2. To make the student familiar with the various drive systems for robot, sensors and their applications in robots and programming of robots.
3. To discuss about the various applications of robots, justification and implementation of robot.

Course Outcome

The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Module	Topic	No. of Lectures
Module1	**Introductory topics** Introduction to medical robotics (applications and paradigms), Basic kinematics concepts (forward, inverse, remote center of motion), Basic control concepts (impedance, admittance), Surgery for engineers, Interventional radiology for engineers	**7**
Module2	**Minimally Invasive Surgery (MIS)** Human-machine interfaces, Teleoperation, Cooperative manipulation, Port placement for MIS, Robot design concepts, Video images in MIS, Augmented reality, Minimally invasive surgery	**9**

	training	
Module3	**Image-Guided Interventions** Medical imaging modalities (e.g., MRI, US, X-ray, CT), Robot compatibility with medical imagers, Image segmentation and modeling, Tracking devices, Frames and transformations, Surgical navigation, Calibration, Rigid and non-rigid registration, Radio surgery	**9**
Module4	**Applications of medical robotics** Cardiac, abdominal, and urologic procedures with tele-operated robots, Orthopaedic surgery with cooperative robots, Prostate interventions with manual "robots", Robotic catheters for heart electrophysiology	**9**
	TOTAL	**34**

TEXT BOOKS:

1. Deb S. R. and Deb S., "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd, 2010.
2. John J.Craig , "Introduction to Robotics", Pearson, 2009.
3. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.

REFERENCES:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics : Control, Sensing, Vision and Intelligence", McGraw Hill, 1987

Lasers & Optics in Medicine
BME(EC) 705C, Contacts: 3L, Credit: 3

Course Objective:
To study about the principles and applications of laser and fiber optics in medical field especially in diagnosis and therapy.

Course Outcome:
After completion of the course the students will gain in-depth knowledge in the

1. Types of laser systems.
2. Operation of laser systems.
3. Role of laser systems in biomedical applications.

Module	Topic	No. of Lectures
Module1	**LASER Fundamentals:** Characteristics of lasers, spontaneous and stimulated emission of radiation, Einstein's co-efficients, Population Inversion, Three level and four level lasers, Properties of laser,Laser modes, Resonator configuration, Cavity damping, Types of lasers: Gas lasers, solid lasers, liquid lasers, semiconductor lasers.	**6**
Module2	**Lasers in surgery**: Surgical instrumentation of CO2, Ruby, Nd-YAG, He-Ne, Argon ion, Q-switched operations, continuous wave, Quasicontinuous, surgical applications: removal of tumours of vocal chords, brain surgery, plastic surgery, gynaecology and oncology.	**7**
Module3	**Laser application**s: Lasers in tissue welding, lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, Laser flow cytometry, Laser transillumination & diaphanography, Speckle intereferometry, holography - Application Safety with biomedical Lasers.	**7**
Module4	**Optical Fibres Fundamentals:** Principles of light propagation through a fibre, Different types of fibres and their properties, fibre characteristic, transmission of signal in SI and GI fibres, attenuation in optical fibres, Connectors and splicers, Fibre termination, Optical sources, Optical detectors.	**7**
Module5	**Optical Fibre bundles and Applications:** Introduction and construction details of optical fibres, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices-fundamentals & principles, fiberscopes and endoscopes fundamentals, fiber optic imaging systems-advances, optical fiber in communication.	**7**
	TOTAL	**34**

Test Books:

1. Leon Goldman, " The Biomedical laser Technology and Clinical Applications " Springer-Verlar
2. Leon Goldman, " Lasers in Medicine", Springer-Verlac
3. Pratesi E.D.R, and Sacchi, "Lasers in photomedicine and photo biology", Springer-Verlay
4. Basht M.L.Wel, "Laser applications in medicine and biology", Vol I,II,III, Plenum Press (1971 & 1974).
5. Nandini K. Jog, "Electronics in medicine and biomedical instrumentation", PHI
6. Wilson J. U Hawkes J.F.B., Opto Electronics: An Introduction, Prentice Hall Int. 1983
7. Allen H.C, An Introduction to optical fibers, Mc Graw Hill, New York, 1983.

PRACTICAL/SESSIONAL

Medical Instruments & Systems Laboratory
BME 791, Contacts: 3P, Credit: 2

Course Objectives:

1. To familiarize students with different types of medical equipments
2. To make them understand about the working principle of versatile medical equipments
3. To familiarize students with the application of such equipments

Course Outcome
After completion of the course the students will be to

1. Describe different types of medical equipments
2. Explain the working principle of versatile medical equipments
3. Describe the application of such equipments

List of experiments:
1. Study on simulated DC defibrillator
2. Study on muscle stimulator
3. Study on ECG heart rate monitor with alarm system
4. Study on peripheral pulse rate monitor with alarm system
5. Study on digital body/skin temperature monitoring system
6. Study on US Doppler / Foetal monitor
7. Study on hearing aid and audiometer: air and bone conduction
8. Study on EMG biofeedback system
9. Study on ECG simulator and servicing of ECG machine
10. Study on Baby incubator / Infusion pump

Medical Image Processing Laboratory
BME 792, Contacts: 3P, Credit: 2

Course Objectives:
To gain the practical knowledge about the processing of medical images, understand the fundamentals of digital image and it s properties. To enhance the medical images by applying various filters and segment the region of interest using various image processing Algorithms.

Course Outcome
After completion of the course the students will gain

1. Knowledge in the science of medical images and image processing, including mathematical transforms.

2. Knowledge in the techniques of Digital Image Processing, including Image Enhancement in the Spatial and Frequency Domain, Compression, Morphology and Segmentation.

3. Knowledge Current science and technological practice in industry and advanced research topics in this area.

List of experiments:
[Students are required to perform at least EIGHT experiments]

1. Image enhancement – Histogram
2. Image smoothing
3. Image sharpening
4. Point detection
5. Line detection
6. Edge detection
7. Image data compression
8. Image Characterization
9. Vector & Matrix Indexing
10. Fourier Transform
11. Image Transformation
12. Morphological Image Processing

Project Part-I
BME 793, Contacts: 3P, Credit: 2

Industrial Training

4th Year-8th Semester

THEORY PAPERS

Design Concept & Maintenance of Biomedical Instruments
BME801, Contacts: 3L, Credit: 3

Course objectives:

1. To introduce students with fundamentals instrumentation of the equipments used in health care systems
2. To familiarize students with the application and troubleshooting, maintenance and repairing aspects of versatile medical equipments

Course outcome:
After completion of the course the students will be able to

1. Identify various medical equipments used in medical institute/research centers
2. Explain the working theories of medical instruments
3. Show the skills in the view points of maintenance, repairing and troubleshooting of medical equipments

Module	Topic	No. of Lectures
Module1	**Fundamentals of Medical Instrumentation:** Bioelectric Signals and Physiological Transducers. Related Anatomy and Physiology.	**5**
Module2	**Operation, functional circuit details**: Patient Safety, Repair, Service and Maintenance of a range of medical equipment	**6**
Module3	**Mechanical Equipment:** BP Apparatus, Suction Machine and Microscope. Recording and Monitoring Equipment: ECG and EEG Machines, Pulse Oximeter, Cardiac Monitor and Audiometer.	**6**
Module4	**Clinical Lab Equipment:** Colorimeter, Spectrophotometer, Semi-Auto Analyzer, Centrifuge and Oven. Imaging Systems: X-Ray and Ultrasound Machines.	**7**
Module5	**Therapeutic Equipment:** Cardiac Defibrillator, Short wave and Ultrasonic Diathermy. Anesthesia Machine.	**6**
Module6	**Maintenance of pc based medical equipment:** Introduction to - System configuration and BIOS, Indentification & Troubleshooting of PC components viz-Motherboard, HDD, FDD, CD ROM, Monitor, Printers, Modems, Ports etc. Installation and operation of - Windows Operating System, Antivirus Software, Internetworking.	**10**
	TOTAL	**40**

TEXT BOOKS:

1. R. S. Khandpur, Biomedical Instrumentation Technology and Applications, McGraw-Hill Professional, 2004 (UNIT I, II)
2. Raja Rao, C; Guha, S.K, Principles of Medical Electronics and Biomedical Instrumentation, Orient Longman Publishers (2000) (UNIT III, IV & V)

REFERENCE BOOKS:

1. R.Anandanatarajan, "Biomedical Instrumentation", PHI Learning, 2009.
2. John G. Webster, Medical Instrumentation: Application and Design, 3rd edition, John Wiley & Sons, New York, 1998.

Hospital Engineering & Management
BME802, Contacts: 3L, Credit: 3

Course objectives:

- Identify various areas of hospitals.
- Identify various activities of departments like out/in patient and nursing.
- Discuss about critical care departments of hospital like iccu, icu and activities of central sterile supply department.
- Discuss about effective hospital management.
- Maintain various medical records and waste management.
- To prepare a competent workforce of hospital managers who have basic knowledge and skills of efficiently planning, managing and maintaining the physical environment,
- Develop knowledge of hospital building maintenance, equipment and systems for health care.
- Develop knowledge regarding plant operations, clinical engineering, biomedical engineering, safety technology and hospital information system.
- Students shall be well trained to solve the rising challenges and specific necessities of modern day hospitals.

Course outcome:

- Develop an understanding of criteria regarding assessment, management, administration and regulation of healthcare technology.
- Improve the clinical effectiveness, efficiency and safety of technology use, considering the importance and impact of technology on patient care.
- Develop projects with a technological component within a hospital environment.
- Develop improvements and solutions to specific biomedical technology issues.
- Promote better management of information regarding identification of biomedical and hospital technology planning, procurement and operation requirements.
- Interact and network with other healthcare technology managers to know of best practices and solutions for common issues.
- An ability to understand environmental considerations and sustainable engineering solutions in hospital engineering and management.
- Develop an ability to understand professional ethics and legal issues related to hospital engineering and healthcare system.
- Develop an ability to function effectively as an individual and a member in diverse team.

Module	Topic	No. of Lectures
Module1	**Healthcare System:** Health organization of the country, health technology and challenges in maintaining normal health, Indian hospitals- challenges and strategies, modern techniques of hospital management.	**7**
Module2	**Hospital Organization:** Classification of hospital, Hospital- social system, location of hospital, site selection of new hospital, Line services, Supportive services and Auxiliary services of hospital.	**10**
Module3	**Engineering Services of hospital:** Biomedical engineer's role in hospital, Maintenance department, MRO, Clinical engineering preventive maintenance of equipment, Electrical system, Power supply system, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system.	**12**
Module4	**Hospital Management and Information System:** Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system.	**7**
Module5	**Regulation and planning of new hospital:** FDA regulation, ISO certification, Fire protection standard, Planning and designing of new hospital.	**4**
	TOTAL	**40**

Text/ Reference Books:

1. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 1993
2. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z report Eschbom, 1986
3. Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press, 1977.
4. Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979
5. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988

Biomedical Hazards & Safety
BME803, **Contacts: 3L, Credit: 3**

Course objectives:

To impart sufficient information on the various hazards and relevant precautionary and safety measures in healthcare system

Course outcome:
After completion of the course the students will be able to

1. Understand and explain types of hazards in healthcare system
2. Understand the guidelines of precautionary and safety measures in medicine.

Module	Topic	No. of Lectures
Module1	**STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS** Define Quality- Need for Standardization & Quality Management**,** TQM in Health care organization-Quality assurance methods ,QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments	**5**
Module2	**REGULATORY REQUIREMENT FOR HEALTH CARE** FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes	**5**
Module3	**ELECTRICAL & FIRE SAFETY** Sources of shocks, macro & micro shocks -Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire , Action to be taken in case of fire in a Hospital.	**8**
Module4	**RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY** Design and description of NM department- Radiation protection in nuclear industry- Guidelines for radiation protection- Molecular medicine and radiation safety program- procedures for safe operation of radiation equipment- Radiation protection in external beam radiotherapy- Radiation protection in brachytherapy-Radioactive wastes.	**8**
Module5	**LASER AND ULTRAVIOLET RADIATION SAFETY** Classification of UV radiation -Sources of UV- Biological effects of UV- Hazards associated with UV radiation- UV control measures - Safety management of UV Classifications of LASER and its radiation hazards- control measures- Emergencies and incident procedures.	**8**
Module6	**ASSESSING QUALITY HEALTH CARE** Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop‘s – Patient Orientation for Total Patient Satisfaction. 5S techniques	**6**
	TOTAL	**40**

Books:

1. Khandpur R.S., Hand book of Biomedical instrumentation ,TMH
2. Carr & Brown , Introduction to Biomedical Equipment,PHI
3. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.
4. Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.

5. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
6. K.Shridhara Bhat, Quality Management, Himalaya Publishing House.
7. Karen Parsley, Karen Parsley Philomena Corrigan‖ Quality improvement in Healthcare, 2nd edition ,Nelson Thrones Pub, 2002
8. Sharon Myers ―Patient Safety & Hospital Accreditation - A Model for Ensuring Success‖ Springer Publishers 2012
9. Joseph F Dyro ―Clinical Engineering Handbook― Elsevier Publishers, 2004

Electives (OE)

Radiotherapy & Nuclear Medicine
BME 804A, Contacts: 3L, Credit: 3

Course objectives:

To impart sufficient information on Radiotherapy & Nuclear Medicine in healthcare system

Course outcome:
After completion of the course the students will be able to

1. Understand and explain Radiotherapy & Nuclear Medicine in healthcare system
2. Describe the application of Radiotherapy & Nuclear Medicine in healthcare system

Module	Topic	No. of Lectures
Module1	Introduction to physical aspects of radiation therapy and treatment planning; Radiation sources in the Department; Radiation protection	**5**
Module2	Absorption of radiation, Radiation chemistry, Survival curves-theory and experiment, Oxygen effect, Chemical modifiers of Radiation damage, Cell cycle dependence of radio sensitivity, Repair phenomena, Dose Rate effects, Solid tumor radiobiology, Cell and tumor kinetics, Tissue radio sensitivity, Acute and late effects, Partial and Whole Body Radiation, Time, Dose & Fractionation relationships, Biology of Hyperthermia	**7**
Module3	**Radiation detectors:** Construction and Principles of Operation – lonization Chamber – Isotope calibrator – Proportional Counter – Geiger muller counter – Voltage calibration of a Geiger Mueller tube, optimum operating condition – Dead time correction – Uses of Gas – filled detectors – Semiconductor detectors	**7**
Module4	**Statistics of counting:** Types of measurement error, Precision and Accuracy – Nuclear counts statistics – Poison, Normal (Gaussian) distribution – Standard deviation, Probable error, confidence limits, Percent standard deviation – Efficient distribution of counting time. Statistical tests. – Chi – square test – Figure of Merit – test – Precision of Rate meter Measurements.	**7**
Module5	**Basic nuclear medicine techniques:** **Diagnostic – In vitro techniques:** Principles of Radio immunoassays (RIA) standard curve, data analysis, Quality Control(QC) and applications, Methods of receptor assays, hormones , drugs. IRMA Immunoradiometric assay, ELISA, RIA, estimation, T3, T4, TSH, thyroid antibodies, and current applications using similar techniques. **In vivo techniques** - (Imaging & non imaging Procedures) a) General Principles of non-imaging techniques, Tracer dose, uptake studies, compartmental analysis in radio nuclide studies, volume dilution studies. (b) General Principles of scintigraphy: Introduction, imaging modalities, documentation of images, analog\digital images, hard copy, formatter, intensity settings, image resolution and contrast, gray scale, color scale. (c) Clinical Nuclear Medicines - Diagnostic studies.	**12**
	TOTAL	**38**

Text book

1. Meredith, Fundamental Physics of Radiology
2. Faiz M Khan, The physics of Radiation Therapy, Edition 3rd
3. Hall E J, Radiobiology for the Radiologist, 6th Edition.
4. Physics of Nuclear Medicine, - James A. Sorenson & Michael
5. Principles and practice of Nuclear Medicine ,Bruce Sodee, Paul J.Early & Sharon Wikepry

Reference books

1. Nuclear Radiation Detection – William J. Price, McGraw – Hill Book Company
2. Principles of Nuclear Medicine – Henry N. Wagner, W.B. Saunders company, London
3. Principles and practice of Nuclear Medicine, Paul J. Early, D. Bruce Sodes. C.V. Mosby company Princeton
4. Instrumentation in Nuclear Medicine – Gerald J. Hine
5. Essentials of Nuclear Medicine, M.V.Merrick
6. Basic Science of Nuclear Medicine,Roy P Parker, Peter A S Smith & David Churchill Livingston, New York 35
7. Essentials of Nuclear Medicine Imaging ,Fred A Metter, Milton J W B Saunders company, London
8. Principles of Nuclear Medicine Henry N Wagner:W B Saunders company, London
9. Clinical Nuclear Medicine M N Masey, K E Britton & D L Gilday, Chapman and Hall medicals
10. Nuclear Medicine Technology & Techniques -Donald R. Bernier , Paul E. Christian & James K. Langan Mosby

Bioinformatics
BME 804B, Contacts: 3L, Credit: 3

Course objectives:
The student should be made to:

1. Expose to the need for Bioinformatics tools
2. Be familiar with the modeling techniques
3. Learn microarray analysis
4. Expose to Pattern Matching and Visualization

Course outcome:
Upon Completion of the course, the students will be able to

1. Develop models for biological data
2. Apply pattern matching techniques to bioinformatics data – protein data genomic data.
3. Apply micro array technology for genomic expression study

Module	Topic	No. of Lectures
Module1	**INTRODUCTION** Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics - Biological Data Integration System.	**6**
Module2	**DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS** Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics	**6**
Module3	**MODELING FOR BIOINFORMATICS** Hidden markov modeling for biological data analysis – Sequence identification –Sequence classification – multiple alignment generation – Comparative modeling –Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks - Molecular modeling – Computer programs for molecular modeling.	**8**
Module4	**PATTERN MATCHING AND VISUALIZATION** Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization –Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension – Game representation of Biological sequences – DNA, Protein, Amino acid sequences.	**8**
Module5	**MICROARRAY ANALYSIS** Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model - Benchmark – Tradeoffs	**8**
	TOTAL	**36**

TEXT BOOK:

1. Yi-Ping Phoebe Chen Edition, "BioInformatics Technologies", First Indian Reprint, Springer Verlag, 2007.

REFERENCES:

1. Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2003.
2. Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Oxford University Press, 2005

Body Area Networks
BME 804C, Contacts: 3L, Credit: 3

Course objective:

The student should be made to:

1. Learn about body area networks' and different hardwares related to it
2. Provide knowledge in the applications of Body Area Networks.

Course outcome:

At the end of the course, the student should be able to:

1. Explain about working of Body Area Network
2. Discuss the applications of BAN.

Module	Topic	No. of Lectures
Module1	**INRODUCTION TO BAN** Introduction to Body Area Network (BAN)-Standard-Architecture-BAN layers-Drawback of BAN.	**6**
Module2	**HARDWARE DEVELOPMENT AND SYSTEM FOR BAN** Wireless body sensors-Sensor nodes and hardware designs-Wireless systems and platforms-Wireless transceivers and microcontrollers-Existing sensor boards-Design of implanted sensor nodes for WBAN-WBAN (Wireless Body Area Network) Systems-Software programs and monitoring.	**7**
Module3	**NETWORK AND MAC PROTOCOL DESIGN FOR WBAN** Network topologies and configuration-Basics of MAC protocol-Traffic characteristics-Scheduled protocol-Random access protocol-Hybrid MAC protocol-Energy management in WBAN-Performance analysis of WBAN.	**7**
Module4	**ANTENNA DESIGN AND PROPAGATION FOR WBAN** Introduction-Antenna gain, Return loss, Efficiency, Reciprocity-Miniaturized Antennas-Implanted Antennas-Volume Conduction Antennas.	**7**
Module5	**ULTRA WIDEBAND FOR WBAN** Introduction-Advantages and limitations of UWB for WBAN-UWB hardware development-PHY layer for UWB WBAN-UWB WBAN Application-Design and Implementation of an UWB - WBAN System.	**7**
	TOTAL	**34**

REFERENCES

1. Huan-Bang Li, Kamya Yekeh Yazdandoost Bin-Zhen, "Wireless Body Area Networks",River Publishers, 2010.
2. Muhannad Quwaider Subir Biswas, "Wireless Body Area Networks"
3. Mark Andrew Hanson, Amy Nicole Miller, "Wireless Body Area Sensor Network Technology For Motion Based Health Assessment"
4. Mehmet Rasti Yuce, Jamil Y.Khan, "Wireless Body Area Network:Technology, Implementation And Application"

PRACTICAL/SESSIONAL
Seminar
BME 891, Contacts: 3P, Credit: 2

Project Part-II
BME 892, Contacts: 3P, Credit: 4

Grand Viva
BME 893, Credit: 2