Regulation - R18

Curriculum Structure & Syllabus

for

B.TECH

in

BIOMEDICAL ENGINEERING

(Effective from 2018-19 admission batch)

Issued by

JIS COLLEGE OF ENGINEERING
(AUTONOMOUS)
Kalyani, West Bengal-741235

Department: Biomedical Engineering
Curriculum Structure & Syllabus
(Effective from 2018-19 admission batch)

Under Autonomy (**GR A:** ECE, EE, EIE, BME; **GR B:** CSE, IT, ME, CE, FT)

1st Semester								
Sl No	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours /Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	M 101	Mathematics -I	3	1	0	4	4
2	BS	CH 101/ PH 101	Chemistry (Gr. A)/ Physics- I (Gr. B)	3	0	0	3	3
3	ES	EE 101/ EC 101	Basic Electrical Engineering (Gr.A) / Basic Electronics Engineering (Gr. B)	3	0	0	3	3
4	HU	HU 101	English	2	0	0	2	2
Total of Theory							**12**	**12**
B. PRACTICAL								
5	BS	CH 191	Chemistry Lab	0	0	3	3	1.5
6	ES	EE 191/ EC 191	Basic Electrical Engineering Lab (Gr.A)/ Basic Electronics Engineering (Gr. B)	0	0	3	3	1.5
7	ES	ME 191/ ME 192	Engineering Graphics & Design (Gr A) / Workshop/Manufacturing Practices (Gr-B)	0	0	3	3	1.5
8	PROJ	PR191	Project-IA	0	0	1	1	0.5
9	PROJ	PR192	Project-IB	0	0	1	1	0.5
C.MANDATORY COURSE/ACTIVITY								
10	MC	MC 181	Induction Program	0	0	0	0	
Total of Theory, Practical & Mandatory Course/Activity							**23**	**17.5**

Course Name: Mathematics-I

Course Code: M 101
Contact: 3:1:0
Total contact Hours: 48
Credit: 4

Prerequisite:

The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra and calculus.

Course Outcome:

COs	DESCRIPTIONS
CO1	Recall the distinctive characteristics of matrix algebra and calculus.
CO2	Understand the theoretical working of matrix algebra and calculus.
CO3	Apply the principles of matrix algebra and calculus to address problems in their disciplines.
CO4	Examine the nature of system using the concept of matrix algebra and calculus.

Course Content:

Module I: Matrix Algebra (11)

Echelon form and Normal (Canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton theorem.

Module II: Differential Calculus and Infinite Series (10)

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Concept of sequence and series, Tests for convergence of infinite series: Comparison test, D'Alembert's ratio test, Raabe's test, Cauchy's root test, Power series; Taylor's series, Series for exponential, trigonometric and logarithm functions.

Module III: Multivariable Calculus (Differentiation) - I (9)

Function of several variables, Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; Chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function, Jacobian.

Module IV: Multivariable Calculus (Differentiation) - II (7)

Maxima and minima of functions of two variables, Method of Lagrange multipliers; Directional derivatives, Gradient, Divergence, Curl.

Module V: Integral Calculus (11)

Evolutes and involutes; Evaluation of definite integrals and its applications to evaluate surface areas and volumes of revolutions; Improper integrals; Beta and Gamma functions and their properties.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
3. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
4. Poole, D., Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
5. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
6. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969

CO-PO Mapping:

PO / COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1
CO4	2	3	1	-	-	-	-	-	-	-	-	1

Course Name: Chemistry

Course Code: CH 101
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite: A basic knowledge in 10+2 science with chemistry

Course Outcome:

CO 1: Able to describe the fundamental properties of atoms & molecules, atomic structure and the periodicity of elements in the periodic table

CO 2: Able to apply fundamental concepts of thermodynamics in different engineering applications.

CO 3: Able to apply the knowledge of water quality parameters, corrosion control & polymers to different industries.

CO 4: Able to determine the structure of organic molecules using different spectroscopic techniques.

CO 5: Capable to evaluate theoretical and practical aspects relating to the transfer of the production of chemical products from laboratories to the industrial scale, in accordance with environmental considerations

Course Content:

9

Module-I: Inorganic Chemistry

Atomic structure (5 Lectures)
Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers, Introduction to the concept of atomic orbitals, diagrams of s, p and d orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation, introduction to Schrodinger equation.
Periodic properties (4 Lectures)
Modern Periodic table, group trends and periodic trends in physical properties: electron affinity, electronegativity, polarizability, oxidation states, effective nuclear charges, penetration of orbitals, variations of s, p and d orbital energies of atoms.

Module-II: Physical Chemistry

8

Use of free energy in chemical equilibria (6 lectures)
Thermodynamic functions: internal energy, enthalpy, entropy and free energy. 2nd Law of Thermodynamics, Estimations of entropy and free energies, Free energy and emf, Cell potentials, the Nernst equation and applications.
Real Gases (2 lectures)
Reason for deviation of real gases from ideal behaviour, Equations of state of real gases, Vander Waals' equation, pressure & volume correction, validity, critical state of gas.

Module III: Organic Chemistry

8

Stereochemistry (4 lectures)
Representations of 3 dimensional structures, Chirality, optical activity, isomerism, structural isomerism, stereoisomers, enantiomers, diastereomers, configurations (D,L & cis trans), racemisation.
Organic reactions (4 lectures)
Concepts of inductive effect, resonance, hyperconjugation, introduction to reactions involving substitution, addition, elimination, oxidation (Baeyer villiger oxidation), reduction (Clemmensen

reduction, Wolff-Kishner reduction)

Module IV: Industrial Chemistry 8

Water (2 lectures)
Hardness, alkalinity, numerical
Corrosion. (2 lectures)
Types of corrosion: wet & dry, preventive measures
Polymers (3 lectures)
Classification of polymers, conducting polymers, biodegradable polymers
Synthesis of a commonly used drug molecule. (1 lecture)
Paracetamol, Aspirin

Module V: Spectroscopic techniques in Chemistry 3

Electromagnetic radiation, Principles of spectroscopy, spectrophotometer, infrared spectroscopy, fingerprint region, functional group region, UV-VIS spectroscopy, 1H Nuclear magnetic resonance spectroscopy, chemical shift

Text Books

1.A Text Book of Organic Chemistry, Arun Bahl & Arun Bahl
2.General & Inorganic Chemistry, P.K. Dutt
3.General & Inorganic Chemistry, Vol I, R.P. Sarkar
4.Physical Chemistry, P.C. Rakshit

Reference Books

1.Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane (iii)Fundamentals of
2. Molecular Spectroscopy, by C. N. Banwell
3.Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
4.Physical Chemistry, by P. W. Atkins
5.Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition
6.http://bcs.whfreeman.com/vollhardtschore5e/default.asp

CO- PO Mapping:

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

Course Name: Basic Electrical Engineering
Course Code: EE101
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Pre-requisite:

Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

Course Outcome:

After completion of the course students able to

CO1: Understand Basic Electrical circuits, Power distribution and Safety measures.

CO2: Analyze an apply DC network theorems.

CO3: Analyze and apply concept of AC circuits of single-phase and three-phase.

CO4: Analyze and apply concepts of AC fundamentals in solving AC network problems.

CO5: Understand basic principles of Transformers and Rotating Machines.

Course Content:

Module I: DC Circuits (9L)

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, active and passive elements, Kirchhoff's laws, Source equivalence and conversion, Network Theorems - Superposition Theorem, Thevenin's Theorem, Norton Theorem, Maximum Power Transfer Theorem, Star-Delta Conversions.

Module II: AC Fundamentals (9L)

Sinusoidal quantities, Average and RMS values, peak factor, Form factor, Phase and Phase difference, concept of phasor diagram, V-I Relationship in R, L, C circuit, Combination R-L-C in series and parallel circuits with phasor diagrams, impedance and admittance, impedance triangle and power triangle, Power factor, concept of resonance, Power in AC circuit, simple problems (series and parallel circuit only), Three-phase balanced circuits, Concept of three-phase power measurement.

Module III: Single-Phase Transformer (5L)

Brief idea on constructional parts, classifications, working principle. Problems on EMF equation. Phasor diagram, Equivalent circuit.

Module IV: Electrical Rotating Machines (8L)

a) DC Machines (4L)

Brief idea on constructional features, classifications, working principle of both motor and generator. Simple problems on Voltage equation.

b) Three-Phase Induction Motor (4L)

Basic concept of three phase circuit and production of rotating magnetic field. Working principle of three-phase induction motor and torque-speed characteristics (concept only). No numerical problem.

Module V: General Structure of Electrical Power System (1L)

Power generation to distribution through overhead lines and underground cables with single line diagram.

Module VI: Electrical Installations (4L)

Earthing of Electrical Equipment, ideas of basic components- MCB, MCCB, ELCB, SFU, Megger.

Text books:

1. D. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.
2. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
3. Ashfaq Hussain, Basic Electrical Engineering, S. Chand Publication.
4. Chakrabarti,Nath & Chanda, Basic Electrical Engineering, TMH.
5. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education**.**

Reference books:

1. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
2. V. D. Toro, "Electrical Engineering Fundamentals", Printice Hall India, 1989.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	2	-	-	-	2	2	1
CO2	2	3	-	-	-	-	-	-	-	-	1	1
CO3	2	3	1	-	-	-	-	-	-	-	1	1
CO4	1	2	3	1	-	-	-	-	-	-	-	1
CO5	3	-	-	-	-	-	-	-	-	-	-	1

Course Name: ENGLISH
Course Code: HU 101
Contact: 2:0:0
Total Contact Hours: 24
Credits: 2

Prerequisite: The course presupposes a high school level knowledge of English grammar, punctuation, and elementary to intermediate reading and writing skills.

Course Outcome:

CO1: ble to comprehend the basic knowledge of communication skills in English through exposure to communication theory and practice.
CO2: pply the basic grammatical skills of the English language through intensive practice.
CO3 ble to develop listening and writing skills.
CO4: ble to write Official Letters , Technical report, memo, notice, minutes, agenda, resume, curriculum vitae.
CO5: Able to apply /illustrate all sets of English Language and Communication skills in creative and effective ways in the professional sphere of their life.

Course Content:

Module 1: Communication in a Globalized World **4L**
1.1 Definition, Process, Types of Communication
1.2 Verbal and Non-Verbal Communication
1.3 Barriers to Communication
1.4 Workplace Communication

Module 2: Functional Grammar **4L**
2.1Articles, Prepositions and Verbs
2.2 Verb-Subject Agreement
2.3 Voice, Modality and Modifiers
2.4 Direct and Indirect Speech
2.5 Common Errors in English

Module 3: Vocabulary and Reading **6L**
3.1 Word Roots, Prefixes and Suffixes
3.2 Antonyms, Synonyms and one word Substitution
3.3 Reading—Purposes and Skills (Skimming, Scanning & Intensive Reading)
3.4 Reading Comprehension (Fictional and Non-fictional prose)

Module 4: Professional Writing **10L**
4.1Writing Functions: Describing, Defining, Classifying
4.2 Structuring—coherence and clarity
4.3 Business Writing—Letters (Enquiry, Order, Sales, Complaint, Adjustment, Job Application letters), Memos, Notices, Circulars, Agendas and Minutes of Meetings).
4.4 E-mails—types, conventions, jargons and modalities.
4.5 Reports and Proposals
4.6 Précis writing

4.7 Essay writing
4.8 Punctuation and its importance in writing
4.9 Writing for an Audience

Text Books:

1.Ruskin Bond: The Night Train at Deoli
2.Khushwant Singh: The Portrait of a Lady
2.Roald Dahl: Lamb to the Slaughter
3.Somerset Maugham: The Man with the Scar
4.Anne Frank: The Diary of a Young Girl (Letters of 3rd February 1944, 12th February 1944 and 13th February 1944)
5.Jawaharlal Nehru: "How Britain Ruled India" (Glimpses of World History, Chap 112)

Reference Books:

1.Raymond Murphy. *English Grammar in Use*. 3rd Edn. CUP, 2001.
2. A. J Thomson and A. V. Martinet. *A Practical English Grammar* Oxford: OUP, 1980.
3. Michael Swan. *Practical English Usage*. Oxford: OUP, 1980.
4. Simeon Potter. *Our Language*. Oxford: OUP, 1950.
5. Pickett, Laster and Staples. *Technical English: Writing, Reading & Speaking*. 8th ed. London: Longman, 2001.
6. Ben Heasley and Liz Hamp-Lyons. *Study Writing*. Cambridge: CUP, 2006.

CO-PO Mapping:

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

Course Name: Chemistry Lab
Course Code: CH 191
Contact: 0:0:3
Total Contact Hours: 24
Credits: 1.5

Prerequisite: 10+2 science with chemistry

Course Outcome:

CO1: Able to operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
CO2: Able to work as an individual also as a team member
CO3: Able to analyse different parameters of water considering environmental issues
CO4: Able to synthesize nano and polymer materials.
CO5: Capable to design innovative experiments applying the fundamentals of chemistry

List of Experiments:

9

1. To determine the alkalinity in given water sample.
2. Redox titration (estimation of iron using permanganometry)
3. To determine calcium and magnesium hardness of a given water sample separately.
4. Preparation of phenol-formaldehyde resin (Bakelite).
5. Heterogeneous equilibrium (determination of partition coefficient of acetic acid between n-butanol and water).
6. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
7. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
8. Determination of dissolved oxygen present in a given water sample.
9. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution).
10. Beyond syllabus experiment: Preparation of silver nano-particles.
11. Innovative experiments

Text Books

1.A Text Book of Organic Chemistry, Arun Bahl & Arun Bahl
2.General & Inorganic Chemistry, P.K. Dutt
3.General & Inorganic Chemistry, Vol I, R.P. Sarkar
4.Physical Chemistry, P.C. Rakshit

Reference Books

1.Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane (iii)Fundamentals of
2. Molecular Spectroscopy, by C. N. Banwell
3.Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishnan
4.Physical Chemistry, by P. W. Atkins
5.Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition
6.http://bcs.whfreeman.com/vollhardtschore5e/default.asp

CO- PO Mapping:

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

Course Name: Basic Electrical Engineering Lab
Course Code: EE191
Contact: 0:0:3
Credits: 1.5

Pre requisite:

Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

Course Outcome:

CO1	Identify and use common electrical components.
CO2	To develop electrical networks by physical connection of various components and analyze the circuit behavior.
CO3	Apply and analyze the basic characteristics of transformers and electrical machines

List of Experiments:

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Verification of Thevenin's and Norton's Theorem.
3. Verification of Superposition and Maximum Power Transfer Theorem.
4. Characteristics of Fluorescent, Tungsten and Carbon filament lamps.
5. Study of R-L-C series circuit.
6. Three-phase Power measurement with two wattmeter method.
7. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
8. Measurement of primary and secondary voltage and current of single-phase transformer – Open Circuit and Short Circuit Test.
9. Starting, Reversing and speed control of DC shunt motor.
10. Torque-Speed characteristics of DC Machine.
11. Torque-Speed characteristics of Three-phase Induction Motor.
12. Test on single-phase Energy Meter.
13. Innovative experiments

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	-	-	-	-	1
CO2	2	3	-	-	-	-	-	-	-	-	1	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1

Course Name: Engineering Graphics & Design
Course Code: ME 191
Contact: 0:0:3
Credits: 1.5

Prerequisite: Basic knowledge of geometry

Course Outcome:
CO1: Get introduced with Engineering Graphics and visual aspects of design.
CO2: Know and use common drafting tools with the knowledge of drafting standards.
CO3: Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints.
CO4: Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.

List of Drawing:
Traditional Engineering Graphics:
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning & Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing
Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic & Isometric Projections
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module 3: Sections and Sectional Views of Right Angular Solids
Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only)

Computer Graphics:
Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics
Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering
Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerancing; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, Changing line lengths (extend/lengthen); Printing documents; Drawing sectional views of solids and project the true shape of the sectioned surface; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and non parametric solid, surface and wireframe modeling, Part editing and two dimensional documentation of models.

Module 6:

Demonstration of a simple team design project

Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, Use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
2. (Corresponding set of) CAD Software Theory and User Manuals

Reference Books:

1. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	1	-	1	1	-	1	2	1	-	-
CO2	2	1	2	-	1	1	-	2	1	2	1	1
CO3	2	1	3	2	3	-	-	2	2	2	1	1
CO4	2	1	3	3	3	1	1	2	2	2	2	2

DETAILED SYLLABUS FOR 2nd SEMESTER

2nd Semester								
Sl No.	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours /Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	M 201	Mathematics -II	3	1	0	4	4
2	BS	CH 201/ PH 201	Chemistry - (Gr. B) / Physics – I (Gr. A)	3	0	0	3	3
3	ES	EE 201/ EC 201	Basic Electrical Engineering (Gr. B) / Basic Electronics Engineering (Gr. A)	3	0	0	3	3
4	ES	CS 201	Programming for Problem Solving	3	0	0	3	3
5	ES	ME 201	Engineering Mechanics	3	0	0	3	3
Total of Theory							**16**	**16**
B. PRACTICAL								
6	ES	CS291	Programming for Problem Solving Lab	0	0	3	3	1.5
7	BS	CH 291/ PH 291	Chemistry Lab (Gr. B) / Physics - I Lab (Gr. A)	0	0	3	3	1.5
8	ES	EE 291/ EC 291	Basic Electrical Engineering Lab (Gr. B) / Basic Electronics Engineering Lab (Gr. A)	0	0	3	3	1.5
9	ES	ME 291/ ME 292	Engineering Graphics & Design (Gr B) / Workshop/Manufacturing Practice (Gr-A)	0	0	3	3	1.5
10	HS	HU 291	Language Lab	0	0	2	2	1
11	PROJ	PR 291	Project-II	0	0	1	1	0.5
12	PROJ*	PR 292	Innovative Activities-I	0	0	0	0	0.5
C.MANDATORY COURSE/ACTIVITY								
13	MC	MC 281	NSS/ NCC/ Physical Activities/Meditation & Yoga/Photography/ Nature Club	0	0	0	3	
Total of Theory, Practical & Mandatory Course/Activity							**34**	**24**

* Inter/ Intra Institutional Activities viz; Training with higher Institutions; Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions etc.; Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop; Working in all the activities of Institute's Innovation Council for eg: IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc. (evaluation by Programme Head through certification).

Innovative activities to be evaluated by the Programme Head/ Event coordinator based on the viva voce and submission of necessary certificates as evidence of activities.

Course Name: Mathematics - II
Course Code: M 201
Contact: 3:1:0
Total Contact Hours: 48
Credits: 4

Prerequisite:

The students to whom this course will be offered must have the concept of (10+2) standard calculus.

Course Outcome:
On successful completion of the learning sessions of the course, the learner will be able to:

CO1:	Use mathematical tools to evaluate multiple integrals and vector integrals
CO2:	Apply effective mathematical tools for the solutions of ordinary differential equations that model physical processes.
CO3:	Recall the properties of Laplace Transform to evaluate multiple integrals and their usage
CO4:	Understand the concept of Laplace transform to solve ordinary differential equations.

Course Content:

Module I: Multivariable Calculus (Integration): (12 Lectures)

Double integration, Change of order of integration in double integrals, Triple integrals, vector line integrals, scalar surface integrals, vector surface integrals, Green's theorem, Gauss divergence theorem and Stokes' theorem.

Module II: First Order Ordinary Differential Equations (ODE): (10 Lectures)

Solution of first order and first degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation, Solution of first order and higher degree ODE: solvable for p, solvable for y solvable for x and Clairaut's equation.

Module III: Second Order Ordinary Differential Equations (ODE): (12 Lectures)

Solution of second order ODE with constant coefficients: C.F. & P.I., Method of variation of parameters, Cauchy-Euler equations, Reduction of 2nd order ODE to a pair of first order ODEs, Solution of simultaneous linear ODEs.

Module IV: Laplace Transform (LT): (14 Lectures)

Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $t\,f\,(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of f (t), LT of $\int f(t)dt$, 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.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.

Reference Books:

6. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.

7. Boyce, W. E. and DiPrima, R. C., Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
8. Ross, S. L., Differential Equations, 3rd Ed., Wiley India, 1984.
9. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.
10. Coddington, E. A., An Introduction to Ordinary Differential Equations, Prentice Hall, India, 1995.

CO-PO Mapping:

POs / COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1	3	2	2	-	-	-	-	-	-	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	1
CO3	2	2	-	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Course Name: Physics –I
Course Code: PH 201
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Pre requisite: Knowledge of Physics up to 12th standard.

Course Outcome

At the end of the course students should be able to

CO1: Describe various types mechanical resonance and its electrical equivalence
CO2: Explain basic principles of Laser, Optical fibers and various types of semiconductors
CO3: Apply superposition to explain interference and diffraction as well as apply wave mechanics to attainment of Heisenberg's uncertainty principle
CO4: Analyze importance of light as a carrier of information and examine different crystallographic structures according to their co-ordination number and packing factors
CO5: Justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics

Course Content:

Module 1: Waves & Oscillations (6L)

Simple Harmonic Motion (only preliminary idea), damped harmonic motion-over damped, critically damped and under damped motion, energy decay, logarithmic decrement, force vibration and resonance (amplitude, velocity resonance), sharpness of resonance, quality factor, related numerical problems. 6L

Module 2: Classical Optics (8L)

Interference of light: Huygens's principle, superposition of waves, conditions of sustained interference, Newton's ring (qualitative descriptions of working principles and procedures-no deduction required). Engineering applications, Numerical Problems.

3

Diffraction of light: Fresnel and Fraunhofer class, Fraunhoffer diffraction of a single slit, multiple slits, intensity distributions, missing order, Rayleigh criterion (no deduction) and resolving power of grating and microscope (no deduction), related numerical problems. 5L

Module 3: Quantum Mechanics-I (8L)

Quantum Theory: Inadequacy of classical physics and its modifications by Planck's quantum hypothesis-qualitative (no deductions), particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment.

4L

Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions; uncertainty principle, relevant numerical problems.

4L

Module 4: Solid State Physics-I (7L)

Crystal Structure: Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices –Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 4L

Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. 3L

Module 5 : Modern Optics-I (7L)

Laser: Concepts of various emission and absorption process, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser. 5L

Fibre optics-Principle and propagation of light in optical fibres- Numerical aperture and Acceptance angle, Numerical problems. 2L

Text Books:

Waves & Oscillations:

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. A text book of Light- K.G. Mazumder & B.Ghoshs, (Book & Allied Publisher)
6. Physics of Oscillations and Waves- R.P. Singh
7. College Physics Vol. II - A.B. Gupta
8. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:

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
7. Physical Optics Möler
8. Optics -F.A. Jenkins and H.E White

Quantum Mechanics-I

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics-Bagde and 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)
7. Quantum mechanics -A.K. Ghatak and S Lokenathan
8. Modern Physics -E.E. Anderson
9. Physics Volume 2 -Haliday, Resnick & Krane Published by Wiley India

Solid State Physics-I:

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 and Nurul Islam (Book & Allied Publisher)
6. Problem in Solid state physics -S.O. Pillai (a. b.)

Reference Books:

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. Perspective & Concept of Modern Physics -Arthur Baiser
4. Principles of engineering physics – Md. N Khan and S Panigrahi.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	-	-	-	-	-	-	-	-	-	-	2
CO2	**3**	-	-	-	-	-	-	-	-	-	-	2
CO3	**3**	2	-	-	-	-	-	-	-	-	-	1
CO4	2	**3**	-	-	-	-	-	-	-	-	-	1
CO5	1	**3**	-	-	-	-	-	-	-	-	-	**1**

Course Name: Basic Electronics Engineering
Course Code: EC 201
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite: A basic course in Electronics and Communication Engineering Progresses from the fundamentals of electricity, direct current (DC) devices and circuits, series and parallel circuits to the study of active and passive components, Ohm's Law, Kirchhoff's Law i.e. KVL, KCL, Ampere's Law etc.

Course Outcome:

CO1: Study PN junction diode, ideal diode, diode models and its circuit analysis, application of diodes and special diodes.

CO2: Learn how operational amplifiers are modelled and analysed, and to design Op-Amp circuits to perform operations such as integration differentiation on electronic signals.

CO3: Study the concepts of both positive and negative feedback in electronic circuits.

CO4: Develop the capability to analyse and design simple circuits containing non-linear elements such as transistors using the concepts of load lines, operating points and incremental analysis.

Course Content:

Module-I: Basics of semiconductor **5**

Conductors, Insulators, and Semiconductors- crystal structure, Fermi Dirac function, Fermi level, E-k and Energy band diagrams, valence band, conduction band, and band gap; intrinsic, and extrinsic (p-type and n-type) semiconductors, position of Fermi level in intrinsic and extrinsic semiconductor, drift and diffusion current – expression only (no derivation) , mass action law , charge neutrality in semiconductor, Einstein relationship in semiconductor , Numerical problems on- Fermi level, conductivity, mass action law, drift and diffusion current .

Module-II: P-N Junction Diode and its applications **7**

P-N junction formation and depletion region , energy band diagram of p-n junction at equilibrium and barrier energy , built in potential at p-n junction , energy band diagram and current through p-n junction at forward and reverse bias, V-I characteristics and current expression of diode , temperature dependencies of V-I characteristics of diode , p-n junction breakdown – conditions , avalanche and Zener breakdown , Concept of Junction capacitance, Zener diode and characteristics.
Diode half wave and full wave rectifiers circuits and operation (I_{DC} , I_{rms} , V_{DC} , V_{rms}, ripple factor without filter, efficiency ,PIV,TUF; Reduction of ac ripples using filter circuit (Qualitative analysis); Design of diode clipper and clamper circuit - explanation with example, application of Zener diode in regulator circuit. Numerical problems

Module III: Bipolar Junction Transistor: **8**

Formation of PNP/NPN Transistors, energy band diagram, current conduction mechanism, CE, CB, CC configurations, transistor static characteristics in CE, CB and CC mode, junction biasing condition for active, saturation and cut-off modes, current gain α, β and γ, early effect.
Biasing and bias stability; biasing circuits - fixed bias; voltage divider bias; collector to base bias, D.C. load line and Quiescent point, calculation of stability factors for different biasing circuits.
BJT as an amplifier and as a switch – Graphical analysis; Numerical Problems.

6

Module IV: Field Effect Transistors:

Concept of field effect, channel width modulation Classification of FETs-JFET, MOSFET, operating principle of JFET. drain and transfer characteristics of JFET (n-channel and p-channel), CS,CG,CD configurations, Relation between JFET parameters. FET as an amplifier and as a switch– graphical analysis. E-MOSFET (n-channel and p-channel), D-MOSFET (n-channel and p-channel), Numerical Problems

Module V: Feedback and Operational Amplifier **8**

Concept of feedback with block diagram, positive and negative feedback, gain with feedback. Feedback topologies, effect of feedback on input and output impedance, distortion, concept of oscillation and Barkhausen criterion.

Operational amplifier – electrical equivalent circuit ,ideal characteristics , Non ideal characteristics of op- amp – offset voltages ;bias current ;offset current; Slew rate ; CMRR and bandwidth, Configuration of inverting and non-inverting amplifier using Op-amp, closed loop voltage gain of inverting and non-inverting amplifier , Concept of virtual ground, Applications op-amp – summing amplifier; differential amplifier; voltage follower ; basic differentiator and integrator .

Problems on Characteristics of Op-amp, CMRR, slew rate, amplifier and application of Op-amp to be discussed. Any other relevant problems related to topic may be discussed or assigned.

Module-VI: Cathode Ray Oscilloscope (CRO) **2**

Operating principle of CRO with block diagram, measurement of voltage, frequency and phase.

Text Books:

1.D. Chattopadhyay, P. C. Rakshit, Electronics Fundamentals and Applications, New Age International
2.Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
3.Sedra & Smith, Microelectronics Engineering

Reference Books:

1.John D. Ryder, Electronic Fundamentals and Applications, PHI
2.J.B.Gupta, Basic Electronics, S.K. Kataria.
3.Malvino: Electronic Principle.
4.Boyelstad & Nashelsky: Electronic Devices & Circuit Theory, McGraw Hill, 1976.

CO- PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2
CO3	3	3	3	2	1	-	-	-	-	-	-	3
CO4	3	3	2	3	2	-	-	-	-	-	-	3

Course Name: Programming for Problem Solving
Course Code: CS 201
Contact: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite: Number system, Boolean Algebra

Course Outcome:

On completion of the course students will be able to

CO1:	Understand and differentiate among different programming languages for problem solving.
CO2:	Describe the way of execution and debug programs in C language.
CO3:	Define, select, and compare data types, loops, functions to solve mathematical and scientific problem.
CO4:	Understand the dynamic behavior of memory by the use of pointers.
CO5:	Design and develop modular programs using control structure, selection structure and file.

Course Content:

Module I: Fundamentals of Computer: (8 L)

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices 3L

Binary and Allied number systems representation of signed & unsigned numbers, BCD, ASCII, Binary number Arithmetic – Addition and Subtraction (using 1's complement and 2's complement) 2L

Overview of Procedural vs Structural language, compiler and assembler (basic concepts) 1L

Problem solving-Algorithm & flow chart 2L

Module II: C Fundamentals: (28 L)

Variable and Data Types: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements 2L

C Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrement operators, bitwise operators, assignment operators, conditional operators, special operators - type conversion, C expressions, precedence and associativity. 3L

Input and Output: Standard input and output, formatted output - printf, formatted input scanf, bit fields. 1L

Branching and Loop Statements: Statement and blocks, if - else, switch, goto and labels, Loops - while, for, do while, break and continue 4L

Fundamentals and Program Structures: auto, external, static and register variables Functions, function types, function prototypes, functions returning values, functions not returning values, scope rules, recursion, C preprocessor and macro 5L

Arrays, Strings and Pointers: One dimensional arrays, Two-dimensional arrays, Multidimensional arrays. Passing an array to a function Character array and string, array of strings, Passing a string to a function, String related functions, Pointers, Pointer and Array, Pointer and String, Pointer and functions, Dynamic memory allocation 7L

Structures and Unions: Basic of structures, arrays of structures, structures and pointers, structures and functions 3L

Files handling with C: Formatted and unformatted files, Command line arguments, fopen, fclose, fgetc, fputc, fprintf, fscanf function 3L

Text books:

Kerninghan B.W. & Ritchie D.M. - The C Programming Language ,PHI, 2nd Edition
Kanetkar Y. - Let us C, BPB Publication, 15th Edition

Reference Books:

E Balagurusamy – Programming in ANSI C, TMH, 3rd Edition
K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition
Reema Thareja – INTRODUCTION TO C PROGRAMMING, OXFORD UNIVERSITY PRESS, 2nd Edition

CO-PO Mapping:

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

Course Name: Engineering Mechanics
Course Code: ME 201
Contacts: 3:0:0
Total Contact Hours: 36
Credits: 3

Prerequisite: Basic Concept of Physics

Course Outcome:

CO1: To understand representation of force, moments for drawing free-body diagrams and analyze friction based systems in static condition
CO2: To locate the centroid of an area and calculate the moment of inertia of a section.
CO3: Apply of conservation of momentum & energy principle for particle dynamics and rigid body kinetics
CO4: Understand and apply the concept of virtual work, rigid body dynamics and systems under vibration.

Course Content:

Module 1: Introduction to Engineering Mechanics: Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy. 6L

Module 2: Friction: Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack. 2L

Module 3: Basic Structural Analysis: Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines. 3L

Module 4: Centroid and Centre of Gravity: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook. 5L

Module 5: Virtual Work and Energy Method: Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium. 5L

Module 6: Review of particle dynamics: Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique). 5L

Module 7: Introduction to Kinetics of Rigid Bodies: Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation. 5L

Module8: Mechanical Vibrations: Basic terminology, free and forced vibrations, resonance and its effects; Degree of

freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.

5L

Text books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education

Reference books:

1. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
2. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
3. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
4. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

CO – PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	1	-	-	-
CO2	3	3	2	2	-	-	-	-	1	-	-	1
CO3	3	2	3	2	1	-	-	-	1	-	-	1
CO4	3	3	3	3	-	-	-	-	1	-	1	-

Course Name: Programming for Problem Solving Lab
Course Code: CS 291
Contact: 0:0:3
Credits: 1.5

Prerequisites: **Number system, Boolean Algebra**

Course Outcomes:

On completion of the course students will be able to

CO1:	Learn the concept of DOS system commands and editor.
CO2:	To formulate the algorithms for simple problems and to translate given algorithms to a working and correct program.
CO3:	To be able to identify and correct syntax errors / logical errors as reported during compilation time and run time.
CO4:	To be able to write iterative as well as recursive programs.
CO5:	Learn the concept of programs with Arrays, Pointers, Structures, Union and Files.

List of Experiments:

1. Some basic commands of DOS, Windows and Linux Operating System, File handling and Directory structures, file permissions, creating and editing simple C program, compilation and execution of C program.
2. Writing C Programs on variable, expression, operator and type-casting.
3. Writing C Programs using different structures of if-else statement and switch-case statement.
4. Writing C Programs demonstrating use of loop (for loop, while loop and do-while loop) concept and use of break and continue statement.
5. Writing C Programs demonstrating concept of Single & Multidimensional arrays.
6. Writing C Programs demonstrating concept of Function and Recursion.
7. Writing C Programs demonstrating concept of Pointers, address of operator, declaring pointers and operations on pointers.
8. Writing C Programs demonstrating concept of structures, union and pointer to structure.
9. Writing C Programs demonstrating concept of String and command line arguments.
10. Writing C Programs demonstrating concept of dynamic memory allocation.
11. Writing C Programs demonstrating concept of File Programming.
12. Innovative Experiment

CO-PO Mapping

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

Course Name: Physics-I Lab
Course Code: PH 291
Contact: 0:0:3
Credits: 1.5

Prerequisite: Basic knowledge of 10+2

Course Outcome:

Student will able to:

CO1: Demonstrate experiments allied to their theoretical concepts

CO2: Conduct experiments using LASER, Optical fiber, Torsional pendulum, Spctrometer

CO3: Participate as an individual, and as a member or leader in groups in laboratory sessions actively

CO4: Analyze experimental data from graphical representations , and to communicate effectively them in Laboratory reports including innovative experiments

List of Experiment:

General idea about Measurements and Errors (One Mandatory):
i) Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.
ii) Proportional error calculation using Carrey Foster Bridge.

Any 7 to be performed from the following experiments

Experiments on Oscillations& Elasticity:
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.
4. Determination of elastic modulii of different materials (Young's modulus and Rigidity modulus)

Experiments on Optics:
5. Determination of wavelength of light by Newton's ring method.
6. Determination of wavelength of light by Laser diffraction method.
7. Determination of numerical aperture and the energy losses related to optical fiber experiment
8. Measurement of specific rotation of an optically active solution by polarimeter.

Experiments on Quantum Physics:
9. Determination of Planck's constant using photoelectric cell.
10. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.

In addition it is **recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

1. Determination of wavelength of light by Fresnel's bi-prism method (beyond the syllabus).
2. Study of half-wave, quarter-wave plate (beyond the syllabus)
3. Study of dispersive power of material of a prism.
4. Study of viscosity using Poyseullie's caplillary flow method/using Stoke's law.
5. Measurement of nodal and antinodal points along transmission wire and measurement of wave length.
6. Innovative experiments.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	2	2	-	1	-	1	2	3
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	2	2	2	2	2	-	-	-	-	-	-	3
CO4	1	2	2	2	2	-	-	-	-	-	-	2

Course Name: Basic Electronics Engineering Lab
Course Code: EC 291
Contact: 0:0:3
Credits: 1.5

Prerequisite: A basic course in electronics and Communication engineering Progresses from the fundamentals of electricity, active and passive components, basic electronics laws like Ohm's law, Ampere's law

Course Outcome:

CO1: Knowledge of Electronic components such as Resistors, Capacitors, Diodes, Transistors measuring equipment like DC power supply, Multimeter, CRO, Signal generator, DC power supply.

CO2: Analyse the characteristics of Junction Diode, Zener Diode, BJT & FET and different types of Rectifier Circuits.

CO3: Determination of input-offset voltage, input bias current and Slew rate, Common- mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.

CO4: Able to know the application of Diode, BJT & OPAMP.

List of Experiment:

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, millimeters etc.
2. Familiarization 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.
7. Study of I-V characteristics of Field Effect Transistors.
8. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
9. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
10. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.
11. Study of Logic Gates and realization of Boolean functions using Logic Gates.
12. Study of Characteristic curves for CB, CE and CC mode transistors.
13. Innovative Experiments

Text Books:

1.D. Chattopadhyay, P. C. Rakshit, Electronics Fundamentals and Applications, New Age International
2.Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
3.Sedra & Smith, Microelectronics Engineering

Reference Books:

1.John D. Ryder, Electronic Fundamentals and Applications, PHI
2.J.B. Gupta, Basic Electronics, S.K. Kataria.

3.Malvino: Electronic Principle.
4.Boyelstad & Nashelsky: Electronic Devices & Circuit Theory, McGraw Hill, 1976.

CO- PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	-	-	-	-	-	-	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2
CO3	3	3	3	2	1	-	-	-	-	-	-	3
CO4	3	3	2	3	2	-	-	-	-	-	-	3

Course Name: Workshop/Manufacturing Practices
Course Code: ME 292
Contact: 0:0:3
Credits: 1.5

Prerequisite: Higher Secondary with Mathematics, Physics and Chemistry

Course Outcome:
Upon completion of this laboratory course, students will be able to

CO1:	Fabricate components with their own hands.
CO2:	Get practical knowledge of the dimensional accuracies and tolerances applicable for different manufacturing processes.
CO3:	Produce small devices of their interest for project or research purpose.

Course Content:
(i) Theoretical discussion & videos: (6P)
Detailed contents:
1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing
8. Plastic moulding& Glass Cutting.

(ii) Workshop Practice:
Module 1 - Machine shop (6P)
Typical jobs that may be made in this practice module:
i. To make a pin from a mild steel rod in a lathe.
ii. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.
Module 2 - Fitting shop (6P)
Typical jobs that may be made in this practice module:
i. To make a Gauge from MS plate.
Module 3 - Carpentry (6P)
Typical jobs that may be made in this practice module:
i. To make wooden joints and/or a pattern or like.
Module 4 - Welding shop (Arc welding 3P + gas welding 3P) (6P)
Typical jobs that may be made in this practice module:
i. ARC WELDING (3P): To join two thick (approx 5mm) MS plates by manual metal arcwelding.
ii. GAS WELDING (3P): To join two thin mild steel plates or sheets by gas welding.
Module 5 - Electrical & Electronics (3P)
House wiring, soft Soldering
Module 6 - Smithy (3P)
Typical jobs that may be made in this practice module:
i. A simple job of making a square rod from a round bar or like.

Innovative Experiments:

Module 7 - Casting

Typical jobs that may be made in this practice module:

i. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 8 - Plastic moulding & Glass Cutting

Typical jobs that may be made in this practice module:

i. For plastic moulding, making at least one simple plastic component should be made.

ii. At least one sample shape on glass should be made using laser cutting machine.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. and Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A.Ghosh and A.K.Mallick, Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C.Sen and A.Bhattacharya, New Central Book Agency, Kolkata.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	1	1	-	-	-	2	1	-	2
CO2	3	3	2	2	1	-	-	-	2	1	-	2
CO3	3	2	2	2	1	1	-	1	2	2	3	2

Course Name: Language Lab
Course Code: HU 291
Contact: 0:0:2
Credit: 1

Pre requisite: Basic knowledge of LSRW skills

Course Outcome:

CO1: Able to understand advanced skills of Technical Communication in English through Language Laboratory.
CO2: Able to apply listening, speaking, reading and writing skills in societal and professional life.
CO3: Able to demonstrate the skills necessary to be a competent Interpersonal communicator.
CO4: Able to analyze communication behaviours.
CO5: Able to adapt to multifarious socio-economical and professional arenas with the help of effective communication and interpersonal skills.

Course Content:

Module 1: Introduction to the Language Lab
a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book
Module 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Academic Listening vs Business Listening
d. Listening in Business Telephony
e. Study of Contextualized Examples based on Lab Recordings
Module 3: Speaking
a. Speaking—Accuracy and Fluency Parameters
b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities—Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
Module 4: Lab Project Work
a. Making a brief Animation film with voice over (5 minutes)OR
b. Making a brief Documentary film (10 minutes)

References:

1.IIT Mumbai**, Preparatory Course in English** syllabus
2. IIT Mumbai, **Introduction to Linguistics** syllabus
3. Sasikumar et al. *A Course in Listening and Speaking*. New Delhi: Foundation Books, 2005.
4. Tony Lynch, *Study Listening*. Cambridge: Cambridge UP, 2004.

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	2	-	-	3	-	**3**	**2**	**2**	**3**	**3**	-	**3**
CO2	2	3	3	3	-	**3**	**3**	**3**	**2**	**3**	-	3
CO3	1	3	3	3	-	**2**	**2**	**2**	**2**	**3**	-	2
CO4	1	2	3	3	-	**2**	**1**	**1**	**2**	**3**	-	2
CO5	3	3	2	3	-	**2**	**3**	**2**	**2**	**3**	-	2

DETAILED SYLLABUS FOR 3rd SEMESTER

3rd Semester								
Sl No	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours /Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	M(BME)301	Mathematics -III	3	1	0	4	4
2	ES	EE(BME)301	Circuit Theory	3	0	0	3	3
3	PC	BME 301	Engineering Physiology & Anatomy	3	0	0	3	3
4	PC	BME 302	Biophysical Signals & System	3	0	0	3	3
5	PC	BME 303	Biomechanics-I (Solid)	3	0	0	3	3
Total of Theory							**16**	**16**
B. PRACTICAL								
6	ES	EE(BME)391	Circuit Theory Lab	0	0	2	2	1
7	PC	BME 391	Engineering Physiology & Anatomy Lab	0	0	3	3	1.5
8	PC	BME 392	Biophysical Signals & System Lab	0	0	2	2	1
10	PROJ	PR 391	Project-III	0	0	2	2	1
11	PROJ*	PR 392	Innovative Activities-II	0	0	0	0	0.5
C.MANDATORY COURSE/ACTIVITY								
12	MC	MC381	Behavioural & Interpersonal skills	0	0	3	3	
Total of Theory, Practical & Mandatory Course/Activity							**28**	**21**

*Students may choose either to work on participation in all the activities of Institute's Innovation Council for eg: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

Innovative activities to be evaluated by the Programme Head/ Event coordinator based on the viva voce and submission of necessary certificates as evidence of activities.

THEORY

COURSE NAME: MATHEMATICS-III
COURSE CODE: M(BME) 301
CONTACT: 3:1:0
TOTAL CONTACT HOURS: 48
CREDITS: 4

Prerequisites:

The students to whom this course will be offered must have the concept of (10+2) standard calculus, basic probability and differential equations.

Course Objectives:

The objective of this course is to disseminate the prospective Bio-medical engineers with advanced techniques for solving ordinary differential equations and basic techniques for solving partial differential equations. It also aims to equip the students with the concepts and tools of numerical analysis, statistics analysis and probability distribution as an intermediate to the advanced level of applications that they would find useful in their disciplines.

Course Outcomes (COs):
On successful completion of the learning sessions of the course, the learner will be able to:

COs	DESCRIPTIONS
CO1	Recall the underlying principle and properties of partial differential equation and ordinary differential equation, statistical analysis, probability distribution of a random variable and numerical analysis.
CO2	Exemplify the statistical data, probability distribution, differential equations, and numerical methods and find their distinctive measures using the underlying mathematical concepts.
CO3	Apply numerical methods used to obtain approximate solutions to intractable mathematical problems.
CO4	Apply effective mathematical tools for the solutions of partial differential equation and ordinary differential equation that model physical processes.
CO5	Compute the probability of real world uncertain phenomena by identifying probability distribution that fits the phenomena.
CO6	Interpret complex statistical findings using the understanding of inferential statistics.

Course Content:

MODULE I: ***Partial Differential Equation (PDE) and Series Solution of Ordinary Differential Equation (ODE): (11 Lectures)***

Solution of PDE: Method of Separation of Variables.
Solution of Initial Value & Boundary Value Problem: One Dimensional Wave Equation, One Dimensional Heat Equation, Two Dimensional Laplace Equation.
Series solution of ODE: General method to solve $P_0\ y'' + P_1 y' + P_2 y = 0$ and related problems to Power series method**,** Bessel's Function, Legendre Polynomial.

MODULE II: ***Probability Distributions: (11 Lectures)***

Random Variable: Discrete and Continuous (definition & examples); Probability Distribution (definition & examples); Probability Mass Function, Probability Density Function and Distribution Function for a single random variable only (definition, properties & related problems); Expectation, Variance and Standard Deviation for a single random variable only (definition, properties & related problems); Binomial Distribution, Poisson Distribution, Binomial Approximation to Poisson Distribution and Normal Distribution (problems only), Mean, Variance and Standard Deviation of Binomial, Poisson and Normal Distribution (problems only).

MODULE III: ***Statistics: (15 Lectures)***

Measures of Central Tendency: Mean, Medianand Mode (definition, properties & related problems).
Measures of Dispersion: Range, Mean Deviation, Varianceand Standard Deviation (definition, properties & related problems).

Sampling Theory: Random Sampling (definition & examples); Parameter & Statistic (definition & examples); Sampling Distribution & Standard Error of Statistic; Central Limit Theorem (statement only); Sampling Distribution of Sample Mean and Sample Variance in Random Sampling from a Normal Distribution (statement only & related problems).

Estimation of parameters: Estimation of Parameters: Point Estimation and Interval Estimation (definition & examples); Properties of Good Estimators: Unbiasedness andConsistency (related problems).
Correlation: Bivariate Data and Scatter Diagram (definition & examples); Karl-Pearson's Co-efficient of Correlation (definition, properties & related problems).
Regression: Regression Lines, Regression Equations and Regression coefficients (definition, properties & related problems).

MODULE IV: ***Numerical Methods: (11 Lectures)***

Error Analysis: Fundamental Errors; Significant Digit; Round-off Error & Truncation Error.
Interpolation: Operator, Missing Term, Lagrange's Interpolation.
Numerical Solution of Algebraic and Transcendental Equation: Bisection Method, Regula-Falsi Method and Newton-Raphson Method.
Numerical Integration: Trapezoidal Rule and Simpson's One-third Rule.
Numerical Solution of Ordinary Differential Equation: Euler's Method, Modified Euler's Method and Runge-Kutta Method (4^{th} order).

Project Domains:

1. Application of PDE and ODE in Bio-medical Engineering.
2. Statistical analysis of biological data.
3. Application of numerical methods for the relevant field of Bio-medical Engineering.
4. Mathematical modeling of an artificial organ and its functionality.

Text Books:

1. M D Raisinghania: Advanced Ordinary & Partial Diff. Equation; S. Chand Publication.
2. N.G. Das:Probability and Statistics;The McGraw Hill Companies.
3. Gupta S. C and Kapoor V K: Fundamentals of Mathematical Statistics; Sultan Chand & Sons.
4. Ross S L: Differential Equations; John Willey & Sons.
5. Sneddon I. N.: Elements of Partial Differential Equations - McGraw Hill Book Co.
6. Dey and Dutta: Numerical Methods; McGraw Hill Book Co.
7. Jain, Iyengar and Jain: Numerical Methods; New Age International Publishers.

Reference Books:

1. Boyce, W. E. and DiPrima, R. C.: *Elementary Differential Equations and Boundary Value Problems*, 9th Edition; Wiley India, 2009.
2. Kreyszig, E., *Advanced Engineering Mathematics*, 9th Edition; John Wiley & Sons, 2006.
3. Lipschutz & Lipson, *Schaum's Outline in Probability*; McGraw Hill Education.
4. Spiegel, M. R. *Theory and Problems of Probability and Statistics (Schaum's Outline Series)*, McGraw Hill Book Co.
5. Spiegel M. R.: Theory and Problems of Probability and Statistics (Schaum's Outline Series); McGraw Hill Book Co.
6. Goon A.M., Gupta M K and Dasgupta B: Fundamental of Statistics; The World Press Pvt. Ltd.
7. Balagurusamy, E.: Numerical Methods; McGraw Hill Education.

CO-PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	1	1	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	-	-	-	-	1
CO4	3	2	2	-	-	-	-	-	-	-	-	1
CO5	3	2	2	-	-	-	-	-	-	-	-	1
CO6	3	3	2	3	-	-	-	-	-	-	-	1

COURSE NAME: CIRCUIT THEORY
COURSE CODE: EE(BME)301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites:
1. Fundamental knowledge of Integral & Differential Calculus, Laplace Theorem & its inverse.
2. Basic knowledge of DC & AC circuit parameters with passive & active circuit elements/components

Course Objective
1. To familiarize students with parameters like Resistance, Inductance, Capacitance and circuit inter-connections.
2. To introduce students to 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 and resonating circuits and their methods of analysis..
6. To highlight the application of Laplace & Inverse Laplace transform in analyzing circuits.
7. To introduce students with transient circuits and describe the methodology to evaluate relevant electrical parameters.

Course Outcome
After completion of this course the students will be able to
CO1: Understand, Describe, Analyze and Design series and parallel RLC circuits and solve related problems
CO2: Analyze circuits using Node Voltage, transient response & Mesh Current Analysis in electrical networks and solve related problems.
CO3: Apply and Analyze Network Theorems to electrical networks to evaluate network parameters in simplified ways.
CO4: Understand, Describe, Analyze and Design Graph and Trees for a given network and build network matrices and solve related problems
CO5: Understand Describe, Analyze and Design Coupled (Magnetic and Electromagnetic) Circuits, Resonating circuit and solve related problems
CO6: Apply Laplace Transform and form Transfer Function for different kinds of electrical networks for analyzing them and solve related problems

Course Content:

MODULE NO	DETAILS	No of Lectures
1	Concept of Resistance, Inductance , Capacitance, current source, voltage source, Source transformation, Series and parallel connection of Resistance, Inductance , Capacitance and related problem solution.Star-Delta transformations. 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 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.	8L
2	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, Solutions and Problems with DC and AC sources	5L
3	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

4	Coupled Circuits: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems	**3L**
	Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltagerise, Transform diagrams, Solution of Problems	**3L**
5	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	**6L**
	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	**3L**
6	Introduction to typical circuitsforPhysiological Parameter measurements: Basic techniques of low voltage low frequency biophysical signal measurement (ECG, EMG, EOG),impedance matching, patient safety & isolation. Introduction to bio-electrodes for specific applications.	**3L**
	TOTAL	**36L**

Text 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)

Reference Books:

1. Skilling H.H.: "Electrical Engineering Circuits", John Wiley & Sons.
2. Edminister J.A.: "Theory & Problemsof Electric Circuits", McGraw-Hill Co.
3. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.
4. R.A.DeCarlo&P.M.Lin- Linear Circuit Analysis- Oxford
5. P.RameshBabu- Electrical Circuit Analysis- Scitech
6. Sudhakar: "Circuits &Networks:Analysis& Synthesis" 2/e TMH
7. M.S.Sukhija&T.K.NagSarkar- Circuits and Networks-Oxford
8. Sivandam- "Electric Circuits and Analysis", Vikas
9. V.K. Chandna, "A Text Book of Network Theory & Circuit Analysis",Cyber Tech
10. Reza F. M. and Seely S., "Modern Network Analysis", Mc.GrawHill .
11. M. H. Rashid:Introduction to PSpice using OrCAD for circuits and electronics, Pearson
12. Roy Choudhury D., "Networks and Systems", New Age International Publishers.
13. D.Chattopadhyay and P.C.Rakshit: "Electrical Circuits" New Age

CO-PO MAPPING

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	3	3	2	-	2	-	-	-	1	-	3
CO2	-	3	3	1	1	2	-	1	2	2	-	2
CO3	-	3	2	2	-	3	-	-	-	-	3	2
CO4	1	2	3	2	2	2	3	1	3	3	-	1
CO5	1	-	2	-	1	-	-	1	3	1	-	2
CO6	-	2	2	3	-	-	3	-	3	-	2	2

COURSE NAME: ENGINEERING PHYSIOLOGY & ANATOMY
COURSE CODE: BME 301
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of Physiology.

Course Objective:

- Students will be able to get an in-depth understanding of anatomy and physiology of various systems like cardiovascular, pulmonary, digestive, renal, musculo-skeletal, nervous system.
- The discussion of these physiological systems will cover the levels of cell, tissue and organ, enabling the students to understand and correlate the corresponding structure-function relationship of these physiological systems.
- Students should be able to measure and interpret data of various physiological processes in living systems.
- Explain mechanisms of communication, integration and homeostasis involved in physiological parameters and energy balance.
- To 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:

After completion of this course students will be able to

CO1: Identify and 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.
CO2: Apply knowledge to comprehend and explain the corresponding structure function relationship of these physiological systems.
CO3: Apply a broad knowledge of Physiology & Anatomy of organ system to logically analyze the mechanisms of function, integration and homeostasis involved in physiological parameters and energy balance.
CO4: Analyze the Structure – Function relations of various human organ systems, to arrive at suitable conclusions to identify problems related to deformity or deviation from normal physiological processes in living systems.
CO5: Interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

Course Content

Module No	Topic	No of Lectures
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.	**7L**
2	**Cardio Vascular System:** Structure & function of Heart, Anatomical position, chambers of heart, Blood circulation through heart and. Special junctional tissue of heart. Cardiac cycle. Heart Sound. Systemic & pulmonary circulation. Cardiac output. Blood Pressure-regulation & controlling factors.	**5L**
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,	**7L**

	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.	
4	**Renal System:** Function of kidney, Anatomy & Histology of Nephron & collecting duct. Urine formation mechanism (Filtration, reabsorption and secretion) Counter-current system of urine concentration, Typical anomalies in renal and excretory system.	**4L**
5	**Digestive System:** Organization of GI system, Movement along GI tract, Function of Liver, Intestine and Pancreas, Digestion and Absorption, Role of Enzymes in Digestion.	**4L**
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:** Overview of Nervous system- CNS, PNS, ANS, Structure and function of neurons. Types of nerve fibers. The action potential, neurotransmitters, Conduction velocity of nerve impulse. Neuromuscular Junction – structure, events in transmission, end-plate potential, post titanic potential. Synapses – types, structure, synaptic potentials, synaptic transmission of the impulse.	**6L**
	TOTAL	**36L**

Text/Reference Books:

1. Essential of Medical Physiology - Anil BaranSinghaMahapatra, Current Books International
2. Human Physiology - C.C.Chatterjee, Medical Allied Agency
3. Text book of Medical Physiology- Guyton

Text/Reference Books:

1. Concise Medical Physiology - Chauduri
2. Anatomy and Physiology – Ross & Wilson, Churchill Livigstone publications.
3. Modern Physiology & Anatomy for Nurses - J Gibson, Black-well Scientific Publishers

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**2**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**3**	**2**	**-**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: BIOPHYSICAL SIGNALS & SYSTEMS
COURSE CODE: BME 302
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Basic Knowledge of Integration, Differentiation, Complex Numbers

Course Objectives:
1. To understand representations/classifications of signals and systems and describe the time & frequency domain analysis of continuous time signals with Fourier series, Fourier transforms Laplace transformsand.
2. To understand Sampling theorem, with time and frequency domain analysis of discrete time signals with DTFS and Z-Transform.
3. To present the concepts of convolution and correlation integrals and also understand the properties in the context of signals/systems,laying down the foundation for advanced courses.
4. To appreciate application of above principles in Biophysical signals.

Course Outcomes:
At the end of the course,student should be able to:
CO1: Understand mathematical description and representation of continuous and discrete time signals and systems.
CO2: Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
CO3: Understand and resolve the signals in frequency domain using Fourier series &Fourier transforms, including its limitationsand need for Laplace transform.
CO4: Use the z-transform to analyse discrete-time signals and systems.
CO5: Determine the response of the LTI system and stability of a feedback system.
CO6: Understand the applicability of principles of signals & system in Biophysical domain.

Course Content:

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 convolution	**7L**
2	**Signal analysis**: Basic concepts of the Fourier Series, Properties of continuous and discrete time Fourier series, Discrete Fourier transform (DFT) and its inverse (IDFT). Fast Fourier transformation (FFT)	**6L**
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,Nyquist criterion. 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.	**8L**
4	**Noise,Feedbackand Control 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 feedback in physiological systems and its importance.	**5L**
5	**Filtering Techniques:** Basic concepts of IIR and FIR filters, difference equations, Realization of Filters using Direct form –I, II & Cascade Form Design of IIR Filter using impulse invariant and bilinear transforms.	**4L**

6	**Applicationin PhysiologicalSystem**: Block diagram representation of cardio vascular system, Electrical analog of blood vessels and its transfer function. Characteristics of various biosignals (ECG, EEG, EMGetc,) signal conditioning and noise handling.	**6L**
	Total	**36L**

Text Books:

1. Oppenheim, Wilskey and Nawab-Signal & System, Prentice Hall India.
2. Hayken& Van Veen- Signal &System,Willey

Reference Books:

1. Taub& Schilling-Principles of Communication System, Tata McGraw Hill.
2. Kennedy &Devis-Electronic Communication System, Tata McGraw Hill
3. Gayakward-Opamps and Linear Integrated Circuits , Prentice Hall India
4. A.K.Sawhney-Electrical & Electronic Measurement & Instrumentation, DhanpatRai& Co. (P) Ltd

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	-	-	-	-	-	-	-	-
CO2	3	1	3	-	-	-	-	-	-	1	-	-
CO3	3	3	3	-	-	3	-	3	-	-	-	-
CO4	-	1	3	3	1	-	-	-	-	-	-	-
CO5	3	3	1	3	-	-	1	-	1	-	3	-
CO6	-	3	1	-	-	-	-	-	-	-	-	-

COURSE NAME: BIOMECHANICS-I (SOLID)
COURSE CODE: BME 303
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Basic knowledge of mechanics which includes kinetics & kinematics and human functional anatomy.

Course Objectives:

1. To relate the fundamentals of engineering mechanics with human posture and locomotion.
2. To describe the types and mechanics of skeletal joints.
3. To Study the strength, deformability, viscoelasticity of bone and flexible tissues, modes of loading and failure.
4. To describe movement precisely, using well defined terms (*kinematics*) and also to consider the role of force and moment in human movement (*kinetics*) -- GAIT analysis.
5. To consider the mechanical properties of cardiovascular system, artificial heart valve, mechanics of orthopedic implants, dental implants and joint replacement.

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

CO1: Understand the fundamentals of mechanics and its application in human system.
CO2: Describe the various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.
CO3: Analyze the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.
CO4: Gain broad working knowledge about the mechanics of moving systems and familiarity with human anatomy to competently analyze gross movement and dynamics of the human body.
CO5: Understand the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.
CO6: Understand the various engineering problems associated with solid biomechanics.

Course Content

Module No	Topic	No of Lecture
1	**Introduction to Biomechanics:** Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Non-coplaner and Concurrent & Non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia, Statics and Dynamics in Biomechanics.	**5L**
2	**Joint Biomechanics:** Analysis of rigid bodies in equilibrium, free body diagrams, Types of joints, Skeletal joints, forces and stresses in human joints, Biomechanical analysis of elbow, shoulder, hip, knee and ankle.	**6L**
3	**Tissue Biomechanics:** Constitutive Properties of Tissues, Structure and Mechanical Properties of Bone, Bone Mechanics and Remodeling- viscoelastic properties, Maxwell & Voight models – anisotropy. Electrical properties of bone. Structure, Functions, Mechanical Properties & Modeling of Collagen and Collagenous Tissues: Cartilage, Tendon, Ligament and	**7L**

	Muscle**,** Testing of Collagenous Connective Tissues.	
4	**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. Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Moment of inertia-limb. Introduction of a modern GAIT lab.	**4L**
5	**Cardiac Biomechanics:** Cardiovascular system, Mechanical properties of heart (cardiac chambers & valves) and blood vessels (arteries, arterioles, capillaries & veins). Introduction to stent and Artificial heart valves, biological and mechanical valves development, testing of valves.	**4L**
6	**Implant Mechanics:** General concepts of Implants, classification of implants, Soft tissue replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of Orthopedic implant, Dental implant, Ocular implant etc. Specifications for a prosthetic joint, fixation of implants.	**5L**
7	**Problems and Failures associated with Biomechanics** Wear and friction in joints, Fatigue, Creep, Stress concentration, Stress shielding, Bending and buckling, Types of fractures, biomechanics of fracture healing, types of fracture fixators.	**5L**
	Total	**36L**

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 Property of living Tissue, Springer, 1996.

Reference Books

1. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010
2. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones & Bartlett Publishers, 2013.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
4. White & Puyator, Biomechanics, Private publication UAE, 2010

CO-PO Mapping:

COs	**B.Tech in Biomedical Engineering Programme Outcomes (POs)**											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	2	3	1	-	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	3	2	2	2	-	1	-	-	-	-
CO6	3	3	2	-	-	1	-	1	-	-	-	-

PRACTICAL

COURSE NAME: CIRCUIT THEORY LABORATORY
COURSE CODE: EE(BME)391
CONTACT: 0:0:2
CREDIT: 1

Prerequisites:
1. Ability to identify various passive and active circuit elements/components and basic knowledge on their operation & application.
2. In depth knowledge in Integral & Differential Calculus and fundamental knowledge on Laplace Theorem & its inverse.
3. Knowledge of analog & digital signal should be clear.

Course Objective
1. To familiarize students with MATLAB Software and its application in circuit analysis.
2. To implement MATLAB in verification of Network theorems.
3. To introduce students with the generation of various waveforms using MATLAB.
4/ To introduce students in evaluating electrical parameters in resonating and transient circuits using MATLAB.
6. To apply MATAB in evaluating impedance and admittance parameters in a circuit.
7. To familiarize students with Laplace for finding poles & zeros concepts and the techniques in evaluating the same

Course Outcome
After completion of this course the students will be able to
CO1: Describe Analyze and Design series and parallel RLC circuits using MATLAB.

CO2: Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks using MATLAB.

CO3: Verify and analyze Network Theorems to electrical networks using MATLAB.

CO4: Understand Describe, Analyze and Design Graph and Trees for a given network and solve related problems using MATLAB.

CO5: Understand Analyze and Design Coupled Circuits and solve related problem using MATLAB.

CO6: Understand, Describe and Laplace Transform and its Inverse transform in electrical networks and solve related problems using MATLAB

List of Experiments:
Implementation of Following Experiments using Software (MATLAB) 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.
9. Innovative experiments

CO-PO MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	-	-	-	3	3	2	2
CO2	-	2	2	-	-	1	-	2	3	2	-	1
CO3	-	-	-	2	2	3	-	3	3	3	-	1
CO4	-	2	2	1	2	1	-	3	2	3	2	2
CO5	3	-	2	3	-	3	1	-	3	3	-	1
CO6	-	3	3	1	-	3	1	-	2	2	2	1

COURSE NAME: ENGINEERING PHYSIOLOGY & ANATOMY LABORATORY
COURSE CODE: BME 391
CONTACT: 0:0:3
CREDITS: 1.5

Prerequisites: Basic knowledge of Biology (Physiology Section)

Course Objectives:

1. 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 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.

Course Outcome:

Students will be able to

CO1: Identify, understand and explain fundamentals of organ structure at the cellular, tissue, organ, & system levels.

CO2: Apply knowledge of science and engineering fundamentals to get hands on exposure of the gross & microscopic approach to Anatomy & Physiology of various organs.

CO3: Perform logical analysis of results, with all necessary lab tools through experiments to arrive at suitable conclusions to physiological problems that promote the critical understanding of the structure function relationship of human systems.

CO4: Conduct and design experiments using modern engineering tools and instruments to demonstrate and interpret physiological abnormality and malfunctioning and its impact on health, safety, environment and society.

CO5: Function effectively as an individual, and as a member in a team to conduct experiments and interpret results.

CO6: Conform to Physiology Practical ethics, and understand the responsibilities and norms of Physiology Laboratory practice.

List of 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).
10. Innovative experiments

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	-	-	1	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	1	-	-
CO3	2	2	3	-	2	1	-	-	-	1	-	-
CO4	2	2	3	2	2	1	-	-	-	-	-	-
CO5	2	1	3	-	2	-	-	-	3	1	-	-
CO6	-	-	-	-	-	-	2	3	1	-	-	-

COURSE NAME: BIOPHYSICAL SIGNALS & SYSTEMS LABORATORY
COURSE CODE: BME 392
CONTACT: 0:0:2
CREDIT: 1

Prerequisites: Engineering Mathematics and Basics of Vector theory and MATLAB

Course Objectives:
The primary objective of this course is to provide a thorough understanding and analysis of signals and systems using MATLAB.

Course Outcomes:
At the end of the course, student should be able to:
CO1: Represent & classify signals, Systems & identify LTI systems using MATLAB.
CO2: Derive Fourier series and Fourier transform for different signals using MATLAB.
CO3: Analyze the Continuous Time systems by performing Convolution using MATLAB
CO4: Understand Discrete-time systems and LTI systems using Z-transforms using MATLAB.
CO5: Understand probability concepts to find statistical properties (mean, variance, auto correlation function) of random variables using MATLAB.

List of Experiments

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 Convolution(Linear and Circular).
4. Fourier transform of the signals (CTFT and DTFT)
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 Fourier- transform using MATLAB.
8. To study LPF &HPF, band-pass and reject filters using RC circuits
9. Innovative experiments

CO-PO Mapping:

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

DETAILED SYLLABUS FOR 4th SEMESTER

4th Semester								
Sl No	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours /Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	BS	PH(BME) 401	Physics-II	3	0	0	3	3
2	PC	BME 401	Biomaterials	3	0	0	3	3
3	PC	BME 402	Biomechanics-II (Fluid)	3	0	0	3	3
4	ES	EC(BME) 402	Analog & Digital Electronics	3	0	0	3	3
5	HU	HU 402	Economics for Engineers	2	0	0	2	2
Total of Theory							**14**	**14**
B. PRACTICAL								
6	BS	PH(BME) 491	Physics-II Lab	0	0	2	2	1
7	PC	BME 491	Biomaterials & Biomechanics Lab	0	0	3	3	1.5
8	ES	EC(BME) 492	Analog & Digital Electronics Lab	0	0	2	2	1
9	PROJ	PR 491	Project-IV	0	0	2	2	1
11	PROJ*	PR 492	Innovative Activities-III	0	0	0	0	0.5
C.MANDATORY COURSE/ACTIVITY								
10	MC	MC 401	Environmental Science	3	0	0	3	
Total of Theory, Practical & Mandatory Course/Activity							**26**	**19**

*Students may choose either to work on participation in all the activities of Institute's Innovation Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

Innovative activities to be evaluated by the Programme Head/ Event coordinator based on the viva voce and submission of necessary certificates as evidence of activities.

THEORY

COURSE NAME: PHYSICS-II
COURSE CODE: PH(BME)401
CONTACTS: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite:
Knowledge of Physics up B.Tech 1st year Physics-I course

Course Objective:
The Physics-II course will provide the exposure to the physics of materials that are applied in digital circuitry, storage devices; exposure to the physics of quantum logic gate operation and quantum computation; an insight into the science & technology of next generation; foundations of electromagnetic theory and communication systems; concept of fundamental particles and associated applications in semiconductors

Course Outcome

After completion of this course student will be able to
CO1: explain the action of various types of microscopes , imaging and radioactive systems.
CO2: apply Schrödinger equation in variety of atomic scale problems including nanomaterials.
CO3: analyze the physics of various kinds of electric and magnetic materials
CO4: justify the importance of ultrasonic sound in biomedical engineering

COURSE CONTENT:
Module 1: Electric and Magnetic properties of materials (12L)
Module 1.01: Insulating materials:
Dielectric Material: Concept of Polarization, the relation between **D, E** and **P**, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), behavior of Dielectric under alternating field (qualitative discussion only), Dielectric losses, Local electric field at an atom: Lorentz field, Lorentz relation; Dielectric constant and polarizability – Clausius-Mossotti equation (with derivation) ;. ferroelctric and piezoelectrics (Qualitative study). **5L**
Module 1.02: Magnetic materials and storage devices:
Magnetic Field & Magnetization M, relation between **B, H, M**. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of θ_p , Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) **5L**
Module 1.03: Super conductivity: Basic concept, qualitative study up to Meissner effect, examples of High Temperature Superconductor, BCS theory (qualitative), Applications in Biomedical Engineering. **2L**

Module 2: Ultrasound (4L)
Ultrasound-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) **Infrasound** – Introduction and definition, production, application, 4L

Module 3: Display, Optical Instruments & Opto-elctronic devices (10L)
3.01: Electron Optics: Operation and application of CRT (AC), Physics of Liquid crystal display (LCD), LED 4L
3.02: Optical Instruments: Imaging-Types of imaging (PET, CT), electron microscope. 3L
3.03: Radiation therapy-radio activity, doses, strength, applications. 3L

Module 4: Quantum Mechanics-II (7L)

Formulation of quantum mechanics and Basic postulates- superposition principle, orthogonality of wave function, expectation value; operator correspondence, Commutator. Measurements in Quantum Mechanics- Eigen value, Eigen function, Schrödinger's equation as energy eigen value equation. 4L

Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only $E<V_0$). 3L

Module 5: Physics of Nanomaterials (3L)

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, grapheme, electronic, environment, medical). 3L

Text Books

1. Insulating Materials: Principles, Materials, Applications, Margit Pfundstein , Roland Gellert , Martin Spitzner & Alexander Rudolphi: Birkhauser Verlag AG; 1
2. High Voltage and Electrical Insulation Engineering, Ravindra Arora, Wolfgang Mosch: Online ISBN: 9780470947906 DOI: 10.1002/9780470947906 Series Editor(s): Mohamed E. El-Hawary
3. Physics-II, Sujay Kumar Bhattacharya and Soumen Pal, McGraw Hill Education Private Limited
4. Advanced Engineering Physics, S. P. Kuila, New Central Book Agency (P) Ltd.
5. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)
6. Quantum Mechanics- Bagde Singh (S. Chand Publishers)
7. Principles of Engineering Physics Vol 1 and Vol 2; by Md. N. Khan and S. Panigrahi, Pub: Cambridge Univ. press

Reference Books

1. Advanced Quantum Mechanics-J. J. Sakurai (TMH)
2. Quantum Computation and Quantum Information(10th Anniversary Edition)- Nielsen & Chuang (Cambridge University Press)
3. Fundamental of Statistical Mechanics: B Laud
4. Introduction to statistical mechanics : .Pathria
5. Fundamental of Statistical and Thermal Physics: .F. Reif Advanced Engineering Physics-S. P. Kuila New Central Book Agency (P)Ltd.
6. Electricity and Magnetism (In Si Units): Berkeley Physics Course - Vol.2, Edward M Purcell
7. Introduction to Electrodynamics-Griffiths David J.
8. The Feynman Lectures on Physics. 2 (2nd ed.)., Feynman, Richard P Addison-Wesley.ISBN 978-0-8053-9065-0
9. Solid State Physics, A. J. Dekker, McMillan
10. Nanostructure and Nanomaterials, B.K. Parthasarathy
11. Introduction to Nanotechnology, B.K. Parthasarathy
12. Essentials of Nanotechnology, Rishabh Anand
13. Nanomaterials Handbook (Advanced Materials and Technologies)-YuryGogotsi (Editor) 1. Nuclear Physics,
14. Nuclear Physics, J. Pearson, University of Manchester, 2008
15. Nuclear and Particle Physics, Jenny Thomas - University College London , 2000.
16. Solid State Physics, S.O. Pillai.

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	2	3	-	-	-	-	-	-	-	-	-	1
CO4	1	2	2	3	-	-	-	-	-	-	-	1

COURSE NAME: BIOMATERIALS
COURSE CODE: BME401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDITS: 3

Prerequisites: Basic knowledge of Chemistry, Physics and Human Physiology.

Course Objectives:

1. To describe the fundamentals of material science.
2. To study the physical, mechanical and other relevant properties of various biomaterials.
3. To describe the types, features and applications of metal, polymer, ceramic and composite.
4. To highlight the factors that influence failure of implants.
5. To impart knowledge about unique features of various bio-compatibility tests and its significance in designing new implants.
6. To illustrate the significance of sterilization and methods to ensure and improve biocompatibility.

Course Outcome:

CO1: Identify and understand the fundamental concepts in material science (e.g., atomic structure and bonding, crystalline structures and defects) and interpretation of phase diagrams.
CO2: Apply a broad knowledge of different types of biomaterials including metals, polymers, ceramics and composites and their use in typical biomedical implants, devices and clinical applications.
CO3: Design an implant using fundamental concept and modern engineering tools by suitable material selection conforming to standards.
CO4: Analyze the basic design of various biocompatible implants to develop and improve Health Care Service to serve mankind and society.
CO5: Demonstrate an understanding of standards, regulations, ethical responsibilities and possible hurdles in the process of developing biomaterials in bringing a product to market.

Course Content:

Module No	Topic	No of Lectures
1	**Basics of Biomaterials:** Fundamentals of material Science: structures & properties, Introduction to biomaterials, Basic criteria for biomaterials, classification of biomaterials, selection and performance of biomaterials, biological responses, surface and physical properties, mechanical properties, stress-strain behavior & hardness, mechanical failures, fatigue, electrical, optical and magnetic properties	**7L**
2	**Metallic Biomaterials:** Stainless steels, Co-Cr Alloys, Ti Alloys, Corrosion of metallic Implants. Stress-corrosion, cracking. Hard tissue replacement materials: Orthopedic implants, Dental implants. Soft tissue replacement materials: Percutaneous and skin implants, Vascular implants, Heart valve implants.	**6L**
3	**Polymeric Biomaterials:** Polymerization and basic structure, Classification according to thermosets, thermoplastics and elastomers., Polymeric biomaterials: Polyethylene (PE), Polypropylene (PP), Polyvinylchloride (PVC), Polyamide (Nylon), Polytetrafluoroethylene (PTFE), Polymethylmethacrylate (PMMA), Polyether ether ketone (PEEK), Silicone rubber, Hydrogels, Biodegradable polymers. Applications of polymers in medical field.	**6L**
4	**Ceramic Biomaterials:** Definition of bioceramics. Bio-inert Ceramics: Alumina, Carbon, Zirconia. Biodegradable Ceramics: Tri-Calcium phosphate, Aluminum-Calcium-Phosphate (ALCAP) Ceramics. Bioactive ceramics: Bioglass, Hydroxyapatite. Medical applications**.**	**5L**
5	**Composite Biomaterials:** Properties and types of composites. 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). Clinical Applications.	**5L**
6	**Biocompatibility & toxicological screening of biomaterials:** Introduction to	**4L**

	biocompatibility, blood compatibility and tissue compatibility. Toxicity screening tests of biomaterials. Evaluation of systemic toxicity, haemolysis, cytotoxicity and special tests. Standards and protocols applicable to biomaterials.	
7	**Sterilization of implantable biomaterials:** Dry heat, Autoclaving, ETO, Gamma radiation. Effects of sterilization on properties of various bio-materials.	**3L**
	TOTAL	**36L**

Text 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

Reference Books:

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

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**-**	**-**	**2**	**-**	**3**	**1**	**1**	**-**	**-**	**-**	**-**

COURSE NAME: BIOMECHANICS- II (FLUID)
COURSE CODE: BME 402
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisites:

Basic knowledge of fluid mechanics, human circulatory system, cardiovascular & respiratory system and joint biomechanics

Course Objective: This course is aimed to

1. Provide the student with basic knowledge on the fundamental principles of fluid mechanics.
2. Study the physiologically relevant fluid flow phenomena, underlying physical mechanisms from an engineering perspective and its application to major human organ systems.
3. Describe and analyze blood flow in macro and microcirculation including other physiological fluid flows.
4. Integrate the basic concepts of fluid mechanics with physiological parameters to address relevant problems of the human body systems.

Course Outcome:
After completion of the course student will be able to
CO1: Describe the basic principles of fluid mechanics and its application in physiological system.
CO2: Understand various engineering aspects of fluid flow in human body, primarily related to blood flow in the heart and blood vessels.
CO3: Identify the specific pathological conditions in human body related to fluid dynamics.
CO4: Apply engineering concepts of fluid mechanics to understand real-life biological flow.

Course Content:

Module No.	Topic	No. of Lecture
I	**Properties of Fluids:** Fluid properties, classification and applications, concept of viscosity, compressibility and Elasticity, Surface tension and capillarity. Newton's law of viscosity, dynamic viscosity, kinematic viscosity, variation of viscosity with temperature, Surface tension and capillarity. Concept of Newtonian & Non Newtonian Fluids.	**5L**
II	**Fluid Flow and Boundary Layer:** Basic laws of fluid dynamics – conservation of mass, conservation of linear momentum, conservation of energy, Reynolds number, Ideal fluid flow, Real fluid flow- Laminar and turbulent flow, Laminar Flow of Non Newtonian Fluids, Transition from laminar to turbulent flow, measurement of viscosity, Application of Bernoulli's equation, Fundamentals of Boundary layer, Velocity profile, Losses in pipes.	**7L**
III	**Blood Rheology and Flow Dynamics in Blood Vessels:** Physical, Chemical and Rheological properties of blood, Effect of shear rate, Hematocrit, Temperature, Protein content on blood viscosity, Relationship between diameter, velocity and Pressure of blood flow (Hagen-Poiseuille equation), Flow properties of blood through the blood vessels-	**11L**

	steady flow and pulsatile flow, Wave propagation in elastic tubes, Forces that drive or resist blood flow, Diseases related to obstruction of blood flow, Friction loss in flow in a tube, velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries. Casson's Equation, Problems associated with extracorporeal blood flow.	
IV	**Cardiac and Respiratory Flow Mechanics:** Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins, Physics of cardiovascular diseases, Fundamentals of fluid structure interaction. Prosthetic heart valves and replacements. Respiratory system physiology. Alveolar ventilation. Air flow in the lungs. Mechanics of breathing. Gas exchange and transport.	**5L**
V	**Synovial Fluid Mechanics in Joints:** Synovial joints physiology, Function of synovial fluid, Diseases, Synovial fluid properties and rheology, Lubrication theory, Different types of lubrication in human joints, Application for synovial fluid flow, Arthritis, Knee and Hip injury.	**5L**
VI	**Biofluid Dynamics in Human Brain:** Cerebrospinal fluid. Cerebral blood flow. Blood brain barrier, Brain diseases.	**3L**
	TOTAL	**36L**

Text Books:

1. Introduction to Fluid Mechanics-James E.A. John & William L. Haberman, 2nd Edn, Prentice Hall, INC.
2. Y.C Fung, Biomechanics- Mechanical properties of living tissues, 2nd Edn, SpringerVerlag, 1993.
3. D.O Cooney, Biomedical engineering Principles. Marcel Dekker, INC New York. 1976.
4. C.Ross Ethier and Craigg A. Simmons, Introductory Biomechanics, Cambridge texts in Biomedical Engineering, 2007.
5. C. Kleinstreuer, Biofluid Dynamics: Principles and Applications, CRC Press, Taylor&Francis Group, 2006.
6. L. Waite, Applied Biofluid Mechanics, McGraw Hill, 2007

Reference Books:

1. Biomechanics by Nihat ozkaya and Margareta Nordin
2. D.A Mc Donald, Blood flow in arteries, Edward Arnold ltd, 1998.
3. J. N. Mazumdar, Biofluid Mechanics, World Scientific, 2004.
4. L. Waite, Biofluid Mechanics in Cardiovascular Systems, McGraw-Hill , 2006.

CO-PO MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	1	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	1	2	-	-	-	-	-	-	1
CO4	3	2	2	2	1	-	-	-	-	-	-	-

COURSE NAME: ANALOG & DIGITAL ELECTRONICS
COURSE CODE: EC(BME)402
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, Basic Electrical Engineering, Basic Electronics Engineering

Course Objective:
1. To give the idea about fundamentals of Analog Electronic Devices and circuits.
2. To familiarize students with Transistors, Op-Amps, amplifiers, oscillators & multi-vibrators.
3. To introduce students to different number systems, codes & their inter-conversion techniques.
4. To impart the concept of different logic families & technologies of circuit integration
5. To describe the procedures for the analysis & design of combinational circuits and sequential circuits
6. To inculcate the concept of memories, programmable logic devices and digital ICs.

Course Outcome
After the course, students will be able to
CO1: Understand and describe /explain concept of different sub-components of Electronics Circuits.
CO2: Apply the knowledge of mathematics, science and engineering fundamentals to solve related numericals.
CO3: Perform logical analysis of result/systems of different types of Electronics Circuits.
CO4: Design different networks using analog as well as digital circuits.

Course Content

Module No	TOPIC	No of Lectures
1	**Power Supply and Regulators:** Transformer, Rectifier, line filters (L,T & π-section), series & shunt regulators, 3TR (78/79xx), SMPS, line & load regulation analysis.	**3L**
2	**Analog Circuit applications of transistors & operational amplifiers:** Integrator, differentiator, comparator, Schmitt Trigger, instrumentation amplifier, Log & Anti-log amplifiers, Trans-conductance multiplier, Precision Rectifier, voltage to current and current to voltage converter, free running oscillator.	**5L**
	Oscillators, inverters & Multi-vibrators: Colpitts, Hartley's, Phase shift, Wien bridge, crystal oscillators, PLL. Astable/Monostable/Bistable multi-vibrators -- typical circuits based on IC 555.	**4L**
3	**Amplifiers:** Classes**,** functioning, coupling concepts, Feedback (Negative / positive, voltage/ current, series/shunt), voltage & current gain, input & output impedance, frequency response characteristics, bandwidth, distortions, efficiency, SNR.	**4L**
4	**Signal filters:** LPF, HPF and BPF, passive & active filters.	**3L**
5	**Digital electronics concepts:** Binary, Octal, decimal and Hexadecimal representation and their conversions; Signed binary number representation & operations with 1's and 2's complement methods; BCD, Gray codes, ASCII, EBDIC. Various Logic gates- their truth tables and circuits; Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, K-map method	**6L**

6	**Combinational & Sequential Circuits:** Adder, Subtractor, Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator Basic memory element-S-R, J-K, D and T Flip Flops, various types of Registers and counters, Irregular counter, State table and state transition diagram, sequential circuits design methodology	**7L**
7	**Memory Systems & Logic Families:** Basics of RAM, ROM, EPROM, EEROM, Programming logic devices and gate arrays.(PLAs, PLDs, FPGA) Introduction to different logic families, TTL, MOS and CMOS logic gates, working principles, relative merits & demerits.	**4L**
	TOTAL	**36L**

Text 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
4. S.Salivahanan, S.Aribazhagan, Digital Circuit & Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
5. Anand Kumar, Fundamentals of Digital Circuits- PHI
6. Kharate- Digital Electronics- Oxford

Reference Books:

1. Millman & Halkias – Integrated Electronics, McGraw Hill.
2. Rashid-Microelectronic Circuits-Analysis and Design- Thomson (Cenage Learning)
3. Malvino—Electronic Principles, 6/e, McGraw Hill
4. Gayakwad R.A -- OpAmps and Linear IC's, PHI
5. Morries Mano- Digital Logic Design- PHI
6. Leach & Malvino—Digital Principles & Application, 5/e, McGraw Hill
7. H.Taub & D.Shilling, Digital Integrated Electronics- McGraw Hill.

CO-PO MAPPING

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	-	-	1	-	3	-	2	-
CO2	-	3	-	2	-	-	3	-	1	1	-	-
CO3	1	-	-	-	-	1	-	2	-	-	3	-
CO4	1	-	3	-	2	-	-	-	2	-	-	-

COURSE NAME: ECONOMICS FOR ENGINEERS
COURSE CODE: HU402
CONTACT: 2:0:0
TOTAL CONTACT HOURS: 24
CREDIT: 2

Pre-requisites: MATH – College Algebra, Pre-Calculus Algebra and Trigonometry.

Course Objective: This course emphasizes the strong correlation between engineering design and manufacturing of products/systems and the economic issues they involve.

Course Outcome:

CO1: Apply the appropriate engineering economics analysis method(s) for problem solving: present worth, annual cost, Rate-of-return, payback, break-even, benefit-cost ratio.

CO2: Evaluate the cost effectiveness of individual engineering projects using the methods learned and draw inferences for the investment decisions.

CO3: Compare the life cycle cost of multiple projects using the methods learned, and make a quantitative decision between alternate facilities and/or systems.

CO4: Evaluate the profit of a firm, carry out the break even analysis and employ this tool to make production decision.

CO5: Discuss and solve advanced economic engineering analysis problems including taxation and inflation.

Course Content:

MODULE I: Introduction [2L]

Managerial Economics-Relationship with other disciplines-Firms: Types, Objectives and goals-Managerial Decisions-Decision Analysis.

MODULE II: Demand and Supply Analysis [6L]

Demand-Types of demand-determinants of demand-Demand function-Demand Elasticity-Demand forecasting-Supply-Determinants of supply-Supply function-Supply Elasticity.

MODULE III: Cost Analysis [6L]

Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – PV ratio,

MODULE IV: Elementary economic Analysis [4L]

Inflation-Meaning of inflation, types, causes, measures to control inflation.
National Income-Definition, Concepts of national income, Method of measuring national income.

MODULEV: Financial Accounting [4L]

Concepts and Definition of Accounting,Journal,Ledger,Trial Balance.
TradingA/C,Profit & Loss A/C and Balance Sheet.

MODULE VI: Investment Decision [2L]

Time value of money- Interest - Simple and compound, nominal and effective
rate of interest, Cash flow diagrams, Principles of economic equivalence.
Evaluation of engineering projects-Present worth method, Future worth method,
Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.

Text Books:

Riggs, Bedworth and Randhwa, "Engineering Economics", McGraw Hill Education India
Principles of Economics, Deviga Vengedasalam; Karunagaran Madhavan, Oxford University Press.
Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
R.Paneer Seelvan, " Engineering Economics", PHI

Reference Books:

Ahuja,H.L., "Principles of Micro Economics" , S.Chand & Company Ltd
Jhingan,M.L., "Macro Economic Theory"
Macro Economics by S.P.Gupta, TMH
Haniff and Mukherjee,Modern Accounting,Vol-1,TMG

Modern Economic Theory – K.K. Dewett (S.Chand)

CO-PO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**1**
CO2	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**1**
CO3	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**1**
CO4	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**1**
CO5	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**3**	**1**

PRACTICAL

COURSE NAME: PHYSICS-II LAB
COURSE CODE: PH (BME) 491
CONTACT: 0:0:2
CREDIT: 1

Course Outcome:
At the end of the course students' will be able to

CO1 : Demonstrate experiments allied to their theoretical concepts
CO2 : Conduct experiments using semiconductors , dielectric and ferroelectrics, ultrasounds
CO3 : Classify various types of magnetic materials
CO4 : Participate as an individual, and as a member or leader in groups in laboratory sessions actively
CO5 : Analyze experimental data from graphical representations , and to communicate effectively them in Laboratory reports including innovative experiments

List of Experiments:
(*At least 7 experiments to be performed during the semester)

Experiments on Module 1: Electric and Magnetic properties of materials
1. Study of dipolar magnetic field behavior using deflection magnetometer.
2. Study of hysteresis curve of a ferromagnetic material using CRO.
3. Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
4. Measurement of Curie temperature of the given sample.
5. Determination of dielectric constant of given sample (frequency dependent)

Experiments on Module 2: Ultrasound
6. Determination of velocity of ultrasonic wave using piezoelectric crystal.

Module 3: Display, Optical Instruments & optielctronic devices
7. Measurement of specific charge of electron using CRT.

Experiments on Module 4: Quantum Mechanics-II
8. Determination of Stefan's radiation constant.
9. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.
10. Determination of band gap of a semiconductor.
11. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor
12. Study of I-V characteristics of a LED.
13. Study of I-V characteristics of a LDR
In addition to regular 7 experiments it is **recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

Probable experiments beyond the syllabus:
1. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.
2. Determination of thermal conductivity of a good conductor by Searle's mothod.
3. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.
4. Innovative experiments

CO-PO Mapping:

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

COURSE NAME: BIOMECHANICS & BIOMATERIALS LABORATORY
COURSE CODE: BME491
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Basic knowledge of mechanics including kinetics & kinematics and human functional anatomy.

Course Objective:
This course provides basic hands on laboratory experiments in Biomaterials & Biomechanics which makes the students:
1. To study Mechanical properties of Biomaterials using destructive and non destructive method.
2. To study the moment of inertia of human limb.
3. To study the biocompatibility of implantable materials.
4. To measure the conductivity, pH of body fluid.
5. To study the stress-strain analysis of hip prosthesis

Course Outcomes:
CO1: Perform Mechanical characterization of biomaterials using destructive and non destructive methods.
CO2: Measure Surface roughness & *invitro* haemocompatibility of biomaterials
CO3: Determine the moment of inertia of human limb & analyze the stress strain diagram of any prosthesis.
CO4: Perform ph determination, viscosity and Conductivity measurement of any body fluid.

Course Content
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. Stress strain analysis of Hip Prosthesis.
6. Determination of moment of inertia of human bone using compound pendulum method.
7. Ultrasonic characterization of biomaterials-NDE
8. Viscosity measurement of body fluid
9. Conductivity measurement of body fluid.
10. pH measurement of body fluid
11. Innovative experiments

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	-	-	-	-	1	-	-	1
CO2	2	2	1	1	-	-	-	-	-	-	-	
CO3	3	2	3	2	-	-	1	-	1		-	1
CO4	3	2	2	2	-	-	-	-	-	-	-	-

COURSE NAME: ANALOG & DIGITAL ELECTRONICS LAB
COURSE CODE: EC(BME)492
CONTACT: 0:0:2
CREDIT: 1

Prerequisites: Basic Electrical Engineering and Basic Electronics Engineering

Course Objective:
1**.** To familiarize students with different components of Analog Circuit and Digital ICs corresponding to different logic gates with their operations.
2. To prepare students to perform the analysis of any Analog and Digital Electronics Circuit from these laboratory experiments.
3. To prepare students to design any Analog and any Digital Electronics Circuit.

Course Outcome -
After the course, students will be able to:
CO1: Explain the concept of Analog& Digital Electronics Circuits with its functional components.
CO2: Apply the knowledge of mathematics, science and engineering fundamentals to solve the related problems.
CO3: Perform logical analysis of result/systems of related Circuits.
CO4: Describe, analyze, formulate and construct different networks using analog as well as digital circuits

List of Experiments:
1. Study of Diode as clipper – clamper.
2. Study of ripple and regulation characteristics of full wave rectifier without and with capacitor filter
3. Construction of a two-stage R-C coupled amplifier & study of its gain & Bandwidth.
4. Study of class A & class B power amplifiers, class C & Push-Pull amplifiers.
5. Realization of current mirror & level shifter circuit using Operational Amplifiers.
6. Realization of a V-to-I & I-to-V converter using Op-Amps.
7. Study of Switch Mode Power Supply.
8. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR and Realization of basic gates using universal logic gates.
9. Gray Code to Binary Code Conversion and Vice Versa.
10. Construction of simple arithmetic circuits-Adder, Subtractor.
11. Construction of simple Decoder and Multiplexer circuits using logic gates.
12. Construction of Four-bit parity generator and comparator circuits.
13. Realization of R-S, J-K and D flip-flops using Universal logic gates.
14. Realization of Counter Circuits
15. Innovative experiments

CO-PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	1	-	3	-	3	-	-	2	-
CO2	-	3	1	-	-	1	-	-	3	1	-	-
CO3	3	-	2	-	-	3	-	1	-	-	3	-
CO4	3	-	1	-	-	3	-	-	2	-	-	-

MANDATORY COURSE

COURSE NAME: ENVIRONMENTAL SCIENCE
COURSE CODE: MC 401
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36

Prerequisite:
Basic knowledge of chemistry

Course Objective(s)

- Be able to understand the natural environment and its relationships with human activities.
- Be able to apply the fundamental knowledge of science and engineering to assess environmental and health risk.
- Be able to understand environmental laws and regulations to develop guidelines and procedures for health and safety issues.
- Be able to solve scientific problem-solving related to air, water, noise & land pollution.

Course Outcome(s)
CO1: To understand the natural environment and its relationships with human activities.
CO2: To apply the fundamental knowledge of science and engineering to assess environmental and health risk.
CO3: To develop guidelines and procedures for health and safety issues obeying the environmental laws and regulations.
CO4: Acquire skills for scientific problem-solving related to air, water, noise & land pollution.
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COURSE CONTENT

1.General **11 L**

1.1 Natural Resources: Forest Resource, water resource, mineral resource, energy resources: alternative source of energy

1.2 Population Growth: Exponential Growth, logistic growth, Maximum sustainable yield, demography

1.3 Disaster Management: Types of disasters (Natural & Man-made), Floods, Earthquake, Tsunamis, Cyclones, landslides (cause, effect & control)

1.4 Ecology & Ecosystem: Elements of ecology, definition of ecosystem- components types and function, Food chain & Food web,
Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems

1.5 Environmental Management: Environmental impact assessment, Environmental laws and protection act of India(The Environment protection Act, Air pollution Act, Water Act, Wildlife Protection Act) , Hazardous waste(management and Handling) Rules.

2. Air pollution and control **10L**

2.1 Sources of Pollutants: point sources, nonpoint sources and manmade sources primary & secondary pollutant

2.2 Types of air pollutants: primary & secondary pollutant ; Suspended particulate matter, oxides of

carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN, Smog (Photochemical smog and London smog),

2.3 Effects on human health & climate: Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion

2.4 Air pollution and meteorology: Ambient Lapse Rate, Adiabatic Lapse Rate, Atmospheric stability & Temperature inversion

2.5 control of air pollution (ESP, cyclone separator, bag house, catalytic converter, scrubber (ventury),

3. Water Pollution **9L**

3.1 Classification of water (Ground & surface water)

3.2 Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, heavy metals, pesticides, volatile organic compounds.

3.3 Surface water quality parameters: pH, DO, 5 day BOD test, BOD reaction rate constants, COD. Numerical related to BOD

Lake: Eutrophication [Definition, source and effect].

3.4 Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only),ground water pollution (Arsenic & Fluoride; sources, effects, control)

3.5 Quality of Boiler fed water: DO, hardness, alkalinity, TDS and Chloride

3.7 Layout of waste water treatment plant (scheme only).

4. Land Pollution **3L**

4.1 Types of Solid Waste: Municipal, industrial, commercial, agricultural, domestic, hazardous solid wastes (bio-medical), E-waste

4.2 Solid waste disposal method: Open dumping, Land filling, incineration, composting, recycling (Advantages and disadvantages).

4.3 Waste management: waste classification, waste segregation, treatment & disposal

5. Noise Pollution **3L**

5.1 Definition of noise, effect of noise pollution on human health,

5.2 Average Noise level of some common noise sources

5.3 Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L_{10} (18 hr Index) .

5.4 Noise pollution control.

Text Books

1. A Textbook of Environmental Studies, Shashi Chawla. Tata McGraw Hill Education Private Limited

Reference BookS

1. Environmental Studies, Dr. J P Sharma, University Science Press
2. Environmental Engineering, J K Das Mohapatra, Vikas Publication

Department: Biomedical Engineering
Curriculum Structure & Syllabus
(Effective from 2018-19 admission batch)

Under Autonomy (**GR A:** ECE, EE, EIE, BME; **GR B:** CSE, IT, ME, CE, FT)

CURRICULUM AND DETAILED SYLLABUS FOR 5TH SEMESTER

5th Semester								
Sl No.	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours /Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	PC	BME 501	Biomedical Instrumentation	3	0	0	3	3
2	PC	BME 502	Biosensors & Transducers	3	0	0	3	3
3	PC	BME 503	Medical Imaging Techniques	3	0	0	3	3
4	HU	HU 504	Principles of Management	2	0	0	2	2
5	PE	BME 504A BME 504B BME 504C	Biophysics & Biochemistry Bio-nanotechnology Computers in Medicine	3	0	0	3	3
6	OE	BME 505A BME 505B BME 505C	Data Structure & Algorithm Database Management System Control Engineering	3	0	0	3	3
Total of Theory							**17**	**17**
B. PRACTICAL								
7	PC	BME 591	Biomedical Instrumentation Lab	0	0	3	3	1.5
8	PC	BME 592	Biosensors & Transducers Lab	0	0	2	2	1
9	OE	BME595A BME595B BME595C	Data Structure & Algorithm Lab Database Management System Lab Control Engineering Lab	0	0	2	2	1
10	PROJ	PR 591	Project-V	0	0	2	2	1
11	PROJ*	PR 592	Innovative Activities-IV	0	0	0	0	0.5
C.MANDATORY COURSE/ACTIVITY								
12	MC	MC581	Constitution of India	3	0	0	3	
Total of Theory, Practical & Mandatory Course/Activity							**29**	**22**

* Students may choose either to work on participation in Hackathons etc. Development of new product/ Business Plan/ registration of start-up.

Students may choose to undergo Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry/ Long Term goals under rural Internship. (Duration 4-6 weeks).

Innovative activities to be evaluated by the Programme Head/ Event coordinator based on the viva voce and submission of necessary certificates as evidence of activities.

COURSE NAME: BIOMEDICAL INSTRUMENTATION
COURSE CODE: BME 501
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

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 acquaint students with biomedical recording devices, patient monitoring systems & their characteristics.

Course Outcome:

After completion of this course students will be able to

CO1: Describe and characterize the origin of bio-potentials and inspect common biomedical signals by their characteristics features.

CO2: Interpret the features and operations of basic medical instrumentation system, recording-monitoring system and PC based medical equipment and its necessity in healthcare system.

CO3: Analyse the characteristics and performance requirements of medical instrumentation and data acquisition system.

CO4: Apply the knowledge to design bio-potential amplifiers, various medical recording systems and patient monitoring systems.

Course Content

Module No.	Topic	No. of Lectures
I	**Medical Instrumentation**: Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors & Computers in medical instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.	**6L**
II	**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**
III	**Bioelectric signals and Bioelectric amplifiers:** Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artefacts, Instrumentation amplifiers, Special features of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector.	**8L**
IV	**Biomedical recording systems:** Basic Recording systems, General consideration for signal conditioners, Preamplifiers, Differential	**10L**

	Amplifier, Isolation Amplifier, Electrocardiograph, Phonocardiograph, Electroencephalograph, Electromyography, Digital stethoscope Other biomedical recorders, Biofeedback instrumentation, Electrostatic and Electromagnetic coupling to AC signals, Proper grounding, Patient isolation and accident prevention.	
V	**Patient Monitoring Systems:** System concepts, Selection of system parameters, Cardiac monitor, Bedside monitors, Central monitors, Heart rate meter, Pulse rate meter, Measurement of respiration rate, Holter monitor and Cardiac stress test, Catheterization Laboratory Instrumentation , Organization and Equipment used in ICCU & ITU.	**6L**
	Total	**36L**

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

Reference Books:

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

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**3**	**-**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	1
CO3	**3**	**2**	**-**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	1

COURSE NAME: BIOSENSORS & TRANSDUCERS
COURSE CODE: BME 502
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic knowledge of sensors and transducers and fundamentals of instrumentation.

Course Objective:

1. To introduce the principle of transduction, Characteristics and different sensor applications in biomedical instrumentation.
2. To impart an understanding of the mechanisms which govern the acquisition and processing of physiological signals recorded from a human subject, both in vivo and in vitro
3. To empower the student on biosensors and transducers associated with measurement of physiological phenomena, including pressure, displacement, flow, volume and biochemistry.
4. To encourage the student to critically evaluate sensor and transducer options for a particular biomedical application.

Course Outcome:

After completion of this course students will be able to

CO1: Demonstrate the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.

CO2: Understand the concepts, types, working and practical applications of important biosensors, electrodes for acquiring and recording various physiological parameters.

CO3: Gain broad knowledge on the applications of various biological sensors and transducers available for physiological and cellular measurements;

CO4: Compare different techniques with emphasis on sensitivity & selectivity and critically evaluate a selected application of a biosensor.

Course content

Module No.	Topic	No. of Lectures
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	**12L**
II	**Biopotential Electrodes** Electrode theory, Electrode electrolyte interface, polarizable and	**8L**

	non-polarizable electrodes, Electrode behavior and Circuit models, Electrode-skin Interface and Motion Artifact, Skin surface recording Electrodes, Microelectrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal microelectrodes, micropipette (metal filled glass and glass micropipette electrodes), properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG & EEG)	
III	**Chemical Biosensors** Blood gas and Acid-Base Physiology, Electrochemical sensors, reference electrode, pH, pO_2, pCO_2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors. Transcuteneous arterial oxygen tension & carbon dioxide tension monitoring enzyme electrode.	**7L**
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.	**4L**
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.	**5L**
	TOTAL	**36L**

Text Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.
3. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.
4. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

Reference Books:

1. Iberall & Guyton, Regulation & Control in Physiological System, Instruments Soc.USA.
2. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.
3. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
4. D. L. Wise, "Applied Bio Sensors", Butterworth, London.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: MEDICAL IMAGING TECHNIQUES
COURSE CODE: BME 503
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Physics and Medical Instruments.

Course Objective

1. To introduce the students with physics & principles underlying the operation of medical imaging equipment.
2. To illustrate the basics of imaging modality using radiations, its biological effects and radiation safety issues in the operation of medical imaging equipment.
3. To familiarize the students with imaging of soft tissues using ultrasound technique.
4. To acquaint the students with clinical applications of different imaging methods.

Course Outcome:

After completion of this course students will be able to

CO1: Understand the physics & principles behind the operations of different medical imaging equipment.

CO2: Gain knowledge about radiation effects on biological tissues and implement efficient radiation safety protocols in the operations of various medical imaging equipment.

CO3: Identify and analyse the basics of imaging modalities based on radiation and ultrasound.

CO4: Interpret the most effective imaging modality for a particular organ.

Course Content

Module No.	Topic	No. of Lectures
I	**X-Ray Machines and X-Ray Image Formation** Physics and production of X-Rays, Stationary and Rotating Anode tube, Tube Enclosure, Tube Rating Charts, Conventional Electrical Circuit of X-Ray Machine, Conventional and High Frequency Generators, Control Circuits- HV control, Filament Control, Tube Current, Exposure Timing, Automatic Exposure Control, Accessories of X-Ray. Stationary X-Ray Unit, Mobile X-Ray and Portable Units. Specialized X-Ray Machine- Mammographic X-Ray Machines, Dental X-Ray Machines. X-Ray Film, Cassettes, Film Sensitometry, Radiographic Film Image Formation. Dark Room Accessories- Developer and Fixer. Image Quality Factors, CR, Image Intensifiers, DR, Safety Protocols and Doses, Dose Equivalent and REM.	**16L**
II	**Computed Tomography** Principles of Computed Tomography, Scanning Systems, Detectors in CT, Data Acquisition System and Processing, Storing and Viewing System, Gantry Geometry, Different Information from	**10L**

	Gantry, Hounsfield Numbers, Image Reconstruction Techniques: Back Projections, Iterative and analytical methods, Image quality and Artifacts, Dose in CT, Spiral CT. Introduction to DICOM and PACS.	
III	**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 structure, probe types, beam steering, Principles of image formation, capture and display - Principles of A Mode, B Mode and M Mode. Types of US Imaging, Real-time ultrasonic imaging systems, electronic scanners, Doppler ultra sound and Colour velocity mapping, duplex ultrasound, image artifacts, bio-effects and safety levels.	**10L**
	TOTAL	**36L**

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", Adam Hilger, Bristol.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**2**	**-**	**1**	**-**	**1**	-	-	-	-
CO2	**2**	**2**	**1**	**1**	**-**	**3**	**2**	**3**	-	-	-	-
CO3	**2**	**3**	**-**	**2**	**1**	**-**	**1**	**-**	-	-	-	-
CO4	**-**	**3**	**-**	**3**	**2**	**1**	**-**	**-**	-	-	-	-

COURSE NAME: PRINCIPLES OF MANAGEMENT
COURSE CODE: HU 504
CONTACT HOUR: 2L
TOTAL CONTACT HOUR- 24
CREDITS: 2

Prerequisites: Nil

Course Objective:

1. To understand and apply management principles in to manufacturing organization.
2. To understand concepts of work study, method study, and Quality control method to improve performance of any organization.

Course outcome:

After completion of the course students will be able to

CO1: Recall and identify the relevance of management concepts.

CO2: Apply management techniques for meeting current and future management challenges faced by the organization

CO3: Compare the management theories and models critically to solve real life problems in an organisation.

CO4: Apply principles of management in order to execute the role as a manager in an organisation.

Course Content

Module No.	Topic	No. of Lectures
I	**Management Concepts:** Definition, roles,functions and importance of Management, Evolution of Management thought-contribution made by Taylor,Fayol,Gilbreth,Elton Mayo,McGregor,Maslow	4L
II	**Planning and Control:** Planning: Nature and importance of planning, -types of planning, Levels of planning - The Planning Process. – MBO, SWOT analysis,McKinsey's7S Approach. Organising for decision making: Nature of organizing, span of control ,Organisational structure –line and staff authority. Control: Basic control process, control as a feedback system, Feed Forward Control, Requirements for effective control.	4L
III	**Group dynamics & Leadership:** Group dynamics: Types of groups, characteristics, objectives of Group Dynamics. Leadership: Definition, styles & functions of leadership, qualities for good leadership, Theories of leadership	4L
IV	**Work Study and work measurement:** Definition of work study, Method Study Steps, Tools and Techniques used in the Method Study and Work Measurement Time Study: Aim & Objectives,, Use of stopwatch procedure in making Time Study. Performance rating, allowances and its types.	4L

	Calculation of Standard Time. Work sampling	
V	**Marketing Management**: Functions of Marketing, Product Planning and development,Promotional Strategy	**2L**
VI	**Quality management**: Quality definition, Statistical quality control, acceptance sampling ,Control Charts –Mean chart, range chart,c chart,p chart,np chart, Zero Defects,Quality circles, , Kaizen & Six Sigma ,ISO -9000 Implementation steps,Total quality management	**6L**
	Total	**24L**

Text Books:

1. Essentials of Management, by Harold Kooritz & Heinz Weihrich Tata McGraw
2. Production and Operations Management-K.Aswathapa,K .Shridhara Bhat,Himalayan Publishing House

Reference Books:

1. Organizational Behavior, by Stephen Robbins Pearson Education, New Delhi
2. New era Management, Daft, 11th Edition, Cengage Learning
3. Principles of Marketing, Kotlar Philip and Armstrong Gary, Pearson publication

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	**3**	-	**3**	-
CO2	-	-	-	-	-	**2**	-	**3**	**3**	-	**3**	**3**
CO3	-	-	-	-	-	-	-	-	**2**	-	**3**	**3**
CO4	-	-	-	-	-	**2**	-	-	**3**	-	**3**	-

COURSE NAME: BIOPHYSICS & BIOCHEMISTRY
COURSE CODE: BME 504A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Fundamental Physics & Chemistry, Cell Biology.

Course objectives:

1. To provide an in-depth knowledge of the core principles, biochemical & biophysical processes and their experimental basis.
2. To enable students to acquire a concept and understanding of the theoretical and technical basis for biophysical & biochemical definition and determination of macromolecular structure.
3. This course focuses on the phenomena related to the interaction and communication between living cells and their molecular constituents, drawing on advanced methods used within the fields of molecular, cellular and clinical biochemistry and biophysics.

Course outcome:

After completion of this course students will be able to

CO1: Acquire, articulate and retain broad and in-depth knowledge and understanding of the ways by which life functions are explained in terms of the principles of chemistry and physics and fundamental processes of Biochemistry and Biophysics.

CO2: Identify and analyze complex problems related to Formation of Structures in Biological Systems, Structural-Functional Relationships of Nucleic Acid and proteins, Biophysical activity, Radioactivity to arrive at suitable conclusions using first principles of Biophysics and Biochemistry.

CO3: Design, develop and conduct investigations to evaluate and interpret results to solve problems related to Cellular Biochemistry, Biophysical and Biochemical activity.

CO4: Apply appropriate techniques, resources, modern engineering tools to interpret complex biophysical, biochemical and biomolecular activities with an understanding of scientific and moral ethics and environmental concerns and in turn develops an awareness of ethical responsibilities while conducting and reporting investigations in Clinical Science.

Course Content

Module No.	Topic	No. of Lectures
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.	**5L**
2	**Bioelectricity:** Membrane potential, Action potential, Electrical properties of membrane, capacitance, resistance, conductance, dielectric properties of membrane.	**5L**

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).	**6L**
4	**Radioactivity:** Ionizing radiation, U-V & IR radiations, Production of radioisotopes, Radioactive decay, Half life period.	**4L**
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.	**8L**
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.	**8L**
	TOTAL	**36L**

Text Books:

1. Bio-Physics by Roland Glaser- Springer, 2nd printing edition (November 23, 2004).
2. Fundamentals of Biochemistry: Life at the Molecular Level by Donald J Voet, Judith G Voet & Charlotte W Pratt- Wliey, 2nd Edition (March 31, 2005).
3. The Biomedical Engineering Hand Book- 3rd Edition- (Biomedical Engineering Fundamentals)- Joseph D Bronzino- CRC- Taylor Francis- 2006 (Section III- Bio-Electrical Phenomena).

Reference Books

1. Lehninger Principles of Biochemistry by David L Nelson & Michael M Cox, 4th Edition (April 23, 2004).
2. Text Book of Medical Physiology- Guyton.
3. Radiation Biophysics by Edward L Alpen- Academic Press, 2nd Edition.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**-**	**2**	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**1**

COURSE NAME: BIO-NANOTECHNOLOGY
COURSE CODE: BME 504B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Fundamental knowledge of physics, biochemistry, biomaterials and nano-materials.

Course Objective:

1. To impart knowledge on fundamental aspects of bionanotechnology.
2. To study on various fabrication and characterization methods of nanomaterials.
3. To familiarize the students with the functional principles of nanotechnology and their. interaction with biomolecules.
4. To correlate the impact of nanotechnology in the field of Biomedical engineering.

Course Outcome:

After completion of this course students will be able to

CO1: Understand the basics of bio-nanotechnology and biomachines.

CO2: Demonstrate a comprehensive understanding of state-of-the-art methods for fabrication, characterization and handling of nano-materials.

CO3: Explain the functional principles of nanotechnology and the interaction between biomolecules and nanoparticle surface.

CO4: Apply the knowledge on nanotechology in the field of Biomedical Engineering

Course Content

Module No.	Topic	No. of Lectures
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.	5L
II	**Synthesis of Biomolecules and Interphase Systems** 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.	8L
III	**Functional Principles of Nanobiotechnology** Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification	7L

	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.	
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.	**8L**
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	**8L**
	Total	**36L**

Text Books:

1. C. M. Niemeyer, C. A. Mirkin, ―Nanobiotechnology: Concepts, Applications and Perspectives‖, Wiley – VCH, (2004).
2. David S Goodsell, "Bionanotechnology‖, John Wiley & Sons, (2004).

Reference Books:

1. T. Pradeep, ―Nano: The Essentials‖, McGraw – Hill education, (2007).
2. Challa, S.S.R. Kumar, Josef Hormes, Carola Leuschaer, ‖Nanofabrication Towards Biomedical Applications, Techniques, Tools, Applications and Impact‖, Wiley – VCH, (2005).

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**-**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**2**	**-**	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**

COURSE NAME: COMPUTERS IN MEDICINE
COURSE CODE: BME 504C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Knowledge of Computer system & Programming and Physiology.

Course Objectives:

1. To study the 8086 architecture, instruction sets and various units of PC-AT.
2. To provide the technique of data acquisition, storage, retrieval and transmission of bioinformation.
3. To describe the application of computers in patient monitoring.
4. To understand the application of computers in system modelling and pattern recognition, medical imaging and development of expert systems.

Course Outcome:

After completion of the course student will be able to

CO1: Understand the 8086 architecture, instruction sets & various unit of PC-AT, Network and database system.

CO2: Explain the techniques related to data acquisition, storage, retrieval and transmission of bio-signals.

CO3: Apply the knowledge in the area of patient monitoring, medical data storage and systems modelling.

CO4: Identify the application area of computers in medical research.

Course Content

Module No.	Topic	No. of Lectures
I	**Overview of Computer Hardware PC-AT** 8086 architecture, system connections, Instruction set & programming, Microcontrollers, Motherboard and its logic, RS232-C and IEEE bus standards, CRT controllers, FDC, HDC and Post sequence, PC based video card, modems and networking.	**8L**
II	**Network and Database** Importance of network, types of network, network software and hardware, database languages, Backup features, data recovery security features.	**6L**
III	**System Design** Multichannel computerised ECG, EMG and EEG data acquisition, storage and retrieval, transmission of signal and images	**5L**
IV	**Computers in Patient Monitoring** Physiological monitoring, automated ICU, computerised arrhythmia monitoring, information flow in a clinical lab, computerised concepts, interfacing to HIS.	**6L**
V	**Computers in Medical Systems Modelling** Radiotherapy, mathematical model of drug design, drug delivery	**7L**

	system, physiological system modelling and simulation.	
VI	**Computers in Medical Research** Role of expert systems, pattern recognition techniques in medical image classification, ANN concepts.	**4L**
	TOTAL	**36L**

Text Books:

1. R.D.Lee, "Computers in Medicine", Tata McGraw-Hill, New Delhi, 1999.
2. Michael Anbar, "Computers in Medicine", Computer Sci.P. 1987

Reference Books

1. Douglas V Hall, "Microprocessors and Interfacing : Programming and hardware", McGraw-Hill, Singapore, 1999.
2. Warner, Sorenson and Bouhaddou, "Knowledge Engineering in Health Informatics (Computers and Medicine)", Springer, 1997.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**1**
CO2	**3**	**2**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**
CO3	**3**	**2**	**2**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**

COURSE NAME: DATA STRUCTURE & ALGORITHM
COURSE CODE: BME 505A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Mathematics, Programming language

Course Objective:

The objective of the course is to provide knowledge of various data structures and algorithms; to introduce difference techniques for analyzing the efficiency of computer algorithms and provide efficient methods for storage, retrieval and accessing data in a systematic manner and explore the world of searching, sorting, traversal and graph tree algorithm along with demonstrate understanding of the abstract properties of various data structures such as stacks, queues, lists and trees.

Course Outcome:

After completion of this course student will be able to

CO1: Use different kinds of data structures which are suited to different kinds of applications, and some are highly specialized to specific tasks.

CO2: Manage large amounts of data efficiently, such as large databases and internet indexing services.

CO3: Use efficient data structures which are a key to designing efficient algorithms.

CO4: Store and retrieve data stored in both main memory and in secondary memory.

Course Content

Module No.	Topic	No. of Lectures
I	**Introduction :** Concepts of data structures: a) Data and data structure b) Abstract Data Type and Data Type. Algorithms and programs, basic idea of pseudo-code. Algorithm efficiency and analysis, time and space analysis of algorithms – order notations. Array : Different representations – row major, column major. Array representation of polynomials. Linked List : Singly linked list, circular linked list, doubly linked list, linked list representation of polynomial and applications.	8L
II	**Stack and Queue:** Stack and its implementations (using array, using linked list), applications. Queue, circular queue, dequeue. Implementation of queue- both linear and circular (using array, using linked list), applications. Recursion : Principles of recursion – use of stack, differences between recursion and iteration, tail recursion. Applications - The Tower of Hanoi.	6L
III	**Trees:** Basic terminologies, forest, tree representation (using array, using linked list). Binary trees - binary tree traversal (pre-, in-, post-order), threaded binary tree (left, right, full) - non-recursive traversal algorithms using threaded binary tree, expression tree. Binary search tree- operations (creation, insertion, deletion, searching). Height balanced binary tree – AVL tree (insertion, deletion with examples	12L

	only). B- Trees – operations (insertion, deletion with examples only). **Graphs:** Graph definitions and Graph representations/storage implementations – adjacency matrix, adjacency list, adjacency multi-list. Graph traversal and connectivity – Depth-first search (DFS), Breadth-first search (BFS) – concepts of edges used in DFS and BFS	
IV	**Sorting Algorithms:** Internal sorting and external sorting Bubble sort and its optimizations, insertion sort, shell sort, selection sort, merge sort, quick sort, heap sort (concept of max heap), radix sort. **Searching:** Sequential search, binary search, Hashing : Hashing functions, collision resolution techniques	**10L**
	TOTAL	**36L**

Text Books:

1. Data Structures Using C, by Reema Thereja, OXFORD Publications
2. Data Structures and Algorithms Using C by Amitava Nag and Joyti Prakash Singh, VIKASH Publication
3. Data Structures by S. Lipschutz.

Reference Books:

1. Data Structures Using C, by E. Balagurusamy E. Mc graw Hill)
2. Data Structures Using C and C++, by Moshe J. Augenstein, Aaron M. Tenenbaum

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**-**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: DATABASE MANAGEMENT SYSTEM
COURSE CODE: BME 505B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge on Mathematics and Basics of Data Structure.

Course Objective:

The objective of the course is to present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively - information from DBMS.

Course Outcome:

After completion of this course student will be able to

CO1: Define Database Management System, explain fundamental elements of a database management system, compare the basic concepts of relational data model, entity-relationship model.

CO2: Design entity-relationship diagrams to represent simple database application scenarios, translate entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data.

CO3: Criticize a database design and improve the design by normalization.

CO4: Choose efficient query optimization techniques, select suitable transaction management, concurrency control mechanism and Recovery management techniques.

Course Contents:

Module No.	Topic	No. of Lectures
I	**Introduction** Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.	2L
II	**Entity-Relationship Model** Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.	3L
III	**Relational Model** Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.	4L
IV	**SQL and Integrity Constraints** Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers.	8L
V	**Relational Database Design** Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies,	8L

	Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF	
VI	**Internals of RDBMS** Physical data structures, Query optimization : join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management : transaction model properties, state serializability, lock base protocols, two phase locking.	**6L**
VII	**File Organization & Index Structures** File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.	**5L**
	TOTAL	**36L**

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing. Company.

Reference Books:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill.
2. Peter Rob and Carlos Coronel, Database Systesm- Design, Implementation and Management (7/e), Cengage Learning.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO2	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**1**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO4	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**2**

COURSE NAME: CONTROL ENGINEERING
COURSE CODE: BME505C
CONTACT: 3:0:0
TOTAL CONTACT HOUR: 36
CREDIT: 3

Prerequisite: Basic Electrical Engineering, Circuit Theory, Laplace transform, Second order differential Equation.

Course Objectives:

Control Engineering plays a fundamental role in modern technological systems. The aim of this course is to serve as an introduction to control system analysis and design.
The objectives include equipping students with:

1. Basic understanding of issues related to control systems such as modeling, time and frequency responses of dynamical systems, performance specifications and controller design
2. Skills and techniques for tackling practical control system design problems

Course Outcome:

After completion of the course students will be able to

CO1: Understand and explain basic structure of control systems, basic terminologies, components.

CO2: Represent physical systems into transfer function form and thus can analyze system dynamic and steady state behavior.

CO3: Analyze system stability and design controllers, compensators in frequency domain.

Course Content:

Module No.	Topic	No. of Lectures
I	**Introduction to control system**: Concept of feedback and Automatic control, Types and examples of feedback control systems, Definition of transfer function, Poles and Zeroes of a transfer function.	3L
II	**Mathematical modeling of dynamic systems**: Writing differential equations and determining transfer function of model of various physical systems including -Translational & Rotational mechanical systems, Basic Electrical systems & transfer function , Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula.	6L
III	**Control system components**: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho- generators.Actuators.	2L
IV	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Determination of time-domain specifications of systems. Step and Impulse response of first and second order systems.	5L

	Stability by pole location. Routh-Hurwitz criteria and applications. Control Actions: Basic concepts of PI, PD and PID control, Steady-state error and error constants.	
V	**Stability Analysis by Root Locus method:** Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros.	**4L**
VI	**Frequency domain analysis of linear system**: Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria and Nyquist plots, measure of relative stability, phase and gain margin. Determination of margins in Bode plot.	**8L**
VII	**Control System performance**: Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation.	**4L**
VIII	**Case-studies**: Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, voltage control of an Alternator.	**4L**
	TOTAL	**36L**

Text books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Control System Engineering, I. J. Nagrath & M. Gopal. New Age International Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuo & F. Golnaraghi, 8th Edition, PHI

Reference Books:

1. Control Engineering Theory & Practice, Bandyopadhyaya, PHI
2. Control systems, K.R. Varmah, Mc Graw hill
3. Control System Engineering, Norman Nise, 5th Edition, John Wiley & Sons
4. Modern Control System, R.C. Dorf & R.H. Bishop, 11th Edition, Pearson Education**.**

CO - PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: BIOMEDICAL INSTRUMENTATION LAB
COURSE CODE: BME 591
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisites: Knowledge of Analog & Digital electronics

Course Objective:

1. To familiarize students with the operation of isolation transformer, DC to DC converter & its application.
2. To introduce students with timer circuits, heart-rate meter & basic operation of X-ray system.
3. To emphasis on the study of EMG, ECG, EEG & PCG waveform & analysis.
4. To acquaint the students with the design of bio-potential amplifiers, filters, power supply unit.

Course Outcome:

After completion of this course the students will be able to

CO1: Understand & implement the isolation techniques in designing biomedical instruments and describe the instrumentation & operation of an X-ray system.

CO2: Investigate & evaluate ON-Time & OFF-Time delay of a waveform.

CO3: Analyse and interpret the electrode placement and EMG, ECG, EEG and PCG waveforms with their characteristics in diagnostic point of views

CO4: Design power supply unit, bio-potential amplifiers and filters.

List of Experiment:

1. Power isolation: isolation transformer and DC-DC converters
2. Design of Timer circuits (astable multivibrator): ON delay and OFF delay study
3. Study on ECG electrodes placement and heart rate measurement.
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 X-ray radiography systems / X-ray simulator
9. Design of filter circuit.
10. Design of Power Supply Unit
11. Study on Instrumentation Amplifier-Design
12. Characterization of bio-potential amplifier for ECG & EMG signals
13. Innovative experiment

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	-	1	-	2	-	-	-	-
CO2	3	2	1	-	1	-	-	-	-	-	-	-
CO3	3	3	-	1	2	-	-	1	-	-	-	-
CO4	1	1	2	2	3	-	1	-	3	-	-	3

COURSE NAME: BIOSENSORS & TRANSDUCERS LAB
COURSE CODE: BME 592
CONTACT: 0:0:2
CREDIT: 1

Prerequisite: Fundamentals of sensors and transducers and basic electronics laboratory.

Course Objectives:

i) To study and analyze the theoretical and practical characteristics of the various transducers for the measurement of the vital physiological signals.
ii) To familiarize the students with the operation of a few transducers having biomedical applications.
iii) To provide experience on design, testing, and analysis of some electronic circuits having application in biomedical equipment.
iv) To empower the student for critically evaluate the sensor and transducer application.

Course Outcome:

After learning the course the students should able to

CO1: Understand the working principle and characteristics of different types of sensors and transducers useful in medical field.

CO2: Implement different sensors as per their applications in biomedical instrumentation.

CO3: Explain the different diagnostic methods for identification of human bio-potentials and their necessary instrumentation.

CO4: Identify the sensors and transducers applicable for a selected biomedical application.

List of Experiment:

1. Temperature measurement using AD590 IC sensor
2. Study of the characteristics of Thermistor/ RTD
3. Displacement measurement by using a capacitive transducer
4. Study of the characteristics of a LDR
5. Pressure and displacement measurement by using LVDT
6. Study of a load cell with tensile and compressive load
7. Torque measurement using Strain gauge transducer
8. Study the characteristics of piezoelectric transducer
9. Study & characterization of bio-transducers – Pressure, Temperature, Humidity
10. Study & characterization of bio-electrodes – ECG, EMG, EEG
11. Innovative experiment

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	1	-	-	-	-	-	1
CO2	3	2	2	-	2	1	-	-	-	-	1	-
CO3	3	3	2	2	2	2	1	-	-	-	1	1
CO4	3	3	2	-	2	-	1	1	-	-	-	1

COURSE NAME: DATA STRUCTURE & ALGORITHM LAB
COURSE CODE: BME 595A
CONTACT: 0:0:2
CREDIT: 1

Prerequisite: Basic Mathematics, Programming language

Course Objectives:

This course enables the students:

1. To assess how the choice of data structures and algorithm design methods impact the performance of programs.
2. To choose the appropriate data structure and algorithm design method for a specified application.
3. To solve problems using data structures such as linear lists, stacks, queues, hash tables, binary trees, heaps, binary search trees, and graphs and writing programs for these solutions.
4. Analyse and compare the different algorithms.

Course Outcomes:

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

CO1: Design and analyze the time and space efficiency of the data structure

CO2: Analyze run-time execution of previous learned sorting methods, including selection, merge sort, heap sort and Quick sort.

CO3: Gain practical knowledge on the applications of data structures.

CO4: Identity the appropriate data structure for given problem.

List of Experiment:

1. Program to Find the Number of Elements in an Array
2. Develop and Implement a menu driven program in C for the following Array operations
   a. Creating Array of N Integer elements.
   b. Display of Array elements with suitable headings.
   c. Inserting an element (ELEM) at a given valid position (POS).
   d. Deleting an element at a given valid position (POS).
   e. Exit
3. Program to convert an Infix Expression into Postfix and Postfix Evaluation
4. Program to implement stack using arrays
5. Program to implement stack using linked list
6. Program to convert infix notation to postfix notation using stacks
7. Program to implement queue using arrays
8. Program to reverse elements in a queue
9. Program to implement circular queue using arrays
10. Program to create add remove & display element from single linked list
11. Program to create add remove & display element from double linked list
12. Program to count number of nodes in linear linked list
13. Program to create add remove & display element from circular linked list
14. Programs to implement stack & queues using linked representation
15. Program to concatenate two linear linked lists
16. Program to accept a singly linked list of integers & sort the list in ascending order.

17. Program to reverse linked list
18. Program to represent polynomial using linked list
19. Program for the creation of binary tree, provide insertion & deletion in c
20. Program for pre-order, post-order & in-order traversals of a binary tree using non reccursive.
21. Program to implement bubble sort program using arrays
22. Program to implement merge sort using arrays
23. Program to implement selection sort program using arrays
24. Program to implement insertion sort program using arrays
25. Program to implement heap sort using arrays
26. Program to implement linear search using arrays
27. Program to implement binary search using arrays
28. Innovative program/ experiment

Text books:

1. Baluja G S, "Data Structure through C", Ganpat Rai Publication, New Delhi, 2015.
2. Pai G A V, "Data Structures and Algorithms: Concepts, Techniques and Applications", 2ndEdn, Tata McGraw-Hill, 2008.
3. Horowitz E., Sahni S., Susan A., "Fundamentals of Data Structures in C", 2nd Edition, University Press, 2010.

Reference books:

1. Tremblay J. P., Sorenson P. G, "An Introduction to Data Structures with Applications", 2nd Edn, McGraw-Hill, Inc. New York, NY, USA.
2. Lipschutz Seymour, "Data Structures", 6th Edn, 9th Reprint 2008, Tata McGraw-Hill.
3. Drozdek Adam, "Data Structures and Algorithms in C++", Thomson Learning, New Delhi – 2007.
4. Feller J., Fitzgerald B., "Understanding Open Source Software Development", Pearson Education Ltd. New Delhi

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	1	2	1	1	-	-	-
CO2	2	3	2	3	2	1	2	-	-	-	1	-
CO3	1	2	2	-	-	-	-	1	1	1	-	-
CO4	3	3	2	3	1	1	1	1	-	-	-	-

COURSE NAME: DATABASE MANAGEMENT SYSTEM LAB
COURSE CODE: BME 595B
CONTACT: 0:0:2
CREDIT: 1

Perquisite: Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

Course Objective:

To develop conceptual understanding of database management system for solving different industry level problems & to learn its applications.

Course Outcome:

After completion of this course students will be able to

CO1: Design and implement a database schema for a given problem-domain

CO2: Create and maintain tables using PL/SQL Course Outcome

CO3: Populate and query a database

CO4: Prepare reports

List of Experiment:

1.Study of Backend Tool – Oracle.
2. Data Definition Language (DDL) commands in RDBMS.
3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
4. High-level language extension with Cursors.
5. High level language extension with Triggers
6. Procedures and Functions.
7. Embedded SQL.
8. Database design using E-R model and Normalization.
9. Mini project (Application Development using Oracle and Visual Basic)
    i.Inventory Control System.
    ii.Material Requirement Processing
    iii.Hospital Management System
    iv.Railway Reservation System
    v.Personal Information System
    vi.Web Based User Identification System
    vii.Time-table Management System
10. Innovative experiment

Text Book

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition

Reference Book

1. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc-Graw Hill.

2. SQL & PL/SQL for Oracle 10g, Black Book, Dr.P.S. Deshpande.

CO- PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**-**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO3	**2**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
CO4	**-**	**-**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

COURSE NAME: CONTROL ENGINEERING LAB
COURSE CODE: BME 595C
CONTACT: 0:0:2
CREDIT: 1

Prerequisite: MATLAB/ SIMULINK

Course Objective:

1. The main objective is to give the students many opportunities to put the controller design principles.
2. Students learn to develop controllers for a set of interesting electromechanical hardware and software based applications.

Course Outcome:

After completion of the course students will be able to

CO1: Simulate physical systems using software simulator or hardware.

CO2: Analyze system behavior in time and frequency domain.

CO3: Design compensators, controllers to meet desired performance of a system.

List of Experiments:

1. Familiarization with MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE
2. Determination of Step response for first order & Second order system with unity feedback on CRO & calculation of control system specification like Time constant, % peak overshoot, settling time etc. from the response.
3. Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.
4. Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for 2^{nd} order system & determination of different control system specification from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determination of approximate transfer functions experimentally from Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead.
8. Innovative experiment

CO- PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	2	3	-	-	-	-	-	-	-
CO2	3	2	-	2	-	-	-	-	-	-	-	-
CO3	3	-	2	2	3	-	-	-	-	-	-	-

COURSE NAME: CONSTITUTION OF INDIA
COURSE CODE: MC 501
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 32

Prerequisite: NA

Course Objectives:

1. To enable the student about the structure, composition and importance of Indian constitution.
2. To familiarize the student on philosophy of fundamental rights and duties.
3. To illustrate the structure of executive, legislature and judiciary.
4. To understand the autonomous nature of constitutional bodies of Central and State Govt.
5. To gain knowledge of emergency on financial and administrative matter and their impact on Indian economy.

Course Outcome:

After completion of the course students will be able to

CO1: Develop human values; create awareness about law ratification and significance of Constitution.

CO2: Comprehend the Fundamental Rights and Fundamental Duties of the Indian Citizen to implant morality, social values and their social responsibilities.

CO3: Create understanding of their Surroundings, Society, Social problems and their suitable solutions.

CO4: Familiarize with distribution of powers and functions of Local Self Government.

CO5: Realize the National Emergency, Financial Emergency and their impact on Economy of the country.

Course content

Sl No.	Topic	No. of Lectures
1	Meaning of the constitution law and constitutionalism	**2L**
2	Historical perspective of the Constitution of India	**2L**
3	Salient features and characteristics of the Constitution of India	**1L**
4	Scheme of the fundamental rights	**2L**
5	The scheme of the Fundamental Duties and its legal status	**2L**
6	The Directive Principles of State Policy – Its importance and implementation	**2L**
7	Federal structure and distribution of legislative and financial powers between the Union and the States	**3L**
8	Parliamentary Form of Government in India – The constitution powers	**2L**

	and status of the President of India	
9	Amendment of the Constitutional Powers and Procedure	**2L**
10	The historical perspectives of the constitutional amendments in India	**2L**
11	Emergency Provisions: National Emergency, President Rule, Financial Emergency	**3L**
12	Local Self Government – Constitutional Scheme in India	**3L**
13	Scheme of the Fundamental Right to Equality	**2L**
14	Scheme of the Fundamental Right to certain Freedom under Article 19	**2L**
15	Scope of the Right to Life and Personal Liberty under Article 21	**2L**
	Total	**32L**

Text Books:

1. Introduction to Constitution of India, D.D. Basu, Lexis Nexus.
2. The Constitution of India, PM Bhakshi, Universal Law.

CO-PO mapping:

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

Department: Biomedical Engineering

Curriculum Structure & Syllabus
(Effective from 2018-19 admission batch)

Under Autonomy (**GR A:** ECE, EE, EIE, BME; **GR B:** CSE, IT, ME, CE, FT)

CURRICULUM AND DETAILED SYLLABUS FOR 6TH SEMESTER

6th Semester								
Sl No.	**Paper Category**	**Paper Code**	**Theory**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. THEORY								
1	PC	BME 601	Biomedical Digital Signal Processing	3	0	0	3	3
2	PC	BME 602	Analytical & Diagnostic Equipments	3	0	0	3	3
3	PC	BME 603	Advanced Imaging Systems	3	0	0	3	3
4	PE	BME 604A BME 604B BME 604C	Bioelectrical & Bioelectronic Measurement Communication Systems & Biotelemetry Medical Informatics	3	0	0	3	3
5	OE	BME 605A BME 605B BME 605C	Microprocessors & Microcontrollers VLSI & Embedded System Soft Computing	3	0	0	3	3
Total of Theory							**15**	**15**
B. PRACTICAL								
6	PC	BME 691	Biomedical Digital Signal Processing Lab	0	0	3	3	1.5
7	PC	BME 692	Biomedical Equipments Lab	0	0	3	3	1.5
8	OE	BME695A BME695B BME 695C	Microprocessors & Microcontrollers VLSI & Embedded System Lab Soft Computing Lab	0	0	3	3	1.5
9	PROJ	PR 691	Project-VI	0	0	2	2	1
10	PROJ*	PR 692	Innovative Activities-V	0	0	0	0	0.5
C.MANDATORY COURSE/ACTIVITY								
10	MC	MC 681	Group Discussion	0	0	3	3	
Total of Theory, Practical & Mandatory Course/Activity							**29**	**21**

*Students may choose either to work on participation in all the activities of Institute's Innovation Council for e.g.: IPR workshop/ Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos etc.

Innovative activities to be evaluated by the Programme Head/ Event coordinator based on the viva voce and submission of necessary certificates as evidence of activities.

COURSE NAME: BIOMEDICAL DIGITAL SIGNAL PROCESSING
COURSE CODE: BME 601
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Biomedical Signal and Systems

Course Objectives:

1. To introduce the students with the theory and the characteristics o a basic BDSP system.
2. To develop competency for transforming discrete signals & systems from time domain to frequency domain.
3. To familiarize the students with required base for developing algorithms for signal processing systems.
4. To acquaint the students with knowledge of MATLAB in designing and simulating the BDSP systems.

Course Outcome:

After completion students will be able to

CO1. Understand the fundamental techniques & applications of digital signal processing with emphasis on biomedical signals.

CO2. Apply the different computation techniques and algorithms based on discrete time signals.

CO3. Analyze the characteristics and performance requirements of BDSP system.

CO4. Design different digital filters using designing prototype to effectively perform BDSP operation.

Course Content

Module No.	Topic	No. of Lectures
I	**Introduction to Discrete Frequency Domain Transformation** Review of Discrete Fourier Series and Discrete-Time Fourier Transform - Frequency domain sampling and reconstruction of discrete time signals - The Discrete Fourier Transform - DFT as a linear transformation - relationship to other transforms -properties of DFT - frequency analysis of signals using DFT - Linear filtering methods based on DFT– Convolution - Fast Fourier Transform algorithms – decimation in time-decimation in frequency-in place computation-direct computation, radix-2 algorithm, implementation of FFT algorithms - Applications of FFT	**10L**
II	**Design of Digital Filters** General considerations - causality and its implications, characteristics of practical frequency selective filters - design of FIR filters - symmetric and anti-symmetric, linear phase-design of IIR filters from analog filters – Design of LPF, HPF, Band pass and band stop filters-Butterworth and Chebyshev filters – properties – design equations - using impulse invariance, bilinear	**12L**

	transformation, characteristics of standard filters and their designs - Frequency transformations in the analog and digital domains, spectrum estimation method (periodogram, Welch's method, etc.).	
III	**Application of DSP IN Biomedical Signal Processing** ECG Signal and its Processing: ECG Signal Filtering & Noise Removal, QRS Detection, Arrhythmia Detection, MI Detection. EMG Signal and its Processing: EMG Signal Filtering & Noise Removal, Detection of Flexion and extension. EEG Signal & its Processing: EEG Signal Filtering & Noise Removal, Decomposition of EEG Signal, Seizure Detection, Evoked Potential.	**14L**
	Total	**36L**

Text Books:

1. S. Sharma, Digital Signal Processing, SK Kataria and Sons.
2. P. Ramesh Babu, Digital Signal Processing, SCITECH.
3. S. Salivahanan, A. Vallavaraj and C. Gnanapriya, Digital Signal Processing, TMH.
4. D.C Reddy, Biomedical Digital Signal processing, TMH

Reference Books:

1. J.R. Johnson, Introduction to Digital Signal Processing, PHI.
2. T. Bose, Digital Signal and Image Processing, Wiley.
3. S.K. Mitra, Digital Signal Processing, TMH.
4. J.G. Proakis and D.G. Manolakis, Digital Signal Processing

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**
CO4	**3**	**2**	**3**	**2**	**2**	**-**	**-**	**1**	**-**	**1**	**-**	**1**

COURSE NAME: ANALYTICAL & DIAGNOSTIC EQUIPMENTS
COURSE CODE: BME 602
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge of Biomedical Instrumentation

Course objectives:

1. To familiarize students with various aspects of measuring clinical parameters from living body.
2. To introduce students with the characteristics of analytical & diagnostic equipment and their related errors.
3. To illustrate computer based analytical equipment along with various types of software used in them.
4. To acquaint students with different analyzers, endoscopic systems, flow meters etc. & their characteristics.

Course outcome:

After completion of this course the students will be able to

CO1: Understand the fundamentals and application of current chemical and scientific theories in analytical & diagnostic equipment.

CO2: Interpret the significance of all the analytical & diagnostic equipment used in Biomedical Engineering.

CO3: Analyze the working principle, functional and constructional features of different analytical & diagnostic medical instruments used for measuring various physiological parameters of human body.

CO4: Apply the proper analytical or diagnostic techniques for measuring specific medical parameters.

Course Content

Module No.	Topic	No. of Lectures
I	**Clinical Equipment** Principles of photometric measurement, Optical filters, Colorimeter, Spectrometer, Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer- Auto analyzer, Coagulometer, Ion Analyzer, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-principles and applications. Methods of cell counting Flow cytometry, Coulter Counters, automatic recognition and differential counting of cells.	**10L**
II	**Cardiac Function Measurement** **Blood pressure apparatus, Blood gas analyzers and Oximeters** Sphygmomanometer, Automated indirect and specific direct method of B.P. monitor. Blood pH measurement, Blood pCO2 measurement, Blood pO2 measurement, a complete blood gas	**10L**

	analyzer, Fiber optic based blood gas sensors, Oximeter & its Principles, Ear oximeter, Pulse oximeter, Intravascular oximeter. **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.	
III	**Pulmonary Function Measurement** Respiratory volumes and capacities, Compliance and related pressure, Spirometer, Pneumotachometer-different types, Measurement of respiration rate-impedance pneumograph / plethysmograph, apnea detector.	**6L**
IV	**Endoscopy** Basic endoscopic equipment, 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	**6L**
V	**Computer Based Instruments** Computers in Biomedical Instrumentation, Types, Computer Interfacing, Computer Network	**4L**
	Total	**36L**

Text Books:

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill.
2. R. S. Khandpur "Handbook of Analytical Instruments", 3rd Edition, Tata McGraw Hill.
3. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
4. Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India.

Reference Books:

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

CO - PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**1**
CO3	**2**	**3**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**2**	**3**	**3**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**1**

COURSE NAME: ADVANCED IMAGING SYSTEMS
COURSE CODE: BME 603
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Pre-requisite: Knowledge of basic medical imaging techniques

Course objectives:

1. To extend the knowledge of the students towards technical basis of advanced medical imaging systems.
2. To introduce the students with the physics & principles underlying the operation of the advanced imaging equipment used in medical imaging process.
3. To develop their skills to critically evaluate the performance and outputs of such systems.
4. To acquaint the students with the clinical applications of most of the advanced imaging techniques.

Course outcome:

After completion of this course the students will be able to

CO1. Understand the physics & principles behind the operations of medical imaging equipment used for advanced.

CO2. Gain integrated knowledge of the applications of physical processes to the diagnosis and treatment of disease, including an understanding of contemporary developments in professional practice**.**

CO3. Identify and analyze the basics of imaging modalities based on technological advancements and thus differentiate among them.

CO4. Interpret the most effective advanced imaging modality for a particular organ and its required safety precautions.

Course Content

Module No.	Topic	No. of Lectures
I	**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, radiation detectors, pulse height analyzer, uptake monitoring equipment, Rectilinear scanners, Gamma Camera principles, Basic principles of PET , SPECT, Scintigraphy, Dual isotope imaging.	**10**
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	**10**

	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.	
III	**Other Imaging Techniques** Fluoroscopy, Angiography, Infrared (IR) imaging, infrared photography, Thermography - Clinical applications, thermographic scanning systems, liquid crystal thermography, microwave thermography. Optical coherence tomography (OCT): Introduction and its medical applications,	**10**
IV	**Computers in Imaging Systems:** Computer systems: operating systems, monitors-Generation & transfer of images: file formats; Picture archiving and communication systems, internet & intranet, tele-radiology, medical image processing system-basic introduction.	**6**
	Total	**36L**

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", Adam Hilger, Bristol.

CO – PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	2	1	1	-	-	-	-	-	-
CO2	2	2	1	1	1	3	1	2	-	-	-	-
CO3	2	3	2	2	3	1	1	-	-	-	-	-
CO4	2	3	-	3	2	1	-	-	-	-	-	-

COURSE NAME: BIOELECTRICAL & BIOELECTRONICS MEASUREMENT
COURSE CODE: BME 604A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basics of electrophysiology, Bio-transducers and Bioinstrumentation.

Course Objectives:

1. To introduce students with the basics of bioelectrical signal & its propagation and characterization of such bio-potential.
2. To familiarize students with the acquisition of bioelectric signals through various kinds of bio-potential electrodes.
3. To impart the knowledge of electronics in the measurement of bioelectrical signals.
4. To describe the application of electronics in the development of prosthetic devices.

Course Outcome:

After completion of this course student will be able to

CO1: Understand the origin & propagation of bioelectric potentials and their characteristics.

CO2: Describe the acquisition of bio-potentials using different types of electrodes and analysis procedure.

CO3: Apply the knowledge of electronics in the measurement of bio-signals.

CO4: Implement the concept of electronics in the development of prosthetic devices.

Course Content

Module No.	Topic	No. of Lectures
I	**Introduction to Bioelectric Potentials** Introduction to Physiological systems of the body, Sources of Bioelectric potentials, Propagation of action potential, Bioelectric potentials ECG, EEG and EMG responses, Spectral characteristic of biosignals, Development of Bioelectric potential measurement, Problems encountered in measuring a living system.	**6L**
II	**Measurement of Bioelectrical Phenomenon** Generation of ECG, Electrocardiography, Measurement of heart rate and cardiac output, Cardiac Abnormality Diagnosis by ECG. Nerve impulse transmission through Spinal cord, Characteristics of Electroencephalogram (EEG), Techniques of Measurement of EEG. Generation of Muscle Action Potential, Motor movement analysis, Physiology of Electromyogram (EMG), Measurement Techniques of Electromyography.	**12L**
III	**Overview of Bioelectronics** Interactions between electronics and biomedical science; fundamental properties of ions in the solution; electrical properties of cellular	**8L**

	components: lipid bilayer and membrane proteins; Natural nanoconductors: ion channels and pumps; Single channel recording: the measurement and the noise; Patch clamp amplifier -the electronics of low noise current detection	
IV	**Development of Bioelectronic Devices** Brain-computer interface, Neural implants, Retinal Implants, Bionic arm, Cochlear implants/ Bionic ear, Artificial heart, Artificial heart-lung machine, Artificial kidney, Nerve – muscle stimulator	**10L**
	Total	**36L**

Text Books:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.
3. Ions, electrodes and membranes. By J. Koryta, John Wiley & Sons, New York, 2nd edition, 1992,
4. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

Reference Books:

1. Iberall & Guyton, Regulation & Control in Physiological System, Instruments Soc.USA.
2. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
3. S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
CO2	**3**	**3**	**2**	**-**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**-**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**1**
CO4	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**2**	**-**	**1**	**-**	**1**

COURSE NAME: COMMUNICATION SYSTEMS & BIOTELEMETRY
COURSE CODE: BME 604B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Mathematics, Digital Electronics, Signal Theory.

Course objectives:

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:

After completion of the course students will be able to

CO1: Define and analyze different methods of modulation

CO2: Analyze data communication oriented problems and solve them

CO3: Apply communication systems in telemedicine.

Course Content

Module No.	Topic	No. of Lectures
I	**Analog Communication:** Introduction to Communication Systems, Modulation: Types; Need for Modulation; Theory of Amplitude Modulation: Basic idea, Modulation and Demodulation; DSBSC and SSBSC: Basic idea, Modulation and Demodulation; Frequency Modulation: Basic idea, Modulation and Demodulation; Pulse Communication: Sampling Theorem, Pulse Amplitude Modulation (PAM): Basic idea, Modulation and Demodulation.	10L
II	**Digital Communication:** Basic concepts of digital modulation, Pulse code Modulation (PCM): Sampling, Quantization, Companding, Coding; Basic idea of DPCM, Delta Modulation; Amplitude Shift Keying (ASK): Basic idea, Modulation and Demodulation; Frequency Shift Keying (FSK): Basic idea, Modulation and Demodulation; Phase Shift Keying (PSK): Basic idea, Modulation and Demodulation; BPSK – QPSK – 8 PSK – 16 PSK: Basic idea; Quadrature Amplitude Modulation(QAM) – 8 QAM – 16 QAM: Basic idea, Modulation and Demodulation.	10L
III	**Data Communication** Data Communication: OSI Model – Basic working principle of each layer, LAN , WAN; Modem – Working Principle, Speed calculation; Switch and Router – Working Principle; Error Detection and Correction – CRC , Hamming code, Huffman coding, GSM , CDMA – Basic Idea	9L

IV	**Biotelemetry:** Introduction, fundamental of RF telemetry, Basics components and its different types; Principles of Multimedia – Video Conferencing, PSTN, ISDN, Internet; Mobile and Satellite communication : Basic idea	**7L**
	Total	**36L**

Text Books:

1. B. P.Lathi, "Modern Analog and Digital Communication Systems", 3rd Edition, Oxford University Press.
2. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons.
3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education.

Reference Books:

1. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education.
2. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications.
4. Martin S.Roden, "Analog and Digital Communication System", 3rd Edition, Prentice Hall of India.
5. B.Sklar, "Digital Communication Fundamentals and Applications" 2 nd Edition Pearson Education.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO2	**2**	**1**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**3**	**2**	**1**	**-**	**3**	**-**	**-**	**-**	**3**	**-**	**1**

COURSE NAME: MEDICAL INFORMATICS
COURSE CODE: BME 604C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic programming skills and knowledge on medical imaging.

Course Objectives:

1. Provide an overview of the major development areas in medical informatics.
2. Illustrate the students about clinical informatics including electronic health record and management.
3. Introduce students with different radiological imaging modalities and advanced diagnostic image processing.
4. Encourage the students for systems design for security, confidentiality and performance optimization through system modelling.

Course Outcome:

CO1: Understand the principles and challenges associated with combining information sciences, data, and the healthcare domain.

CO2: Discuss the implementation, management, and evaluation of information technology for improved healthcare delivery and research

CO3: Identify the appropriate methods for medical image analysis and for addressing specific problems in health care

CO4: Apply the Knowledge in designing of conceptual and theoretical framework and deploying advanced data analysis and information systems for health care practice

Course Content

Module No.	Topic	No. of Lectures
I	**Overview of Medical Informatics** Definition and importance; Medical standards- DICOM & HL7; HIS, RIS, PACS. IHE and workflow integration; Big Data in hospitals	**6L**
II	**Clinical Informatics** Basics of Clinical Informatics: Health care environment and processes; electronic health records and management; clinical decision making; clinical information retrieval; clinical natural language processing.	**8L**
III	**Imaging Informatics** Basic medical imaging: acquisition, diagnostic display, enhancement and analysis; radiological image modalities; computer aided diagnosis (CAD) and advanced diagnostic image processing; digital pathology; analytical pathology imaging	**12L**
IV	**Systems Design and Designing for Safety** Networking and teleradiology; Fault-tolerance, scalability, and robustness; Security and confidentiality in medicine; Clinical	**10L**

	modeling and performance optimization; Patient flow analysis; Clinical decision support	
	Total	**36L**

Text Books:

1. Mark A Musen, Handbook of Medical Informatics, J Van Bemmel & M.A. Musen (Editors), Springer, 2002.
2. Shortliffe, E.H., Perreault, L.E., Wiederhold, G., Fagan, L.M. (Eds.), Medical Informatics: Computer Applications in Health Care and Biomedicine, Springer.
3. Robert E. Hoyt & Ann Yoshihashi, Medical Informatics: Practical Guide for Healthcare and Information Technology Professionals Fourth Edition.

Reference Books:

1. David J Lubliner, Biomedical Informatics: An introduction to Information Systems and Software in Medicine and Health, CRC Press.
2. Dinesh Bhatia, Medical Informatics, Prentice-Hall of India Pvt.Ltd; 1st edition.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**-**	**3**	**-**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**-**	**3**	**2**	**-**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

COURSE NAME: MICROPROCESSORS & MICROCONTROLLERS
COURSE CODE: BME 605A
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge in Digital Electronics.

Course objectives:

To developed an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Course outcome:

CO1: Able to correlate the architecture, instructions, timing diagrams, addressing modes, memory interfacing, interrupts, data communication of 8085

CO2: Able to interprete the 8086 microprocessor-Architecture, Pin details, memory segmentation, addressing modes, basic instructions, interrupts

CO3: Recognize 8051 micro controller hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts

CO4: Apply instructions for assembly language programs of 8085, 8086 and 8051

CO5: Design peripheral interfacing model using IC 8255, 8253, 8251 with IC 8085, 8086 and 8051.

Course Content

Module No.	Topic	No. of Lectures
I	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).	**10L**
II	Assembly language programming with examples, Interrupts of 8085 processor, programming using interrupts, Stack and Stack Handling, Call and subroutine, DMA, Memory interfacing with 8085	**4L**
III	**8086 Microprocessor:** 8086 Architecture, Pin details, memory segmentation, addressing modes, Familiarization of basic Instructions, Interrupts, Memory interfacing, ADC / DAC interfacing. **Assembly language programming with 8086:** Addition, Subtraction, Multiplication, Block Transfer, Ascending order, Descending order, Finding largest & smallest number etc	**7L**
IV	**8051 Microcontroller:** 8051 architecture, hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts, Memory interfacing, ADC / DAC interfacing.	**4L**

V	**Assembly language Programming using 8051:** Moving data: External data moves, code memory read only data moves, PUSH and POP opcodes, data exchanges; Logical operations: Byte-level, bit-level, rotate and swap operations; Arithmetic operations: Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic; Jump and call instructions: Jump and call program range, jumps, calls and subroutines, interrupts and returns	**4L**
VI	**Support IC chips:** 8255, 8253 and 8251: Block Diagram, Pin Details, Modes of operation, control word(s) format. Interfacing of support IC chips with 8085, 8086 and 8051	**5L**
VII	**Brief introduction to PIC microcontroller (16F877):** Architecture, PIN details, memory layout.	**2L**
	Total	**36L**

Text Books:

1. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International
2. The 8051 microcontroller - K. Ayala ,Thomson
3. Microprocessors & interfacing – D. V. Hall,Tata McGraw-hill
4. Ray & Bhurchandi, Advanced Microprocessors & Peripherals, TMH
5. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson
6. An Introduction to Microprocessor and Applications –Krishna Kant,Macmillan

Reference Books:

1. Microprocessors and microcontrollers- N. Senthil Kumar, M. Saravanan and Jeevananthan,Oxford university press
2. 8086 Microprocessor –K Ayala, Cengage learning
3. The 8051 microcontrollers – Uma Rao and Andhe Pallavi ,Pearson

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**3**
CO2	**3**	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**3**
CO3	**3**	**3**	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**3**
CO5	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**3**

COURSE NAME: VLSI & EMBEDDED SYSTEM
COURSE CODE: BME 605B
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Basic Electronic circuits knowledge with BJT, FET, and MOSFET. Digital Electronics with logic gate based design and sequential and combinational circuit knowledge.

Course objectives:

Students will be able to apply the theoretical VLSI circuits and embedded systems fundamentals knowledge for designing circuits in the domain of biomedical chip (or subsystem design) or general VLSI chip design. 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 chip design in biomedical engineering field, which in turn help society to have biomedical chips for simplifying /helping everyday life either in form of advanced health care system design or in the form of biomedical computing systems or in medical image processing chip design.

Course outcome:

CO1: Describe MOS transistor based circuit operation for static and dynamic circuits.

CO2: Design subsystems with low power circuit knowledge.

CO3: Describe embedded systems architecture and hardware.

CO4: Write programs for embedded systems with RTOS knowledge.

Course Content

Module No.	Topic	No. of Lectures
I	**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
II	**CMOS combinational and sequential circuits:** basic gates, adder, CMOS transmission gates with examples,SR Latch, JK Latch, D latch, Edge triggered Flipflops.	5L
III	**Dynamic Logic Circuits:** Dynamic logic circuits basics, Pre-charge and evaluate logic, cascading problem, Domino Logic.	4L
IV	**Low power CMOS logic circuits:** switching, short circuit & leakage power dissipation, variable threshold CMOS circuits, Multiple threshold CMOS circuits, pipelining and parallel processing approach, Switching activity estimation and optimization, Adiabatic logic circuits.	6L
V	**Subsystem design:** Single bit Adder, serial-parallel multiplier, RAM, ROM, SRAM, DRAM	4L

VI	**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**
7	**Programming Concepts for Embedded systems:** High level languages, Macros, functions, data types, data structures, modifiers, statements ,loops, pointers Queue, stack, Lists and ordered lists, compilers and cross compilers.	**3L**
8	**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	**8L**
	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)

Reference Books:

1. David Hodges, Horace G Jackson & Resve A Saleh-Analysis & Design of Digital Integrated Circuits, Tata Mc Graw-Hill
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)

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO2	**3**	**2**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO3	**3**	**2**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**
CO4	**3**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**3**

COURSE NAME: SOFT COMPUTING
COURSE CODE: BME 605C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36
CREDIT: 3

Prerequisite: Knowledge on Mathematics, Set theory.

Course Objectives:

To give students knowledge of soft computing theories fundamentals, that is of fundamentals of non-traditional technologies and approaches to solving hard real-world problems, namely of fundamentals of artificial neural networks, fuzzy sets, fuzzy logic and genetic algorithms.

Course outcome:

On completion of this course student will be able to

CO1: Understand the importance of Soft Computing.

CO2: Remember different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.

CO3: Implement algorithms based on soft computing

CO4: Apply soft computing techniques to solve engineering or real life problems.

Course Content

Module No.	Topic	No. of Lectures
I	**Introduction:** Soft Computing. Difference between Hard and Soft computing, Requirement of Soft Computing, Major Areas of Soft Computing, Applications of Soft Computing.	4L
II	**Fuzzy Systems:** Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Min-max Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.	10L
III	**Genetic Algorithm:** History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.	7L
IV	**Neural Networks [8L]:** Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.	8L
V	**Multi-objective Optimization Problem Solving [6L]:**	4L

	Concept of multi-objective optimization problems (MOOPs) and issues of solving them. Multi-Objective Evolutionary Algorithm (MOEA). Some applications with MOEAs.	
VI	**Hybrid Systems:** Introduction to Hybrid Systems, Neuro Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.	**3L**
	Total	**36L**

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**1**	**1**
CO2	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**
CO3	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**2**
CO4	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**2**

COURSE NAME: BIOMEDICAL DIGITAL SIGNAL PROCESSING LAB
COURSE CODE: BME691
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Knowledge in Biomedical Signal and Systems

Course Objectives:

1. To introduce students with the basic principles, methods, and applications of digital signal processing.
2. To help students to explore its algorithmic, computational, and programming aspects.
3. To familiarize students with aspects of biomedical signal processing.
4. To facilitate students in programming of DSP hardware for real-time signal processing applications.

Course Outcome:

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

CO1. Understand the fundamental techniques and applications of DSP with emphasis on biomedical signals.

CO2. Implement the steps for collecting raw file of biomedical signal from specific database or through DAQ.

CO3. Analyze the applications of practical signal processing algorithm used in biomedical signal processing.

CO4. Design adaptive filters & algorithms for various applications of Biomedical Signal Processing.

List of Experiments:

1. Study on generalized Waveforms and Plot.
2. Study on Biomedical Signal Database.
3. Frequency Domain Description of Signals: DFT (sinusoidal signals).
4. Design and Application of Digital Filters: FIR & IIR Filters.
5. Implementation of a Practical DSP System for ECG Signals.
6. Implementation of a Practical DSP System for EMG Signals.
7. Implementation of a Practical DSP System for EEG Signals.
8. Implementation of signal processing technique on the data acquired through DAQ.
9. Introduction of coding for discrete wavelet transforms.
10. Implementation of DSP in biomedical signal processing through TMS3206713.
11. Innovative experiment.

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	1	-	-	1
CO2	2	3	3	2	2	-	-	2	1	-	-	-
CO3	2	3	2	3	2	-	-	1	-	-	-	-
CO4	3	3	3	2	3	1	1	2	-	-	1	1

COURSE NAME: BIOMEDICAL EQUIPMENT LAB
COURSE CODE: BME 692
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Knowledge in Basic Electronics & Biomedical Instrumentation

Course Objectives:

1. To introduce students with purpose & significance of different clinical instrument.
2. To facilitate the students with the working principles of different analytical & diagnostic instrument.
3. To familiarize students with the maintenance process of various analytical & diagnostic instrument.
4. To acquaint the students with the basic design principle of the major biomedical clinical equipment.

Course Outcomes:

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

CO1. Understand the fundamental principles and utilization of different biomedical analytical devices and measurement of different sample concentration & some physiological parameters using those devices.

CO2. Acquire the skills to recognize different biomedical diagnostic devices with their structures, functions and applications.

CO3. Analyze the working principle of different therapeutic devices and how they are applied to give physiotherapy to the patients.

CO4. Investigate & evaluate the problems, circuit performance in the areas of analysis, diagnosis & therapy.

List of experiments:

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

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	-	-2	-	-	-	-
CO2	2	3	2	3	2	-	-	1	-	-	-	-
CO3	3	3	2	3	2	-	-	1	-	-	-	-
CO4	2	3	2	3	1	1	1	-	-	-	-	3

SUBJECT NAME: MICROPROCESSORS & MICROCONTROLLERS LAB
SUBJECT CODE: BME 695A
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Knowledge in Digital Electronics

Course Objectives:

To apply ALP Programming for arithmetic-logical solutions and also to interpret the interfacing programming by conducting experiments.

Course Outcome:

After completion of this course the students will be able to

CO1: Solve small assignments using the 8085 basic instruction sets and memory mapping through trainer kit and simulator.

CO2: Write 8085 assembly language programs like Addition, Subtraction, Multiplication, Square, Complement, Look up table, Copying a block of memory, Shifting ,Packing and unpacking of BCD numbers, Ascending order, Descending order etc. using trainer kit.

CO3: Validate the interfacing technique using 8255 trainer kit through subroutine calls and IN/OUT instructions like glowing LEDs accordingly, stepper motor rotation etc.

CO4: Test fundamental of 8051 programs using the trainer kit.

List of Experiment:

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
3. Write a program in 8085 microprocessor to subtract 05H from 09H and store the result in 8072H. 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.
4. Write a program in 8085 microprocessor to multiply 08H with 03H and store the result in 9065H location.
5. Write a program in 8085 microprocessor to divide 07H by 03H and store the quotient in 9075H and reminder in 9076H memory location.
6. 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.
7. Write a program in 8085 microprocessor of shifting block of five (5) data from 9055H location to 9080H location.

8. 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.
9. 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
10. In 8086 microprocessor write a program to add two numbers 0465H and 2010H and store the result at different registers.
11. In 8086 microprocessor write a program to subtract two numbers 0006H from 0009H and store the result at different registers.
12. In 8086 microprocessor write a program to multiply between 24H and 45H and store the result at different registers
13. In 8086 microprocessor write a program to divide 0009H by 0002H and store the quotient and remainder at different registers.
14. 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.

    a. Port A Equ. 80H, b. Port B Equ. 81H, c. Control Register Equ. 83H
15. 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
16. Write a program in 8051 microcontroller to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.
17. 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.
18. Write a program in 8051 microcontroller to multiply 06H by 05H and store the result in RAM address 46H.
19. Innovative experiment

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	1	1	1	1	3	1	2	3
CO2	3	3	3	3	2	1	1	1	3	2	2	3
CO3	3	3	3	3	2	2	1	1	3	2	2	3
CO4	3	3	3	2	2	1	1	1	3	1	3	3

COURSE NAME: VLSI & EMBEDDED SYSTEM LAB
COURSE CODE: BME 695B
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Basic knowledge of logic gates & devices (BJT, FFET, MOSFET) and fundamentals of programming.

Course Objectives:

The objective of the course is to provide students enough practical hand to design and simulate basic VLSI circuits to advanced ones and to make students able to write the codes in latest embedded environment to integrate, acquire, activate devices sensors and in general scenario as well.

Course Outcome:

CO1: Identify circuit diagrams composed of CMOS.

CO2: Design CMOS based circuits for both static and dynamic nature.

CO3: Generate any CMOS based combinational and sequential circuit

CO4: Write programming code for embedded device to interface and acquiring senor data.

List of Experiments:

1. Design and simulation of CMOS AND, NAND, NOR gates by static CMOS design.
2. Design and simulation of 1 bit full adder and subtractor.
3. Design and simulation of single stage dynamic circuit(pre-charge and evaluate).
4. Design and simulation of a ROM circuit.
5. Design and Simulate SR,JK Latch and Flip flop.
6. Basics of arduino Board and different on board component identification.
7. Write a code to perform switching activity by arduino.
8. Write a code to perform serial communication between arduino and Host PC.
9. Write a code to read sensor data and visualization of the data.
10. Write code to interface arduino with relay with condition.
11. Innovative experiment

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	2	-	1	-	-	-	2	2	1	3
CO2	1	2	1	3	3	-	-	-	3	2	1	3
CO3	2	1	3	-	2	-	-	-	3	1	2	3
CO4	3	2	2	-	3	-	-	-	2	3	2	3

COURSE NAME: SOFT COMPUTING LAB
COURSE CODE: BME 695C
CONTACT: 0:0:3
CREDIT: 1.5

Prerequisite: Mathematics, set theory and basic computation.

Course Objectives:

To give students knowledge of soft computing theories fundamentals, that is of fundamentals of non-traditional technologies and approaches to solving hard real-world problems, namely of fundamentals of artificial neural networks, fuzzy sets, fuzzy logic and genetic algorithms.

Course Outcome:

After completion of this course student will be able to

CO1: Understand importance of soft computing techniques and tools.

CO2: Remember different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.

CO3: Implement algorithms based on soft computing techniques.

CO4: Apply soft computing techniques to solve engineering or real life problems.

List of Programs:

1. Overview of Matrix, Matrix Operations, Giving input to Matrix, Displaying elements of Matrix.
2. Performing Operations on Matrix like Addition, Subtraction, and Multiplication.
3. Performing Transpose Operations on Matrix.
4. Plotting of mathematical functions like log(x), sin(x), cos(x) etc
5. Write a Program in MATLAB to check whether a number is even or odd
6. Write a program in MATLAB to find out the sum of "N" natural numbers.
7. Write a Program in MATLAB to generate the fibonacci series upto N, where N is the desired value input by user
8. Write a MATLAB program to solve MATRIX based problems.
9. Write a MATLAB Program to implement LMS Learning rule.
10. Write a MATLAB program to verify McCulloch OR Function.
11. Write a MATLAB program to verify Hebb's Rule.
12. Write a MATLAB program to implement various Fuzzy Operations. (Eg Union, Intersection, Complement, XOR Operation) For two Fuzzy Set
    P = (0.3/a) + (0.9/b) + (1.0/c) + (0.7/d) + (0.5/e) + (0.4/f) + (0.6/g)
    Q = (1/a) + (1/b) + (0.5/c) + (0.2/d) + (0.2/e) + (0.1/f) + (0.4/g)
13. Write a MATLAB program to implement Max-Min Composition. For Two Fuzzy sets
    P = [0.3 0.7 ; 0.9 0.4 ; 0.2 0.5]
    Q = [0.4 0.1 0.8;0.3 0.7 0.6]
14. Implementation of Union , Intersection , Complement , XOR Operation and Demorgan's Law
15. Write a MATLAB program to implement MAX Composition for the two set of Matrix
    S = [0.3 0.7;0.9 0.4;0.2 0.5]

R = [0.4 0.1 0.8;0.3 0.7 0.6]

16. Write a MATLAB program to implement Deffuzification of α-cut method for the fuzzy set F = (0.6/a) + (0.3/b) + (0.7/c) + (1.0/d).
17. Project assigned by instructor to model real world problems.
18. Innovative program

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	2	-	-	-	2	-	1	1
CO2	3	2	2	2	-	-	-	-	1	-	-	1
CO3	2	3	2	2	1	-	-	-	1	-	-	2
CO4	3	2	3	2	2	-	-	-	2	-	-	2