Autonomy Curriculum & Syllabus of B.Tech (BME) 3rd Semester
Implemented From the Academic Year-2018

B.Tech BME 3rd Semester Curriculum

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	3	3	1.5
C.SESSIONAL								
9	PW	BME 381	Innovations & Technical Skill Development	0	0	3	3	1.5
Total of Theory, Practical & Sessional							27	21.5
D. PROJECT*								
10	Project Code		Project Name	Contact Hours /Week				Credit Points
	M(BME)351		Mathematics –III Project	1				0.5
	EE(BME)351		Circuit Theory Project	1				0.5
	BME 351		Engineering Physiology & Anatomy Project	1				0.5
	BME 352		Biophysical Signals & System Project	1				0.5
	BME 353		Biomechanics-I (Solid) Project	1				0.5
*Total of Project				4				2
Total of Theory, Practical, Sessional and Project				31				21.5+2

*Students need to select any four projects (Total Credit: 0.5*4 =2)

Total Credit in Semester III: 21.5+2=23.5

B.Tech BME 3rd Semester Syllabus

THEORY

Course Name: Mathematics-III
Course Code: M(BME) 301
Total Contact Hours: 44
Credit: 4

Prerequisite:

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:

CODES	BLOOM'S TAXONOMY	DESCRIPTIONS
M(BME) 301.1	Remember	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.
M(BME) 301.2	Understand	Exemplify the statistical data, probability distribution, differential equations, and numerical methods and find their distinctive measures using the underlying mathematical concepts.
M(BME) 301.3	Apply	Apply numerical methods used to obtain approximate solutions to intractable mathematical problems.
M(BME) 301.4	Apply	Apply effective mathematical tools for the solutions of partial differential equation and ordinary differential equation that model physical processes.
M(BME) 301.5	Apply	Compute the probability of real world uncertain phenomena by identifying probability distribution that fits the phenomena.
M(BME) 301.6	Analyze	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): (10 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: (10 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: (14 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: (10 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:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
M(BME) 301.1	3	1	1	-	-	-	-	-	-	-	-	1
M(BME) 301.2	3	2	1	-	-	-	-	-	-	-	-	1
M(BME) 301.3	3	2	2	-	-	-	-	-	-	-	-	1
M(BME) 301.4	3	2	2	-	-	-	-	-	-	-	-	1
M(BME) 301.5	3	2	2	-	-	-	-	-	-	-	-	1
M(BME) 301.6	3	3	2	3	-	-	-	-	-	-	-	1

SUBJECT NAME: CIRCUIT THEORY
SUBJECT CODE: EE(BME)301
TOTAL CONTACT HOURS: 39
CREDIT: 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

EE(BME)301.1 Understand, Describe, Analyze and Design series and parallel RLC circuits and solve related problems

EE(BME)301.2 Analyze circuits using Node Voltage, transient response & Mesh Current Analysis in electrical networks and solve related problems.

EE(BME)301.3. Apply and Analyze Network Theorems to electrical networks to evaluate network parameters in simplified ways.

EE(BME)301.4. Understand, Describe, Analyze and Design Graph and Trees for a given network and build network matrices and solve related problems

EE(BME)301.5. Understand Describe, Analyze and Design Coupled (Magnetic and Electromagnetic) Circuits, Resonating circuit and solve related problems

EE(BME)301.6. 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.	**7L**
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	**4L**
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	**39L**

Recommended Books:

1. Valkenburg M. E. Van, Network Analysis, Prentice Hall./Pearson Education
2. Hayt"Engg Circuit Analysis 6/e Tata McGraw-Hill
3. D.A.Bell- Electrical Circuits- Oxford
4. A.B.Carlson-Circuits- Cenage Learning
5. John Bird- Electrical Circuit Theory and Technology- 3/e- Elsevier (Indian Reprint)
6. Skilling H.H.: "Electrical Engineering Circuits", John Wiley & Sons.
7. Edminister J.A.: "Theory & Problemsof Electric Circuits", McGraw-Hill Co.
8. Kuo F. F., "Network Analysis & Synthesis", John Wiley & Sons.
9. R.A.DeCarlo&P.M.Lin- Linear Circuit Analysis- Oxford
10. P.RameshBabu- Electrical Circuit Analysis- Scitech
11. Sudhakar: "Circuits &Networks:Analysis& Synthesis" 2/e TMH
12. M.S.Sukhija&T.K.NagSarkar- Circuits and Networks-Oxford
13. Sivandam- "Electric Circuits and Analysis", Vikas
14. V.K. Chandna, "A Text Book of Network Theory & Circuit Analysis",Cyber Tech
15. Reza F. M. and Seely S., "Modern Network Analysis", Mc.GrawHill .
16. M. H. Rashid:Introduction to PSpice using OrCAD for circuits and electronics, Pearson
17. Roy Choudhury D., "Networks and Systems", New Age International Publishers.
18. D.Chattopadhyay and P.C.Rakshit: "Electrical Circuits" New Age

CO-PO MAPPING

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**
EE(BME)301.1		3	3	2		2				1		3
EE(BME)301.2		3	3	1	1	2		1	2	2		2
EE(BME)301.3		3	2	2		3					3	2
EE(BME)301.4	1	2	3	2	2	2	3	1	3	3		1
EE(BME)301.5	1		2		1			1	3	1		2
EE(BME)301.6		2	2	3			3		3		2	2

SUBJECT NAME: ENGINEERING PHYSIOLOGY & ANATOMY
SUBJECT CODE: BME 301
TOTAL CONTACT HOURS: 39
CREDIT: 3

Prerequisite: Basic knowledge of Biology (Physiology Section)

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:
Students will be able to
BME 301.1 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.
BME 301.2 Apply knowledge to comprehend and explain the corresponding structure function relationship of these physiological systems.
BME 301.3 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.
BME 301.4 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.
BME 301.5 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.	8L

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, Muscle fatigue, Rigor mortis, Sliding filament theory, Slow & fast muscle fibers, Isotonic & Isometric contraction. Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial Joint, Cartilage, Tendon, Ligament.	**8L**
4	**Renal System:** Function of kidney, Anatomy & Histology of Nephron & collecting 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.	**7L**
	TOTAL	**39L**

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

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME 301.1	**3**	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
BME 301.2	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
BME 301.3	**3**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
BME 301.4	**2**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
BME 301.5	**3**	**2**	**-**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**

SUBJECT NAME: BIOPHYSICAL SIGNALS & SYSTEMS
SUBJECT CODE: BME 302
TOTAL CONTACT HOURS: 39
CREDIT: 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:
BME 302.1.Understand mathematical description and representation of continuous and discrete time signals and systems.
BME 302.2. Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
BME 302.3. Understand and resolve the signals in frequency domain using Fourier series &Fourier transforms, including its limitationsand need for Laplace transform.
BME 302.4. Use the z-transform to analyse discrete-time signals and systems.
BME 302.5. Determine the response of the LTI system and stability of a feedback system.
BME 302.6. 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)	**8L**
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.	**9L**
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	**39L**

Text/Reference Books:

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

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BME302.1	3		1									
BME302.2	3	1	3							1		
BME302.3	3	3	3			3		3				
BME302.4		1	3	3	1							
BME302.5	3	3	1	3			1		1		3	
BME 302.6		3	1									

SUBJECT NAME: BIOMECHANICS-I (SOLID)
SUBJECT CODE: BME 303
TOTAL CONTACT HOURS: 39
CREDIT: 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

BME 303.1: Understand the fundamentals of mechanics and its application in human system.

BME 303.2: Describe the various properties of hard tissues (bone) & soft tissues (articular cartilage, tendons and ligaments) and identify the appropriate model to demonstrate mechanical behavior.

BME 303.3: Analyze the biomechanics of different human joints and also the forces at a skeletal joint for various static and dynamic human activities.

BME 303.4: 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.

BME 303.5: Understand the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.

BME 303.6: Understand the various engineering problems associated with solid biomechanics.

Course Contents

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.	**6L**
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 Muscle**,** Testing of Collagenous Connective Tissues.	**8L**
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.	**6L**
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	**39L**

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.
5. Carol A. Oatis, The Mechanics and Pathomechanics of Human Movement, Lippincott Williams & Wilkins, 2010
6. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones & Bartlett Publishers, 2013.

Reference Books

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

CO-PO Mapping:

COs	B.Tech in Biomedical Engineering Programme Outcomes (POs)											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
BME 303.1	3	3	2	-	-	-	-	-	-	-	-	-
BME 303.2	3	2	3	1	-	-	-	-	-	-	-	-
BME 303.3	3	3	-	-	2	-	-	-	-	-	-	-
BME 303.4	3	3	2	-	-	-	-	-	-	-	-	-
BME 303.5	3	3	3	2	2	2	-	1	-	-	-	-
BME 303.6	3	3	2	-	-	1	-	1	-	-	-	-

PRACTICAL

SUBJECT NAME: CIRCUIT THEORY LABORATORY
SUBJECT CODE: EE(BME)391
CREDIT: 1

Prerequisite:

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

EE(BME)391.1. Describe Analyze and Design series and parallel RLC circuits using MATLAB.

EE(BME)391.2. Analyze circuits using Node Voltage & Mesh Current Analysis in electrical networks using MATLAB.

EE(BME)391.3. Verify and analyze Network Theorems to electrical networks using MATLAB.

EE(BME)391.4. Understand Describe, Analyze and Design Graph and Trees for a given network and solve related problems using MATLAB.

EE(BME)391.5. Understand Analyze and Design Coupled Circuits and solve related problem using MATLAB.

EE(BME)391.6. Understand, Describe and Laplace Transform and its Inverse transform in electrical networks and solve related problems using MATLAB

Course Content:

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.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EE(BME)391.1	3	2	2	2	3				3	3	2	2
EE (BME)391.2		2	2			1		2	3	2		1
EE(BME)391.3				2	2	3		3	3	3		1
EE (BME)391.4		2	2	1	2	1		3	2	3	2	2
EE(BME)391.5	3		2	3		3	1		3	3		1
EE(BME)391.6		3	3	1		3	1		2	2	2	1

SUBJECT NAME: ENGINEERING PHYSIOLOGY & ANATOMY LABORATORY
SUBJECT CODE: BME 391
CREDIT: 1.5

Prerequisites: Basic knowledge of Biology (Physiology Section)

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.

Outcome:

Students will be able to

BME 391.1 Identify, understand and explain fundamentals of organ structure at the cellular, tissue, organ, & system levels.

BME 391.2 Apply knowledge of science and engineering fundamentals to get hands on exposure of the gross & microscopic approach to Anatomy & Physiology of various organs.

BME 391.3 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.

BME 391.4 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.

BME 391.5 Function effectively as an individual, and as a member in a team to conduct experiments and interpret results.

BME 391.6 Conform to Physiology Practical ethics, and understand the responsibilities and norms of Physiology Laboratory practice.

Course Contents

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).

CO – PO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
BME 391.1	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
BME 391.2	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
BME 391.3	**2**	**2**	**3**	**-**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**
BME 391.4	**2**	**2**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**
BME 391.5	**2**	**1**	**3**	**-**	**2**	**-**	**-**	**-**	**3**	**1**	**-**	**-**
BME 391.6	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**1**	**-**	**-**	**-**

SUBJECT NAME: BIOPHYSICAL SIGNALS & SYSTEMS LABORATORY
SUBJECT CODE: BME 392
CREDIT: 1.5

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:
BME 392.1. Represent & classify signals, Systems & identify LTI systems using MATLAB.
BME 392.2. Derive Fourier series and Fourier transform for different signals using MATLAB.
BME 392.3. Analyze the Continuous Time systems by performing Convolution using MATLAB
BME 392.4. Understand Discrete-time systems and LTI systems using Z-transforms using MATLAB.
BME 392.5. Understand probability concepts to find statistical properties (mean, variance, auto correlation function) of random variables using MATLAB.

Course Contents:

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

CO-PO Mapping:

CO	PO1	PO 2	PO3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO10	PO11	PO12
BME 392.1	3		1		2							
BME 392.2	2	2		3								
BME 392.3	3	3	3									
BME 392.4		2	3		1		2					3
BME 392.5			3		3							