Department of Biomedical Engineering
JIS College of Engineering

R25 (B. Tech. BME)
Curriculum & Syllabus for B. Tech Under Autonomy
Incorporation of NEP 2020

First Year Curriculum Structure (Effective from 2025-26 admission batch)

1st Year 1st Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME101	Introduction to Biomedical Engineering	3	0	0	3	3
2	SCI	Multidisciplinary	PH101	Engineering Physics	3	0	0	3	3
3	SCI	Multidisciplinary	M101	Engineering Mathematics- I	3	0	0	3	3
4	HUM	Value Added Course	HU101	Environmental Science	2	0	0	2	2
5	HUM	Value Added Course	HU102	Indian Knowledge System	1	0	0	1	1
B. PRACTICAL/ SESSIONAL									
6	ENGG	Major	BME191	Introduction to Biomedical Engineering Lab	0	0	3	3	1.5
7	SCI	Skill Enhancement Course	PH191	Engineering Physics Lab	0	0	3	3	1.5
8	ENGG	Skill Enhancement Course	ME194	Engineering Graphics & Computer Aided Design Lab	0	0	3	3	1.5
9	HUM	Ability Enhancement Course	HU191	Communication & Presentation Skill	0	0	3	3	1.5
C. MANDATORY ACTIVITIES/ COURSES									
10	MC	Mandatory Course	MC181	Induction Program	0	0	0	0	0
Total of Theory & Practical								**24**	**18**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Introduction to Biomedical Engineering
Course Code: BME101
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge of Physics and Biology.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce students to the field of Biomedical Engineering, its historical evolution, interdisciplinary nature, and the various roles and recent advancements that define the profession.
2. Develop a comprehensive understanding of the structure and function of cells, including the differences between plant and animal cells, cell organelles, and key cellular processes such as the cell cycle, mitosis, and meiosis.
3. Equip students with analytical skills for solving electrical circuit problems, including the application of Kirchhoff's laws, mesh and node analysis, and network transformations.
4. Enable students to evaluate and apply various electrical machines and drives in biomedical and industrial settings, understanding their operational principles and suitability for specific applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the evolution, scope, and interdisciplinary nature of Biomedical Engineering, including its recent advancements and professional roles.
CO2	Illustrate the structural and functional differences between plant and animal cells, and demonstrate understanding of the cell cycle and cellular processes like mitosis and meiosis.
CO3	Analyze electrical circuits using Kirchhoff's laws, mesh and node analysis, and perform network transformations involving star-delta conversions.
CO4	Evaluate the operational principles and performance of different electrical machines and drives, and justify their application in biomedical and industrial systems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	-	-	-	2	-	3
CO2	3	2	3	-	1	-	-	-	-	-	-	2	-	3
CO3	3	3	3	2	3	1	1	-	-	-	-	3	2	-
CO4	3	3	3	3	3	2	1	1	1	1	-	3	3	2
Avg.	3	2.75	2.75	2	2	1.5	1	1	1	1	-	2.5	2.5	2.67

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-I: Introduction to Biomedical Engineering 7L

Evolution of Modern Health Care System; Impact of Biomedical Engineering; Component and Scope of Biomedical Engineering; Roles Played by Biomedical Engineers; Recent Advancement in Biomedical Engineering; Fundamentals of Interdisciplinary Engineering Domains.

Module- II: Cell Biology 14L

Cell: Definition, shape and size; Cell theory; Structure of a Cell: Cell Envelop, Cytoplasm, Nucleus, Cell Organelles, Plant Cell and Animal Cell; Prokaryotic and Eukaryotic Cell; Cells grow and reproduce; Cellular differentiation; Cell metabolism; Cells respond to their external environments. Phases of Cell Cycle; Interphase; M-Phase; Amitosis or Direct Cell Division; Mitosis and its significance; Meiosis and its significance.

Module-III: Electrical Circuits and Essential Electrical Machines 15L

Introductory Concepts of Electrical Network; Kirchhoff's Laws; Node and Mesh Analysis; Methods for Analyzing DC and AC Networks; Principle of Duality; Network Transformation - Using Star to Delta and Delta to Star Network; Dot Convention for Coupled Circuits; Introduction to DC, Single Phase and Three Phase Electrical Systems; Supply, Distribution & Protective Mechanisms; Construction, Types and Basic Operating Principles of Transformers, Motors (DC, Stepper, Synchronous and Induction - Torque & Speed Control); Inverters, Control Relays and Electrical Drives.

Text Books:

1. Molecular Biology of the Cell by Bruce Alberts et al. (Garland Science)
2. Electric Circuits by James W. Nilsson and Susan A. Riedel (Pearson)
3. Biomedical Engineering Fundamentals by Joseph D. Bronzino (CRC Press)

Reference Books:

1. Handbook of Biomedical Instrumentation by R.S. Khandpur (McGraw Hill)
2. Essential Cell Biology by Alberts et al. (Garland Science)
3. Electrical Machines by P.S. Bimbhra (Khanna Publishers)

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Physics
Course Code: PH101
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Physics up to 12th standard.

Course Objective(s):

The objective of the course is to make the students able to

1. Provide foundational understanding of core physical principles such as optics, quantum mechanics, solid-state physics, and statistical mechanics relevant to engineering disciplines.
2. Develop the ability to apply theoretical knowledge of physical sciences in interpreting engineering phenomena and solving problems using scientific reasoning and quantitative analysis.
3. Expose students to the working principles of modern devices and technologies like lasers, fiber optics, semiconductors, and nanomaterials used in engineering and industrial applications.
4. Encourage scientific curiosity and innovation by connecting physical theories with practical tools and techniques in emerging fields like nanotechnology and quantum systems.
5. Understand the role of physics in interdisciplinary domains for the advancement of science, technology, and sustainable development through real-life engineering contexts.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the principles of lasers, fibre optics, and holography and apply them in modern optical and communication systems.
CO2	Identify different crystal structures and compute structural parameters such as Miller indices and packing factors; distinguish between metals, semiconductors, and insulators using band theory.
CO3	Utilize the principles of quantum theory, wave-particle duality, and Schrödinger equation—to interpret fundamental quantum phenomena.
CO4	Illustrate the basic concepts of statistical mechanics and examine their implications on microscopic particle behaviour.
CO5	Describe the properties of nanomaterials and display/storage devices and analyze their applications in modern technology.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	2	-	2	-	-	-
CO2	3	3	-	-	-	-	-	-	2	-	2	-	-	-
CO3	3	3	-	-	-	-	-	-	2	-	2	-	-	-
CO4	3	3	-	-	-	-	-	-	2	-	2	-	-	-
CO5	3	3	-	-	-	-	-	-	2	-	2	-	-	-
Avg.	3	3	-	-	-	-	-	-	2	-	2	-	-	-

Course Content:

Module 1: Modern Optics **11L**

1.01- Laser: Concepts of various emission and absorption processes, 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, related numerical problems. 6L

1.02- Fibre Optics: Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

1.03- Holography: Theory of holography (qualitative analysis), viewing of holography, applications. 2L

Module 2: Solid State Physics **5L**

2.01 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. 3L

2.02 Semiconductor: Physics of semiconductors, electrons and holes, metal, insulator and semiconductor, intrinsic and extrinsic semiconductor, p-n junction. 2L

Module 3: Quantum and Statistical Mechanics **14L**

3.01 Quantum Theory: Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: Black body radiation, Photoelectric and Compton Effect: no derivation required), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment, related numerical problems. 5L

3.02 Quantum Mechanics 1: Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions-Qualitative discussion; uncertainty principle, relevant numerical problems, Introduction of Schrödinger wave equation (only statement). 4L

3.03 Statistical Mechanics: Concept of energy levels and energy states, phase space, microstates, macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)-physical significance, conception of bosons, fermions, classical limits of quantum

statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level-Qualitative discussion. 5L

Module 4: Physics of Nanomaterials 4L

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, graphene, electronic, environment, medical).

Module 5: Storage and display devices 2L

Different storage and display devices-Magnetic storage materials, Operation and application of CRT, CRO, LED and OLED.

Text Books:

1. Concepts of Modern Engineering Physics- A. S. Vasudeva. (S. Chand Publishers)
2. Engineering Physics - Rakesh Dogra
3. Introduction to Nanoscience and Nanotechnology, An Indian Adaptation-Charles P. Poole, Jr., Frank J. Owens.
4. Quantum Mechanics – S. N. Ghosal
5. Nanotechnology – K. K. Chattopadhyay

Reference Books:

1. Optics - Ajay Ghatak (TMH)
2. Solid state Physics - S. O. Pillai
3. Quantum mechanics -A.K. Ghatak and S Lokenathan
4. Fundamental of Statistical Mechanics: B. B. Laud
5. Perspective & Concept of Modern Physics—Arthur Beiser

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Mathematics- I
Course Code: M101
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, coordinate geometry, and elementary calculus concepts including limits, continuity, differentiation, and integration.

Course Objective(s):

The objective of the course is to make the students able to

1. Develop a strong foundation in both fundamental and advanced concepts of linear algebra and calculus essential for engineering applications.
2. Build competency in applying integration techniques in multiple dimensions, including line, surface, and volume integrals, to solve problems relevant to engineering and applied sciences.
3. Gain proficiency in analyzing multivariable functions using differentiation techniques such as partial and total derivatives, Jacobians, and methods for finding extrema.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply linear algebra methods to perform matrix operations, classify matrix structures, solve systems of linear equations, and compute eigenvalues and eigenvectors in engineering contexts.
CO2	Apply differential and integral calculus to evaluate and approximate the behavior of single-variable and multivariable real-valued functions relevant to engineering scenarios.
CO3	Analyze the properties of eigenvalues and eigenvectors to assess matrix diagonalizability and interpret linear transformations using the Cayley-Hamilton theorem in engineering systems.
CO4	Analyze single-variable and multivariable real-valued functions using differential and integral calculus to model and interpret complex behavior in engineering applications.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
CO4	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
Avg.	**3**	**2.5**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.5**	**-**	**-**	**-**

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module I: Liner Algebra **11L**

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 matrix, Cayley-Hamilton theorem.

Module II: Single Variable Calculus **5L**

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Taylor's series.

Module III: Multivariable Calculus (Differentiation) **13L**

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; Maxima and minima of functions of two variables.

Module IV: Multivariable Calculus (Integration) **7L**

Double Integral, Triple Integral; Change of order in multiple integrals; Line Integral, Surface Integral, Volume Integral. Change of variables in multiple integrals.

Text Books:

1. Higher Engineering Mathematics, Grewal, B.S., Khanna Publishers, 36th Edition, 2010.
2. Advanced Engineering Mathematics, 9th Edition, Kreyszig, E., John Wiley & Sons, 2006.

Reference Books:

1. A text book of Engineering Mathematics-I, Guruprasad, S., New age International Publishers.
2. Higher Engineering Mathematics, Ramana, B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Engineering Mathematics for first year, Veerarajan, T., Tata McGraw-Hill, New Delhi, 2008.
4. A text book of Engineering Mathematics, Bali, N.P. and Goyal, M., Laxmi Publications, Reprint, 2008.
5. Calculus and Analytic geometry, 9th Edition, Thomas, G.B. and Finney, R.L., Pearson, Reprint, 2002.
6. Calculus, Volumes 1 and 2 (2nd Edition), Apostol, M., Wiley Eastern, 1980.
7. Linear Algebra - A Geometric approach, Kumaresan, S., Prentice Hall of India, 2000.
8. Linear Algebra: A Modern Introduction, 2nd Edition, Poole, D., Brooks/Cole, 2005.
9. Schaum's Outline of Matrix Operations, Bronson, R., 1988.
10. Differential and Integral Calculus, Vol. I & Vol. II, Piskunov, N., Mir Publishers, 1969.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Environmental Science
Course Code: HU101
Contact: 2:0:0
Total Contact Hours: 24
Credit: 2

Prerequisites: Basic knowledge of Physics and Biology.

Course Objective(s):

The objective of the course is to make the students able to

1. Realize the importance of environment and its resources.
2. Apply the fundamental knowledge of science and engineering to assess environmental and health risk.
3. Know about environmental laws and regulations to develop guidelines and procedures for health and safety issues.
4. Solve scientific problem-solving related to air, water, land and noise pollution.

Course Outcomes (COs):

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

COs	Statement
CO1	Able to understand the natural environment and its relationships with human activities.
CO2	The ability to apply the fundamental knowledge of science and engineering to assess environmental and health risk.
CO3	Ability to understand environmental laws and regulations to develop guidelines and procedures for health and safety issues.
CO4	Acquire skills for scientific problem-solving related to air, water, noise & land pollution.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	-	-	2	3	1	-	-	1	-	-	-
CO2	3	3	3	1	1	2	3	1	-	-	1	-	-	-
CO3	3	3	3	2	1	2	3	1	-	-	1	-	-	-
CO4	1	3	3	-	-	2	1	1	-	-	1	-	-	-
Avg.	2.25	2.75	3	1.5	1	2	2.5	1	-	-	1	-	-	-

Course Content:

Module-1: Resources and Ecosystem **6L**

1.1: Resources (4L)

Types of resources, Human resource, Population Growth models: Exponential Growth, Logistic growth curve with explanation. Maximum Sustainable Yield [Derivation]

Alternative sources of Energy [Solar energy, tidal energy, geothermal energy, biomass energy]

1.2: Ecosystem **2L**

Components of ecosystem, types of ecosystems, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Pond eco system, Food chain, Food web.

Module-2: Environmental Degradation **10L**

2.1: Air Pollution and its impact on Environment **3L**

Air Pollutants, primary & secondary pollutants, Criteria pollutants, Smog, Photochemical smog and London smog, Greenhouse effect, Global Warming, Acid rain, Ozone Layer Depletion.

2.2: Water Pollution and its impact on Environment **4L**

Water Pollutants, Oxygen demanding wastes, heavy metals, BOD [Rate equation], COD, Eutrophication, Hardness, Alkalinity, TDS and Chloride, Heavy metal (As, Hg, Pb) poisoning and toxicity. Numerical on BOD, Hardness.

2.3: Land Pollution and its impact on Environment **1L**

Solid wastes, types of Solid Waste, Municipal Solid wastes, hazardous wastes, bio-medical wastes, E-wastes,

2.4: Noise Pollution and its impact on Environment **2L**

Types of noise, Noise frequency, Noise pressure, Measurement of noise level and decibel (dB) Noise intensity, Noise Threshold limit, Effect of noise pollution on human health. Numerical on Measurement of noise level and decibel (dB) and Noise Threshold limit.

Module-3: Environmental Management **6L**

3.1: Environmental Impact Assessment **1L**

Environmental Auditing, Environmental laws and Protection Acts of India, carbon footprint, Green building practices. *(GRIHA norms)*

3.2: Pollution Control and Treatment **2L**

Air Pollution controlling devices, Catalytic Converter, Electrostatic Precipitator.

Waste Water Treatment (Surface water treatment &Activated sludge process), Removal of hardness of water (Temporary &Permanent -Permutitprocess).

3.3: Waste Management **3L**

Solid waste management, Open dumping, Land filling, incineration, composting & Vermicomposting, E-waste management, and Biomedical Waste management.

Module-4: Disaster Management **2L**

4.1: Study of some important disasters **1L**

Natural and Man-made disasters, earthquakes, floods drought, landslide, cyclones, volcanic eruptions, tsunami, oil spills, forest fires.

4,2: Disaster Management Techniques **1L**

Basic principles of disaster management, Disaster Management cycle, Disaster management policy, Awareness generation program

Department of Biomedical Engineering
JIS College of Engineering

Text Books:

1. Basic Environmental Engineering and Elementary Biology (For MAKAUT), Gourkrishna Dasmohapatra, Vikas Publishing.
2. Basic Environmental Engineering and Elementary Biology, Dr. Monindra Nath Patra & Rahul Kumar Singha, Aryan Publishing House.
3. Textbook of Environmental Studies for Undergraduate Courses, Erach Barucha for UGC, Universities Press.

Reference Books:

1. A Text Book of Environmental Studies, Dr. D.K. Asthana & Dr. Meera Asthana, S.Chand Publications.
2. Environmental Science (As per NEP 2020), Subrat Roy, Khanna Publisher.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Indian Knowledge System
Course Code: HU102
Contact: 1:0:0
Total Contact Hours: 12
Credit: 01

Prerequisites: A basic knowledge (10+2 level) of Indian history, civilization and culture.

Course Objectives:

The objective of this course is to make the students able to

1. Understand the extent and aspects of ancient Indian cultural, philosophical and scientific heritage.

2. Explore the philosophical roots of Indian knowledge, the scientific temper and quest for advanced understanding of the universe and deeper knowledge of the self.

3. Identify and describe the Indian scientific and technological tools, techniques and discoveries and assess their significance and continuing relevance.

4. Develop a liberality and open-mindedness of outlook to foster lifelong learning.

5. Acquire the skills to apply traditional knowledge in their everyday lives.

Course outcome:

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

COs	Statement
CO1	Define, identify, describe and classify the philosophical, literary and socio-religious heritage of ancient India and the core concepts of the Vedic corpus and way of life.
CO2	Discover, enumerate, compare, contrast and categorize the importance of pioneering developments in science and mathematics and evaluate their continuing relevance.
CO3	Analyze, appraise, correlate and describe the ancient Indian heritage in science and technology and examine technological correlations with present-day technological applications.
CO4	Discover, assess and describe traditional knowledge in health care, architecture, agriculture and other sectors and to explore the history of traditional Indian art forms.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	1	2	-	3	-	3	-	-	-
CO2	2	-	1	-	-	2	-	-	3	-	3	-	-	-
CO3	3	1	1	1	2	3	-	-	3	-	3	-	-	-
CO4	2	-	1	-	2	3	-	-	3	-	3	-	-	-
Avg.	2.33	1	1	1	2	2.25	2	-	3	-	3	-	-	-

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-1: An overview of Indian Knowledge System (IKS) 3L

Importance of Ancient Knowledge - Definition of IKS - Classification framework of IKS - Unique aspects of IKS.

The Vedic corpus: Vedas and Vedangas - Distinctive features of Vedic life.

Indian philosophical systems: Different schools of philosophy (Orthodox and Unorthodox).

Module-2: Salient features of the Indian numeral system 3L

Developments in Indian Mathematics in ancient India - Importance of decimal representation - The discovery of zero and its importance - Unique approaches to represent numbers- Contribution of ancient Indian mathematicians

Highlights of Indian Astronomy: Historical development of astronomy in India- key contributions of ancient Indian astronomers.

Module-3: Indian science and technology heritage 3L

Metals and metalworking - Mining and ore extraction –Structural engineering and architecture in ancient India: planning, materials, construction and approaches- Dyes and painting; Shipbuilding.

Module-4: Traditional Knowledge in Different Sectors 3L

Traditional knowledge and engineering. Traditional Agricultural practices (resources, methods, technical aids); Traditional Medicine and Surgery; History of traditional Art forms and Culture.

Text Books:

1. Amit Jha . *Traditional Knowledge System in India*. New Delhi: Atlantic Publishers, 2024.
2. B. Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana . *Introduction to Indian Knowledge System: Concepts and Applications*. New Delhi: PHI, 2022.
3. Angad Godbole. *Science and Technology in Ancient India*. New Delhi: Biblia Implex, 2023.
4. Pritilakshmi Swain. *Indian Knowledge System*. New Delhi: Redshine Publication, 2024.
5. Vishnudut Purohit. *Fundamentals of Indian Knowledge System*. New Delhi: ABD Publishers, 2024.

Reference Books:

1. A. L. Basham. *The Wonder that was India*. Vol. I. New Delhi: Picador, 2019.
2. Arun Kumar Jha and Seema Sahay ed. *Aspects of Science and Technology in Ancient India.* Oxford and New Delhi: Taylor and Francis, 2023.
3. Kapil Kapoor and Awadhesh Kumar Singh. *Indian Knowledge Systems*. Vols. 1 and 2. New Delhi: D. K. Printworld, 2005.

4. S. N. Sen and K. S. Shukla, *History of Astronomy in India*. New Delhi: Indian National Science Academy, 2nd edition, 2000.
5. Arpit Srivastava. *Indian Knowledge System*. Rewa: AKS University, 2024.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Introduction to Biomedical Engineering
Course Code: BME191
Contact: 0:0:3
Credit: 1.5

Prerequisites:

- Basic understanding of **cell biology** (cell types, mitosis, meiosis).
- Fundamental knowledge of **DC circuits, Kirchhoff's laws,** and **electrical machines.**

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the foundational concepts and interdisciplinary nature of Biomedical Engineering, covering its evolution, scope, recent advancements, and professional roles through conceptual understanding and discussion.
2. Develop practical knowledge of cell biology, including the identification of different cell types and understanding of cellular processes such as mitosis and meiosis through hands-on experiments using slides and temporary mounts.
3. Equip with analytical skills in basic electrical engineering, including circuit analysis using Kirchhoff's laws, mesh and nodal analysis, and star-delta transformations through simulation and lab-based experiments.
4. Enable to evaluate the characteristics and performance of electrical machines and drives, particularly transformers and induction motors, and relate their application to biomedical systems through laboratory experimentation and innovation.

Course Outcomes (COs):

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

COs	Statement
CO1	Identify various cell types and phases of cell division using microscopy.
CO2	Prepare and observe temporary mounts of biological samples
CO3	Apply Kirchhoff's laws and perform circuit analysis on DC electrical circuits.
CO4	Evaluate transformer and electrical machine performance through experiments.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	-	-	-	2	-	3
CO2	3	2	2	1	1	-	-	-	-	-	-	2	-	2
CO3	3	3	3	2	3	1	1	-	-	-	-	3	2	-
CO4	3	3	3	3	3	2	1	1	1	1	-	3	3	2
Avg.	3	2.75	2.5	1.75	2	1.5	1	1	1	1	-	2.5	2.5	2.33

List of Experiments:

1. Identification of permanent slides: Prokaryotic Cell, Eukaryotic cell, Plant & Animal Cell.

2. Preparation & Observation of temporary mounts of human cheek squamous epithelial cells
3. Preparation & Observation of temporary mounts of Striated muscle fibers
4. Study of the phases of mitosis using permanent slides.
5. Study of the phases of meiosis using permanent slides.
6. Verification of Kirchhoff's Laws
7. Mesh and Nodal Analysis in DC Circuits
8. Star-Delta and Delta-Star Transformation
9. Transformer Characteristics and Efficiency
10. Study of Three-Phase Induction Motor
11. Innovative experiment

Textbooks:

1. *Electrical Circuits by James W. Nilsson and Susan A. Riedel (Pearson)*
2. *Electrical Machines, Drives and Power Systems by Theodore Wildi (Pearson)*

Reference Books:

1. *Cell Biology by P.S. Verma and V.K. Agarwal (S. Chand)*
2. *Electrical Machines by P.S. Bimbhra (Khanna Publishers)*
3. *Network Analysis by M.E. Van Valkenburg (Prentice Hall)*

Course Name: Engineering Physics Lab
Course Code: PH191
Contact: 0:0:3
Credit: 1.5

Prerequisites: Knowledge of Physics up to 12^{th} standard.

Course Objective(s):

The objective of the course is to make the students able to

1. Become familiar with scientific instruments and measurement techniques used to determine various physical parameters of materials and systems.
2. Reinforce theoretical concepts learned in classroom physics by performing related practical experiments and observing real-time outcomes.
3. Develop a systematic and analytical approach to collecting, organizing, and interpreting experimental data for error analysis and validation of physical laws.
4. Engage in the experimental validation of physical laws through laboratory activities involving classical mechanics, optics, electronics, and quantum phenomena.
5. Encourage innovation and problem-solving abilities through hands-on investigation of advanced and application-oriented physics experiments, including specially designed extension activities.

Department of Biomedical Engineering
JIS College of Engineering

Course Outcomes (COs):

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

COs	Statement
CO1	Determine mechanical properties such as Young's modulus and rigidity modulus through hands-on experiments and analyze material behaviour under applied forces.
CO2	Perform optical experiments including Newton's Rings, laser diffraction, and optical fiber characterization, and interpret the results based on wave optics principles.
CO3	Investigate quantum effects such as the photoelectric effect and atomic transitions, and relate experimental outcomes to basic quantum principles.
CO4	Study the performance of semiconductor and electronic devices like solar cells, LEDs, and LCR circuits, and investigate their operational characteristics.
CO5	Conduct experiments such as Hall Effect, e/m determination, prism dispersion, or optical rotation to demonstrate the application of advanced physical principles in practical scenarios.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**3**	**-**	**-**		**-**	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**
CO3	**3**		**-**	**-**	**3**	**-**	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**
CO4	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**
Avg.	**3**	**3**	**-**	**-**	**3**	**-**	**-**	**3**	**2**	**-**	**2**	**-**	**-**	**-**

Course Content:

Module 1: General idea about Measurements and Errors (One Mandatory)

a) Error estimation using Slide callipers/ Screw-gauge/travelling microscope for one experiment.

Module 2: Experiments on Classical Physics (Any 4 to be performed from the following experiments)

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of Young's moduli of different materials.
3. Determination of Rigidity moduli of different materials.
4. Determination of wavelength of light by Newton's ring method.
5. Determination of wavelength of light by Laser diffraction method.
6. Optical Fibre-numerical aperture, power loss.

Module 3: Experiments on Quantum Physics (Any 2 to be performed from the following experiments)

7. Determination of Planck's constant using photoelectric cell.
8. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
9. Determination of Stefan's Constant.

10.

a) Study of characteristics of solar cell (illumination, areal, spectral)
b) Study of characteristics of solar cell (I-V characteristics, Power-load characteristics, Power-wavelength characteristics)

Module 4: Perform at least one of the following experiments

11. Determination of Q factor using LCR Circuit.
12. Study of I-V characteristics of a LED/LDR.
13. Determination of band gap of a semiconductor.

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

Module 5: Probable experiments beyond the syllabus

1. Determination of the specific charge of the electron (e/m) from the path of an electron beam by Thomson method.
2. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor3. Study of dispersive power of material of a prism.
3. Determination of thermal conductivity of a bad/good conductor using Lees-Charlton / Searle apparatus.
4. Determination of the angle of optical rotation of a polar solution using polarimeter.
5. Any other experiment related to the theory.

Text book:

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)

2. Practical Physics by K.G. Mazumder (New Central Publishing) 3. Practical Physics by R. K. Kar (Book & Allied Publisher)

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Graphics & Computer Aided Design Lab
Course Code: ME194
Contact: 0:0:3
Credits: 1.5

Prerequisites: Basic knowledge of geometry

Course Objectives:

The objective of the course is to teach detailed engineering drawing and modeling of a component or system for a given dimension or constraints through ample understanding of engineering views, projections and sections. It will help students to acquire the manual drawing techniques as well as computer aided graphics skills, using modern engineering tools to communicate their design effectively in industries.

Course Outcomes:

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

COs	Statement
CO1	Use common drafting tools with the knowledge of drafting standards.
CO2	Understand the concepts of engineering scales, projections, sections.
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 represent a design project work.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	3	-	2	1	-	2	-	1	-	-	-	-
CO2	-	-	3	-	2	1	-	2	-	1	-	-	-	-
CO3	-	-	3	-	3	1	-	2	-	2	-	-	-	-
CO4	-	-	3	-	3	1	-	2	-	2	-	-	-	-
Avg.	-	-	3	-	2.5	1	-	2	-	1.5	-	-	-	-

Course Contents:

Basic Engineering Graphics: **3P**

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 **6P**

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 **6P**

Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on 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 6P

Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape ofthe 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: **3P**

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 3P

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 6P

Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerance; 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); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project 3P

Illustrating Geometry and topology of engineered components: creation of engineering models and presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; 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 PublishingHouse
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, KhannaPublishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, PearsonEducation
4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Communication and Presentation Skill
Course Code: HU191
Contact: 0:0:3
Credit: 1.5

Pre requisites: Basic knowledge of LSRW skills.

Course Objectives: The objectives of the course are to make the students able to

1. Acquire interpersonal communication skills of listening comprehension and speaking in academic and professional situations.
2. Understand English pronunciation basics and remedy errors.
3. Operate with ease in reading and writing interface in global professional contexts.
4. Deliver professional presentations before a global audience.
5. Develop confidence as a competent communicator.

Course Outcomes (COs):

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

COs	Statement
CO1	Recognize, identify and express advanced skills of Technical Communication in English and Soft Skills through Language Laboratory.
CO2	Understand, categorize, differentiate and infer listening, speaking, reading and writing skills in societal and professional life.
CO3	Analyze, compare and adapt the skills necessary to be a competent interpersonal communicator in academic and global business environments.
CO4	Deconstruct, appraise and critique professional writing documents, models and templates.
CO5	Adapt, negotiate, facilitate and collaborate with communicative competence in presentations and work-specific conclaves and interactions in the professional context.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	1	2	3	-	-	-	-
CO2	-	2	-	-	-	2	-	-	-	3	-	-	-	-
CO3	-	-	-	-	-	2	-	-	3	3	-	-	-	-
CO4	-	2	-	-	-	-	-	3	-	3	-	-	-	-
CO5	-	-	-	-	-	3	-	-	3	3	-	-	-	-
Avg.	-	2	-	-	-	2.33	-	2	2.67	3	-	-	-	-

Course Contents:

Module 1: Introduction Theories of Communication and Soft Skills

a. Communication and the Cyclic Process of Communication (Theory, benefits and application)
b. Introduction to Workplace Communication (Principles and Practice)
c. Non-Verbal communication and its application
c. Soft Skills Introduction: Soft-Skills Introduction

Department of Biomedical Engineering
JIS College of Engineering

What is Soft Skills? Significance of Soft-Skills
Soft-Skills Vs. Hard Skills
Components of Soft Skills
Identifying and Exhibiting Soft-Skills (Through classroom activity)

Module 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c.Differences between Listening and Hearing, Critical Listening, Barriers to Active Listening, Improving Listening.
d. Listening in Business Telephony and Practice
Practical (Role plays, case studies)

Module 3: Speaking Skills
a. Effective Public Speaking: Public Speaking, Selecting the topic for public speaking, (Understanding the audience, Organizing the main ideas, Language and Style choice in the speech, delivering the speech, Voice Clarity). Practical (Extempore)
Self-Learning Topics: Preparation, Attire, Posture and Delivery techniques

b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focused activities—JAM, Conversational Role Plays, Speaking using
Picture/Audio
Visual inputs
d. Group Discussion: Principles, Do's and Don'ts and Practice;

Module 4: Writing and Reading Comprehension
a. Reading and Writing a Book Review (classroom activity)
b. Writing a Film Review after watching a short film (classroom activity)
c. Reading Strategies: active reading, note-taking, summarizing, and using visual aids like diagrams and graphs
d. Solving Company-Specific Verbal Aptitude papers (Synonyms, Antonyms, Error Correction and RC Passages).

Module 5: Presentation Skills
Kinds of Presentation. Presentation techniques, planning the presentation,
Structure of presentation: Preparation, Evidence and Research, Delivering the presentation, handling questions, Time management, Visual aids.

- Self-Introduction, Creation of Video Resume`
- Need for expertise in oral presentation.•Assignment on Oral presentation.
- Rules of making micro presentation (power point). Assignment on micro presentation

Text Books:

1. Pushp Lata and Sanjay Kumar. *A Handbook of Group Discussions and Job Interviews*. New Delhi: PHI, 2009.
2. Jo Billingham. *Giving Presentations*. New Delhi: Oxford University Press, 2003.
3. B. Jean Naterop and Rod Revell. *Telephoning in English*. 3rd ed. Cambridge: Cambridge University Press, 2004.
4. Jeyaraj John Sekar. *English Pronunciation Skills: Theory and Praxis*. New Delhi: Authorspress, 2025.

5. Career Launcher. *IELTS Reading: A Step-by-Step Guide*. G. K. Publications. 2028

Reference Books:

1. Ann Baker. *Ship or Sheep? An Intermediate Pronunciation Course*. Cambridge: Cambridge University Press, 2006.
2. Barry Cusack and Sam McCarter. *Improve Your IELTS: Listening and Speaking Skills.* London: Macmillan, 2007.
3. Eric H. Glendinning and Beverly Holmström. *Study Reading.* Cambridge: Cambridge University Press, 2004.
4. Malcolm Goodale. *Professional Presentations*. New Delhi: Cambridge University Press, 2005.
5. Mark Hancock. *English Pronunciation in Use*. Cambridge: Cambridge University Press, 2003.
6. Tony Lynch, *Study Listening*. Cambridge: Cambridge University Press, 2004.
7. J. D. O'Connor. *Better English Pronunciation*. Cambridge: Cambridge University Press, 2005.
8. Peter Roach. *English Phonetics and Phonology: A Practical Course*. Cambridge: Cambridge University Press, 2000.

Department of Biomedical Engineering
JIS College of Engineering

1st Year 2nd Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME201	Bioelectronics	3	0	0	3	3
2	ENGG	Major	BME202	Biomechanics- I	3	0	0	3	3
3	ENGG.	Minor	CS202	Introduction to Artificial Intelligence	2	0	0	2	2
4	SCI	Multidisciplinary	CH201	Engineering Chemistry	2	0	0	2	2
5	SCI	Multidisciplinary	M201	Engineering Mathematics –II	3	0	0	3	3
6	HUM	Value Added Course	HU205	Constitution of India & Professional Ethics	1	0	0	1	1
7	HUM	Ability Enhancement Course	HU203	Design Thinking & Innovation	1	0	0	1	1
B. PRACTICAL/ SESSIONAL									
8	ENGG	Major	BME291	Bioelectronics Lab	0	0	3	3	1.5
9	ENGG	Major	BME292	Biomechanics-I Lab	0	0	3	3	1.5
10	SCI	Skill Enhancement Course	CH291	Engineering Chemistry Lab	0	0	***2***	2	1
11	ENGG	Minor	CS292	Introduction to Artificial Intelligence Lab	0	0	3	3	1.5
12	ENGG	Skill Enhancement Course	ME293	IDEA LAB Workshop	0	0	3	3	1.5
C. MANDATORY ACTIVITIES/ COURSES									
13	MC	Mandatory Course	MC281	NSS/ Physical Activities/ Meditation & Yoga/ Photography/ Nature Club	0	0	0	0	0
Total of Theory & Practical								**29**	**22**
Total Credit in First Year									**40**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Bioelectronics
Course Code: BME201
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Fundamental knowledge of Physics and Mathematics.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the fundamental concepts of electrical circuits, including passive components, signal sources, and the basic principles of circuit analysis and filtering.
2. Develop an understanding of semiconductor devices such as diodes, transistors, and their applications in rectifiers, clipping/clamping, and amplification circuits.
3. Provide knowledge on the operation of operational amplifiers and oscillators, and their use in designing analog circuits like amplifiers, integrators, differentiators, and signal generators.
4. Explore the integration of electronics and communication systems in biomedical applications, including physiological signal monitoring, bioinstrumentation, and telemedicine.

Course Outcomes (COs):

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

COs	Statement
CO1	Illustrate the basic components, circuits and devices of electrical and electronics engineering.
CO2	Apply the concept of diode in rectifiers, filters circuits and wave shaping.
CO3	Implement the simple circuits like amplifiers, integrator and differentiator using OPAMPS and BJT.
CO4	Evaluate the operational principles and performance of different electrical machines and drives, and justify their application in biomedical and industrial systems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	-	-	-	2	2	2
CO2	3	3	2	2	2	-	-	-	-	-	-	3	2	2
CO3	3	3	3	2	2	-	-	-	1	1	-	3	2	3
CO4	3	2	2	2	3	2	1	1	1	2	1	3	3	3
Avg.	3	2.5	2.25	1.75	2	2	1	1	1	1.5	1	2.75	2.25	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Basic Circuits Concepts 7L

Passive components: Resistance, Inductance, Capacitance; series, parallel combinations; Kirchhoff's law: Voltage, Current; Linearity; Signal sources: Voltage and Current sources; Non-ideal sources; concept of Gain, Trans-conductance, Trans-impedance; Introduction to Filters (LPF, BPF & HPF); Working Principle of Transformer.

Module- 2: Diodes and Transistors 8L

Semiconductor; P-N Junction Diode Characteristics, Diode applications: Clipper; Clamper circuits, Zener diode, LED, Photodiode; Rectifier; Half wave, Full wave (center-tapped, bridge), Regulated power supply.

BJT configuration and Characteristics (Common Emitter, Common Base, Common Collector), Transistor as an amplifier, Transistor biasing- basic idea, Thermal compensation, Construction and working principle of JFET and MOSFET.

Module- 3: The Operational Amplifier and Oscillator 8L

Basic feedback theory; positive and negative feedback; Advantages of negative feedback.

Ideal OPAMP characteristics; Virtual ground concept; Inverting Amplifier, Non-inverting Amplifier, Adder, Subtractor.

Oscillator- Concept of Tank circuit; Barkhausen criteria; Type of Oscillator- Basics of RC, LC and Crystal Oscillator.

Module- 4: Networking System 8L

Introduction, Wired and Wireless Communication system, LAN, MAN, WAN, Internet/Intranet, Transmission media, OSI model, Modem, Switch, IP Address, Router, Bluetooth.

Module- 5: Application of Bioelectronics System 5L

Bioinstrumentation system: Transducer, Strain Gauge; Remote Monitoring, Physiological Parameter Monitoring, Audio-Video System; Telemedicine.

Text Books:

1. D. Chattopadhyay, P C Rakshit: Electronics Fundamentals and Applications, New Age International.
2. Millman & Halkias, Integrated Electronics, Tata McGraw Hill.
3. E. Hughes: “Electrical and Electronics Technology”, Pearson, 2010.
4. BL Theraja & AK Theraja: Textbook of electrical technology. S. Chand Limited, 2006.

Reference Books:

1. John D. Ryder, Electronic Fundamentals and Applications, PHI
2. Sandro Carrara, Krzysztof Iniewski (Eds.): Handbook of Bioelectronics- Directly Interfacing Electronics and Biological Systems. Cambridge University Press, September 2015.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomechanics-I
Course Code: BME202
Contact: 3:0:0
Contact Hours: 36
Credits: 3

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

Course Objective(s):

The objective of the course is to make the students able to

1. Provide a foundational understanding of the principles of mechanics and their relevance to static and dynamic analysis in human biomechanics.
2. Introduce the biomechanical structure and function of joints and tissues, enabling students to understand joint mechanics, muscle action, and tissue remodeling in health and disease.
3. Develop the ability to analyze human motion and gait dynamics using biomechanical tools and concepts, including joint forces and pressure mapping.
4. Explore the design, evaluation, and failure mechanisms of orthopedic and cardiac implants, preparing students to assess implant performance under biomechanical loads.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the principles of mechanics and their application in analyzing static and dynamic conditions in human movement and biomechanics.
CO2	Apply biomechanical principles to evaluate joint functions, gait dynamics, and tissue behavior in normal and pathological conditions.
CO3	Analyze mechanical properties of biological tissues and cardiovascular components to interpret their functional and pathological performance.
CO4	Evaluate the design criteria, failure mechanisms, and performance of orthopedic and cardiac implants under biomechanical loading conditions.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	3	2	2	2	-	-	-	-	-	-	3	3	2
CO3	3	3	-	3	2	-	-	-	-	-	-	3	2	3
CO4	3	3	3	2	3	1	1	-	1	2	1	3	2	3
Avg.	3	2.75	2.5	2.33	2.33	1	1	-	1	2	1	2.75	2.25	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content

Module- 1: Introduction to Biomechanics 5L

Review of the principles of mechanics, Vector mechanics- Resultant forces of Co-planer and Non-co-planer and Concurrent and 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.

Module- 2: Joint Biomechanics 6L

Types of skeletal joints, Types of synovial joints, Movements at synovial joints, forces and stresses in human joints, Mechanisms of joint stability: Bony, ligamentous, and muscular contributions Biomechanics of elbow, shoulder, hip, knee and ankle.

Module- 3: Tissue Biomechanics 7L

Constitutive Properties of Tissues, Structure and Mechanical Properties of Bone, Bone Mechanics and Remodelling- viscoelastic properties, Maxwell and Voight models – anisotropy. Electrical properties of bone. Structure, Functions, Mechanical Properties and Modelling of Collagen and Collagenous Tissues: Cartilage, Tendon, Ligament and Muscle, Testing of Collagenous Connective Tissues. Tissue repair and regeneration.

Module- 4: Movement Biomechanics 4L

Gait analysis, body and limbs: mass and motion characteristics actions, forces transmitted by joints. Joints forces results in the normal and disable human body, Biomechanics of walking and running. Joint Biomechanics in Movement, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Moment of inertia-limb.

Module- 5: Cardiac Biomechanics 4L

Cardiovascular system, Mechanical properties of heart (cardiac chambers and valves) and blood vessels (arteries, arterioles, capillaries and veins). Cardiac Cycle and Heart Mechanics, Introduction to stent and Artificial heart valves, biological and mechanical valves development, testing of valves.

Module- 6: Implant Mechanics 5L

General concepts of Implants, classification of implants, Soft tissue replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of Orthopaedic implant, Dental implant, Ocular implant etc. Specifications for a prosthetic joint, fixation of implants, Implant failure mechanism.

Module- 7: Problems and Failures associated with Biomechanics 5L

Biomechanical Problems and Failures: 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. Common Musculoskeletal Injuries and Their Biomechanics.

Text Books:

1. R. M. Kennedy, A textbook of Biomedical Engineering, GTU, 2010
2. Richard Shalak and Shu Chien, Handbook of Bioengineering,

3. Sean P. Flanagan, Flanagan, Biomechanics: A case-based Approach, Jones and 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 and Wilkins, 2010
2. Sean P. Flanagan, Flanagan, Biomechanics: A Case Based Approach, Jones and Bartlett Publishers, 2013.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009
4. White and Puyator, Biomechanics, Private publication UAE, 2010

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Introduction to Artificial Intelligence
Course Code: CS202
Contact: 2:0:0
Contact Hours: 30
Credits: 2

Prerequisite: Basic Computer Knowledge.

Course Objective(s):

The objective of the course is to make the students able to

1. Comprehend the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context.
2. Formulate a problem as State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
3. Use the strategies of AI-Heuristics to find acceptable solutions avoiding brute-force techniques.
4. Design AI-Frameworks for Inferencing based on knowledge base.
5. Analyse the effectiveness of AI-Inferencing Model in offering solutions to the respective problem.

Course Outcomes (COs):

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

COs	Statement
CO1	Understand and explain the fundamental concepts of Knowledge Representation and Inferencing in Artificial Intelligence and its utilitarian importance in current technological context for further exploration leading towards lifelong learning.
CO2	Identify and formulate an engineering problem primarily to fit a State-Space Exploration Framework or an Inferencing Model/Agent Design Framework within the scope of Artificial Intelligence paradigm.
CO3	Explore relevant literature and apply the concept of Heuristic Techniques of Artificial Intelligence to solve problems.
CO4	Develop Inferencing Models for proposing solutions to the problems of Artificial Intelligence.
CO5	Implement Inferencing Models of Artificial Intelligence through developing feasible algorithms and investigate their effectiveness by analyzing their performances in solving the relevant problems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	3	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	2	-	-	-
CO5	2	2	3	3	2	-	-	-	-	-	2	-	-	-
Avg.	2.2	2.2	2.67	2.67	2	-	-	-	-	-	2.33	-	-	-

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module 1: Introduction to Artificial Intelligence 3L

Why AI, Definition of AI, Goals of AI, History and evolution of AI, Types of AI: Narrow, General, Super, Human vs Artificial Intelligence, Applications of AI in various domains, AI for social good

Module 2: Intelligent Agents and Logic-Based Thinking 8L

Intelligent systems, Agents and environments, Decision making using rules and logic, Symbolic AI concepts, Propositional Logic: Knowledge Representation and Inference using Propositional Logic, Predicate Logic: Knowledge Representation, Inference and Answer Extraction using First Order Predicate Logic

Module 3: Overview of AI Branches and Perception 8L

Machine learning, Deep learning, Natural language processing, Computer vision, Expert systems, Fuzzy logic, Evolutionary algorithms, Reinforcement learning, Planning, and scheduling, Human-AI collaboration

Module 4: Basics of Machine Learning 6L

What is machine learning, AI vs ML, Types of learning: supervised, unsupervised, Concept of dataset, features, and labels, ML model and prediction flow, Common ML applications, Introduction to decision trees (concept only), ML pipeline overview.

Module 5: Applications and Ethics of AI 5L

AI in robotics and automation, AI-enabled smart applications, Industry 4.0 and intelligent systems, AI in different sectors: healthcare, agriculture, transport, education, etc. Human-AI teamwork, Basics of AI ethics: bias, fairness, privacy, Career opportunities and future scopes in AI.

Text Books:

1. AI for Everyone: A Beginner's Handbook for Artificial Intelligence (AI), Saptarsi Goswami, Amit Kumar Das, Amlan Chakrabarti, Pearson.
2. Artificial Intelligence, Rich, E., Knight, K and Shankar, Tata McGraw Hill, 3rd Edition, B. 2009.
3. Artificial Intelligence - A Modern Approach, Russell, S. and Norvig, Prentice Hall, 3rd edition, P. 2015

Reference Books:

1. Artificial Intelligence: Beyond Classical AI, Reema Thareja, Pearson.
2. Introduction to Artificial Intelligence and Expert Systems, Patterson, Pearson.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Chemistry
Course Code: CH201
Contact: 2:0:0
Contact Hours: 24
Credits: 2

Prerequisite: Knowledge of 10+2 level chemistry.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.
2. Apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.
3. Apply the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.
4. Analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.
5. Evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices

Course Outcomes (COs):

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

COs	Statement
CO1	Understand the basic principles of atomic structures and periodic properties of elements, different engineering materials, advanced polymers.
CO2	Apply the knowledge of free energy, energy storage device and semiconductors to design environment friendly and sustainable devices.
CO3	Utilize the concept of corrosion and fuel to improve its efficacy and application for industrial purpose.
CO4	Analyze the organic reaction with the structure of organic molecules by applying the knowledge of different spectroscopic techniques.
CO5	Evaluate the electrical, optical, and structural properties of semiconductors to analyze their potential applications in modern electronic and energy devices

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	**3**	-	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO3	**3**	-	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO4	**3**	**3**	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO5	**3**	**3**	**3**	-	-	-	-	-	**2**	-	**2**	-	-	-
Avg.	**3**	**3**	**3**	-	-	-	-	-	**2**	-	**2**	-	-	-

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Course Content

Module-1 **6L**

Quantum Properties of Atoms **4L**

Schrodinger Wave Equation (time independent – basic principles only), de Broglie Equation, Heisenberg Uncertainty Principle, Quantum Numbers, Effective nuclear charge, Slater's rule, penetration of orbitals, variations of orbital energies in the periodic table, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, oxidation properties.

Chemistry of materials **2L**

Semiconductor-Based Memory Materials (Si & Ge) [Introduction, Properties and role of Si & Ge), Intensive & Extensive semiconductor,

Module-2 **7L**

Chemical Thermodynamics **5L**

1^{st} & 2^{nd} Law of Thermodynamics, Tendency for maximum randomness, Carnot Heat Engine [Derivation], Entropy characteristics, Mathematical explanation & physical significance of Entropy, Entropy change of ideal gas for isothermal reversible process, Gibbs free Energy Function, Standard free Energy, Criterion of spontaneity.

Electricity production through chemical reactions **2L**

Electrochemical Cell, writing of cell notation, free energy and EMF, Criterion of spontaneity in terms of Cell,

Nernst equation (only expression, no derivation) and applications, calculation of EMF of a cell, calculation of single electrode potential, calculation of Kc, calculation of Kc from G^0.

Working principle and applications of Lithium-ion batteries

Module-3 **6L**

Polymers for Engineering Applications **3L**

Polymers and their classifications (based on origin, chemical structure, polymeric structure, tacticity and molecular forces)

Commercially important polymers: Synthesis and applications of Bakelite, nylon 6,6, HDPE & LDPE

Conducting polymers –Types examples and applications.

Biodegradable polymers –definition, example and uses

Industrial Chemistry **3L**

Types of corrosion, Electrochemical theory of corrosion, rusting of iron, comparison of chemical & electrochemical corrosion. [Mechanism excluded]

Factors affecting the rate of corrosion; nature of metal (physical state, purity, position in Galvanic series) & environment.

Corrosion control: Cathodic protection, anodic protection, Inorganic coatings.

Classification of Fuel (LPG, CNG, BIOGAS), Calorific value, Octane number, Cetane number, HCV, LCV. [Definition only]

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JIS College of Engineering

Module-4 **5L**

Organic Reactions & synthesis of drugs **3L**

Acidity and basicity comparison of organic compounds (acids, alcohols & amines), Nucleophilic Substitution reaction and Electrophilic Addition reactions, Markonikov's rule, peroxide effect, Synthesis of Paracetamol& Aspirin and uses. (Name reactions are not in syllabus)

Spectroscopy **2L**

Electromagnetic spectrum, Lambert-Beer Law, Finding of λ max value & concentration of the unknown solution, Applications of UV-VIS spectroscopy, Chromophores & Auxochromes.

Applications of IR spectroscopy, Fingerprint region

Text Books:

1. Chemistry –I, Gourkrishna Das Mohapatro
2. A text book of Engineering Chemistry, Dr. Rajshree Khare
3. Engineering Chemistry, U. N. Dhar
4. Physical Chemistry, P.C. Rakshit

Reference Books:

1. Engineering Chemistry, Jain & Jain
2. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S.Krishna
3. Text book of Engineering Chemistry, Jaya Shree Anireddy

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Mathematics - II
Course Code: M201
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

The students to whom this course will be offered must have the understanding of (10+2) standard algebraic operations, coordinate geometry, and elementary calculus concepts including limits, continuity, differentiation, and integration.

Course Objective(s):

The objective of the course is to make the students able to –

1. Develop a thorough understanding of ordinary differential equations and their role in modeling real-world systems.
2. Build competency in applying the Laplace transform as a tool for solving initial value problems and linear differential equations in engineering contexts.
3. Gain proficiency in numerical techniques for solving mathematical problems where analytical methods are difficult or impossible.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply analytical methods to solve ordinary differential equations in engineering contexts.
CO2	Apply the properties and inverse of Laplace Transforms to compute improper integrals and determine solutions of linear ordinary differential equations with constant coefficients in engineering scenarios.
CO3	Apply numerical methods to interpolate data, perform numerical integration, and solve ordinary differential equations in engineering applications.
CO4	Analyze the behavior of solutions using analytical and numerical approaches, including Laplace transforms, to assess stability, convergence, and accuracy in engineering contexts.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO4	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**	**-**
Avg.	**3**	**2.25**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.25**	**-**	**-**	**-**

Course Content:

Module I: First Order Ordinary Differential Equations (ODE) 9L

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 and solvable for $x$and Clairaut's equation.

Module II: Second Order Ordinary Differential Equations (ODE) 8L

Solution of second order ODE with constant coefficients: Complementary Function and Particular Integral, Method of variation of parameters, Cauchy-Euler equations.

Module III: Laplace Transform (LT) 12L

Concept of improper integrals; Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of $tf(t)$, LT of $\frac{f(t)}{t}$, LT of derivatives of $f(t)$, LT of integral of $f(t)$, Evaluation of improperintegrals 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 oflinear ODE with constant coefficients (initial value problem) using LT.

Module IV: Numerical Methods 7L

Introduction to error analysis, Calculus of finite difference. **Interpolation:** Newton forward and backward interpolation, Lagrange's interpolation. **Numerical integration:** Trapezoidal rule, Simpson's 1/3 Rule. **Numerical solution of ordinary differential equation:** Euler method, Fourth order Runge-Kutta method.

Text Books:

1. Higher Engineering Mathematics, Grewal, B.S., Khanna Publishers, 36th Edition, 2010.
2. Advanced Engineering Mathematics, 9th Edition, Kreyszig, E., John Wiley & Sons, 2006.

Reference Books:

1. A text book of Engineering Mathematics-I, Guruprasad, S. New age International Publishers.
2. Higher Engineering Mathematics, Ramana, B.V., Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Engineering Mathematics for first year, Veerarajan, T., Tata McGraw-Hill, New Delhi, 2008.
4. A text book of Engineering Mathematics, Bali, N.P. and Goyal, M., Laxmi Publications, Reprint, 2008.
5. Calculus and Analytic geometry, 9th Edition, Thomas, G.B. and Finney, R.L., Pearson, Reprint, 2002.
6. Calculus, Volumes 1 and 2 (2nd Edition), Apostol, M., Wiley Eastern, 1980.
7. Linear Algebra - A Geometric approach, Kumaresan, S., Prentice Hall of India, 2000.
8. Linear Algebra: A Modern Introduction, 2nd Edition, Poole, D., Brooks/Cole, 2005.
9. Schaum's Outline of Matrix Operations, Bronson, R., 1988.
10. Differential and Integral Calculus, Vol. I & Vol. II, Piskunov, N., Mir Publishers, 1969.

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JIS College of Engineering

Course Name: **Constitution of India and Professional Ethics**
Course Code: HU205
Contact: 1:0:0
Total Contact Hours: 12
Credit: 1

Prerequisites: A basic knowledge (10+2 level) of the Indian Constitution and moral science.

Course Objectives:

The objectives of this course are to make the student able to

1. Understand the salient features of the Indian constitution and form of government.
2. Develop ethical awareness and responsible professional conduct.
3. Understand ethical frameworks, guidelines and recognize ethical dilemmas.
4. Understand professional responsibilities and applications of ethical principles in real-life scenarios.
5. Develop an awareness of the social impact of the profession and act responsibly in the broader community.

Course Outcomes (COs):

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

Cos	Statement
CO1	Identify, define and understand the significance of the Constitution of India, its spirit and values and the fundamental rights and duties as a responsible citizen.
CO2	define and discover core ethical concepts, the basic perception of profession, and professional ethics that shape the ethical behavior of an engineer.
CO3	identify, examine and apply codes of engineering ethics, engineers' social responsibilities and industrial standards and ethical dilemmas.
CO4	consider, correlate and appraise ethical leadership and principles in addressing gender issues, concerns of IPR and industrial responsibilities.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	**2**	-	-	**2**	-	-	-
CO2	-	-	-	-	-	**3**	**3**	**2**	-	-	**2**	-	-	-
CO3	-	-	-	-	-	**2**	**3**	**2**	-	-	**2**	-	-	-
CO4	-	-	-	-	-	**2**	**3**	**3**	-	-	**2**	-	-	-
Avg.	-	-	-	-	-	**2.33**	**3**	**2.25**	-	-	**2**	-	-	-

Course Contents:

Module 1: Introduction to the Constitution of India and Indian Government 2L

Preamble: Salient Features, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliament -Powers and Functions –Executive- President -Governor - Council of Ministers.

Module 2: Professional Ethics and Human Values **3L**

Introduction to Ethical Thinking; what is Ethics, Work ethics; Scope of Professional Ethics, Values and Characteristics, Types of values: Negative and positive values, Ethical values for Professional success.

Module 3: Codes of Professional Ethics, Violation and Safeguards **4L**

Engineering Ethics, Ethical theories: a brief overview; utilitarianism, deontology, virtue ethics.

Professional Codes, Codes of Professional Ethics-Moral dilemmas, and moral autonomy-Internal ethics of business: whistle blowing, conflicts of interest, Job discrimination, and Exploitation of Employees; Social and ethical responsibilities of technologists: Responsibilities towards Customers, shareholders, employees – Social Audit.

Case Studies: Bhopal Gas Tragedy, Chernobyl (linking ethics to real-world failures).

Module 4: Business Ethics and Workplace Issues **3L**

Business ethics, ethical decision-making frameworks - Impact of ethics on business policies and strategies- Characteristics of ethical leaders; fostering integrity in teams; Addressing occupational crime, discrimination, and gender-based issues in Workplaces-Intellectual property rights (IPR), Plagiarism and Academic Misconduct.

Text Books:

1. Durga Das Basu. *Introduction to the Constitution of India*. 27th ed. New Delhi: Lexis Nexis, 2024.
2. R.S Naagarazan. *A Textbook on Professional Ethics and Human Values*. New Age International (P) Limited, 2022.
3. N. Subramanian. *Professional Ethics.* New Delhi: Oxford University Press, 2017.
4. A N Tripathi, *Human Values*. New Delhi: New Age Publishers, 2019.
5. S. K. Chakraborty. *Values and Ethics for Organizations: Theory and Practices*. New Delhi: Oxford University Press, 1997.

Reference Books:

1. O. C. Ferrell, John Friaedrich and Linda Ferrell. *Business Ethics: Ethical Decision Making and Cases.* New Delhi: Cengage India, 2024.
2. Charles Fledderman. *Engineering Ethics*. 3rd ed. New Delhi: Pearson Education, 2007.
3. Dinesh G. Harkut and Gajendra R. Bamnote. *Professional Ethics for Engineers*. Chennai: Notion Press, 2023.
4. U.C.Mathur, *Corporate Governance and Business Ethics*: *Text and Cases*. Chennai: Macmillan, 2012.
5. Fernando. A. C., K. P. Muralidheeran and E. K. Satheesh. *Business Ethics – An Indian Perspective*. New Delhi: Pearson Education, 2019.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: **Design Thinking and Innovation**

Course Code: HU203

Contact: 1:0:0

Total Contact Hours: 15

Credit: 1

Prerequisites:

For a course on the Basics of Design Thinking, students should ideally possess basic computer skills, communication abilities, problem-solving aptitude, critical thinking, introductory knowledge of Sustainable Development Goals, curiosity, and openness to new ideas, as well as basic understanding of mathematics, technology, and manufacturing processes.

However, even if these prerequisites are not satisfied, the faculty will cover them in the first few classes.

An awareness of 21st-century skills, including creativity and collaboration, is also beneficial.

These prerequisites aim to provide a foundation, and any gaps in knowledge will be addressed by the instructor early in the course.

Course Objectives:

The objective of this Course is to provide new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing innovative products and services which are useful for a student in preparing for an engineering career.

Course Outcomes (COs):

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

COs	Statement
CO1	Analyze emotional experience and expressions to better understand stakeholders while designing innovative products through group brainstorming sessions.
CO2	Generate and develop design ideas through different technique
CO3	Develop new ways of creative thinking and learn the innovation cycle of Design Thinking process for developing any innovative products using facility in AICTE IDEA LAB

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	-	2	2	-	2	3	1	-	-	3	2	3
CO2	1	2	3	3	3	-	2	3	-	3	2	3	2	3
CO3	1	3	3	3	3	2	2	3	-	2	2	3	3	3
Avg.	1	2.33	3	2.67	2.67	2	2	3	1	2.5	2	3	2.33	3

Course Content:

Module-1: Basics of Design Thinking **2L**

Definition of Design Thinking, Need for Design Thinking, history of Design Thinking, Concepts & Brainstorming, 2X2 matrix, 6-3-5 method, NABC method,

Module-2: Process of Design: Understanding Design thinking **4L**

Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

Stages of Design Thinking Process (explain with examples) –

Empathize (Methods of Empathize Phase: Ask 5 Why / 5W+H questions, Stakeholder map, Empathy Map, Peer observation, Trend analysis).

Define (Methods of Define Phase: Storytelling, Critical items diagram, Define success).

Ideate (Brainstorming, 2X2 matrix, 6-3-5 method, NABC method).

Prototype (Types of prototypes - Methods of prototyping - Focused experiments, Exploration map, Minimum Viable Product).

Test (Methods of Testing: Feedback capture grid, A/B testing).

Module-3: Tools for Design Thinking 2L

Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space– Empathy for design – Collaboration in distributed Design.

Module-4: Design Thinking in IT 2L

Design Thinking to Business Process modelling – Agile in Virtual collaboration environment – Scenario based Prototyping.

Module-5: Design Thinking For strategic innovations 2L

Growth – Story telling representation – Strategic Foresight - Change – Sense Making - Maintenance Relevance – Value redefinition - Extreme Competition – experience design - Standardization – Humanization - Creative Culture – Rapid prototyping, Strategy and Organization – Business Model.

Module-6: Problem Solving & Critical thinking 3L

Introduction to TRIZ, SCAMPER, UI and UX,

Sustainable development goals (SDG)- Integrating and mapping 17 Sustainable development goals (SDG) during designing a product; goods or service. Introduction to 21st Century Skill Set.

Text Books:

1. Karmin Design Thinking by Dr. Bala Ramadurai, Mudranik Technology Private Ltd. ISBN 978-93-5419-0I0-0.
2. John.R.Karsnitz, Stephen O'Brien and John P. Hutchinson, "Engineering Design", Cengage learning (International edition) Second Edition, 2013.
3. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press , 2009.
4. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011
5. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Reference Books:

1. Yousef Haik and Tamer M.Shahin, "Engineering Design Process", Cengage Learning, Second Edition, 2011.
2. Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author),

Andrew King (Author), Kevin Bennett (Author).

3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins e-books, 2009.
4. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Toolbox, John Wiley & Sons, 2020.
5. Michael Lewrick, Patrick Link, Larry Leifer, The Design Thinking Playbook, John Wiley & Sons, 2018.
6. Kristin Fontichiaro, Design Thinking, Cherry Lake Publishing, USA, 2015.
7. Walter Brenner, Falk Uebernickel, Design Thinking for Innovation - Research and Practice, Springer Series, 2016.
8. Gavin Ambrose, Paul Harris, Design Thinking, AVA Publishing, 2010.
9. Muhammad MashhoodAlam, Transforming an Idea into Business with Design Thinking, First Edition, Taylor and Francis Group, 2019.
10. S. Balaram, Thinking Design, Sage Publications, 2011.

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JIS College of Engineering

Course Name: Bioelectronics Lab
Course Code: BME291
Contact: 0:0:3
Credits: 1.5

Prerequisite: Basic knowledge of Physics and Mathematics.

Course Objective(s):

The objective of the course is to make the students able to

1. identify and understand the functions of various active and passive electronic components and the operation of basic electronic instruments such as multimeters, oscilloscopes, and function generators.
2. Provide practical knowledge of electronic devices by analyzing the V-I characteristics of diodes, transistors, JFETs, and MOSFETs, and by constructing circuits such as rectifiers, clippers, and clampers.
3. Train students in designing and evaluating circuits for voltage regulation, signal amplification, and rectification using discrete components and OPAMP configurations.
4. Develop circuit analysis and design skills through implementation and testing of amplifiers, including determination of voltage gain for inverting and non-inverting configurations.

Course Outcomes (COs):

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

COs	Statement
CO1	Identify various electronic components and fundamental operation of electrical and electronic devices.
CO2	Illustrate the characteristic features of different electronic devices such as diode, transistors etc., and simple circuits like rectifiers, amplifiers etc.
CO3	Determine the Gain of various types of amplifiers.
CO4	Design simple circuits like voltage regulator, half wave and full wave rectifier, amplifiers etc.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	3	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	3	2	2
CO3	2	2	2	3	2	-	-	-	-	-	-	2	2	2
CO4	3	2	3	3	3	-	-	-	1	1	1	3	2	3
Avg.	2.75	2.25	2	2.25	2.25	-	-	-	1	1	1	2.75	2	2

List of Experiments:

1. Identification of Various active and passive electronic components.

2. Operation and Implementation of Multimeter, Function Generator, DC Power supply, Oscilloscope etc.
3. V-I Characteristics of P-N Junction Diode
4. Design of Clipper and Clamper Circuit using Diode
5. Study on Zener Diode as a voltage regulator
6. Design a Half wave and Full wave rectifier
7. Study on input-output characteristics of Common Base mode.
8. Study on input-output characteristics of Common Emitter mode.
9. Characteristics of JFET and MOSFET
10. Calculation of Gain of Inverting Amplifier and Non-Inverting Amplifier
11. Innovative experiment

Text Books/ Reference Books:

1. Zbar Paul, Basic Electronics: A Text Lab Manual. Tata McGraw Hill, 2001.
2. Introductory Bioelectronics - For Engineers and Physical Scientists

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomechanics- I Lab
Course Code: BME292
Contact: 0:0:3
Credits: 1.5

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

Course Objectives:

The objective of the course is to make the students able to

1. Impart hands-on experience in measuring mechanical properties such as moment of inertia using experimental setups like compound pendulum and dynamometer.
2. Develop the ability to analyze human motion and posture by evaluating gait patterns, joint angles, and foot pressure data using biomechanical instruments.
3. Train students in assessing muscular performance through quantitative measurements of grip and muscle strength for evaluating functional biomechanics.
4. Familiarize students with experimental methods for simulating orthopedic and biomechanical conditions, including stress-strain testing of prosthetic components and torque measurement techniques.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply experimental techniques to determine the moment of inertia using compound pendulum and dynamometer methods in biomechanical systems.
CO2	Analyze gait parameters, joint angles, and foot pressure to assess and interpret human locomotion and posture.
CO3	Evaluate muscle and grip strength measurements to determine functional capabilities and detect biomechanical deficiencies.
CO4	Design and perform stress-strain and torque experiments (e.g., on hip prosthesis and tapping torque) to simulate and assess real-world biomechanical conditions.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	3	2	-	-	-	-	-	-	3	2	2
CO2	3	3	-	2	2	-	-	-	1	-	-	3	3	2
CO3	2	3	-	3	2	-	-	-	1	-	-	3	2	2
CO4	3	2	3	3	3	-	1	-	2	2	1	3	2	3
Avg.	2.75	2.5	3	2.75	2.25	-	1	-	1.33	2	1	3	2.25	2.25

List of Experiments:

1. Determination of Moment of Inertia using Compound Pendulum method
2. Determination of Moment of Inertia using dynamometer

3. Measurement of Gait variables
4. Muscle Strength Measurement
5. Foot Pressure measurement
6. Joint angle measurement
7. Grip Strength Measurement
8. Stress strain analysis of Hip Prosthesis
9. Tapping Torque Measurement
10. Innovative Experiment

Text Books:

1. Fung, Y. C. (1993). Biomechanics: Mechanical Properties of Living Tissues (2nd ed.). Springer.
2. Hall, S. J. (2018). Basic Biomechanics (8th ed.). McGraw-Hill Education.
3. Haff, G. G., & Dumke, C. (2018). Laboratory Manual for Exercise Physiology (2nd ed.). Human Kinetics.
4. Bartlett, R. (2007). Introduction to Sports Biomechanics: Analysing Human Movement Patterns (2nd ed.). Routledge.

Reference Books:

1. Nigg, B. M., & Herzog, W. (2007). Biomechanics of the Musculo-skeletal System (3rd ed.). Wiley.
2. Bartel, D. L., Davy, D. T., & Keaveny, T. M. (2006). Orthopaedic Biomechanics: Mechanics and Design in Musculoskeletal Systems. Pearson Prentice Hall.
3. Floyd, R. T. (2014). Manual of Structural Kinesiology (18th ed.). McGraw-Hill Education.

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Course Name: Introduction to Artificial Intelligence Lab
Course Code: CS292
Contact: 0:0:3
Credit: 1.5

Prerequisites: Basic Computer Knowledge

Course Objective(s):

The objective of the course is to make the students able to –

1. Gain foundational knowledge of PROLOG to implement an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing.
2. Formulate a problem by analysing its characteristics to fit a State-Space Exploration Framework or an Inferencing Framework of Artificial Intelligence.
3. Apply the concepts of Artificial Intelligence to solve a problem by implementing well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
4. Build expert systems offering solutions to the challenging problems of Artificial Intelligence.
5. Implement Artificial Intelligence based ideas as executable PROLOG programs through developing intelligent heuristic strategies.

Course Outcomes (COs):

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

COs	Statement
CO1	**Acquire** foundational knowledge of PROLOG to **implement** an Artificial Intelligent Agent as an executable computer program for Knowledge Representation and Inferencing and **understand** the working principle of the agent and **assess** its utilitarian importance in current technological context leading towards lifelong learning.
CO2	**Identify** and **formulate** an engineering problem by analyzing its characteristics to fit a State-Space Exploration Framework or an Inferencing Agent Formulation Framework of Artificial Intelligence.
CO3	**Explore** relevant literature and **apply** the concepts of Artificial Intelligence to **solve** a problem by **implementing** well-known Artificial Intelligence strategies using proper techniques and tools of PROLOG.
CO4	**Develop** ideas and **propose an** expert system offering solutions to the challenging problems of Artificial Intelligence.
CO5	**Plan and Implement** Artificial Intelligence based ideas as executable PROLOG programs through **developing** intelligent heuristic strategies or expert systems with adequate documentation in a collaborative environment for successfully carrying out projects on Artificial Intelligence Problems and **investigate** their effectiveness by **analysing** the performances using proper techniques and tools.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	2	2	3	-	-	-	-	-	-	-	-	-	-
CO5	2	2	3	3	2	2	2	2	2	2	2	-	-	-
Avg.	2.2	2.2	2.67	2.67	2	2	2	-	2	2	2	-	-	-

Course Content:

Module 1: Introduction to PROLOG Programming along with the IDE and its Basic Components (3 Lectures)

Assignments for understanding the Basic Components of Knowledge Representation and Inferencing in Artificial Intelligence using PROLOG Programming and its working strategy. Understanding facts, rules, queries, and syntax.

Module 2: Recursive definitions in Prolog (5 Lectures)

Fibonacci Series, Calculator, Factorial, summation, list length, etc. Using recursive rules.

Module 3: Defining facts and simple queries (4 Lectures)

Writing a knowledge base for family relationships, basic objects.

Module 4: **Rules and inference in Prolog (4 Lectures)**

Creating logical rules and testing inferences.

Module 5: List operations in Prolog (4 Lectures)

Checking membership, concatenation, reverse, max/min of list.

Module 6: Pattern matching and symbolic reasoning (5 Lectures)

Simple examples involving pattern recognition (e.g., shape or name matching, Family Tree design)

Module 7: Expert system simulation (Mini project) (5 Lectures)

Building a mini knowledge-based system (e.g., Animal Classification, Medical diagnosis, etc).

Text book:

Prolog Programming for Artificial Intelligence, Ivan Bratko, Addison-Wesley, 4th Edition.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Engineering Chemistry Lab
Course Code: CH 291
Contact Hours: 0:0:2
Credit: 1

Prerequisites: Knowledge of 10+2 Chemistry

Course Objective(s):

The objective of the course is to make the students able to

1. Study the basic principles of pH meter and conductivity meter for different applications
2. Analysis of water for its various parameters in relation to public health, industries & environment
3. Learn to synthesis Polymeric materials and drugs
4. Study the various reactions in homogeneous and heterogeneous medium
5. Designing of innovative experiments

Course Outcomes (COs)

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

COs	Statement
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 analyse and determine the composition and physical property of liquid and solid samples when working as an individual and also as a team member
CO3	Able to analyse different parameters of water considering environmental issues
CO4	Able to synthesize drug and sustainable polymer materials
CO5	Capable to design innovative experiments applying the fundamentals of modern chemistry

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	**3**	-	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO3	**3**	-	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO4	**3**	**3**	-	-	-	-	-	-	**2**	-	**2**	-	-	-
CO5	**3**	**3**	**3**	-	-	-	-	-	**2**	-	**2**	-	-	-
Avg.	**3**	**3**	**3**	-	-	-	-	-	**2**	-	**2**	-	-	-

List of Experiments:

(Any 10 experiments to be conducted preferably a combination of estimation, water quality analysis, instrumental analysis and synthesis)

1. To determine strength of given sodium hydroxide solution by titrating against standard oxalic acid solution.

2. Estimation of amount of Fe^{2+} in Mohr's salt using permanganometry.
3. To determine the surface tension of a given liquid at room temperature using stalagmometer by drop number method.
4. To determine the viscosity of a given unknown liquid with respect to water at room temperature, byOstwald's Viscometer.
5. Water quality analysis :
    i. Determination of total, permanent and temporary hardness of sample water by complexometric titration.
    ii. Determination of Cl^- ion of the sample water by Argentometric method
    iii. Determination of alkalinity of the sample water.
    iv. Determination of dissolved oxygen present in a given water sample.
6. Determination of the concentration of the electrolyte through pH measurement.
7. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
8. Determination of cell constant and conductance of solutions.
9. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
10. Determination of Partition Coefficient of acetic acid between two immiscible liquids.
11. Drug design and synthesis
12. Synthesis of polymers (Bakelite) for electrical devices and PCBs.
13. Synthesis of Silver Nanoparticles doped organic thin film for organic transistors.
14. Determination of R_F of any amino acid by thin layer chromatography.
15. Saponification /acid value of any oil.
16. Isolation of graphene from dead dry batteries

Department of Biomedical Engineering
JIS College of Engineering

Course Name: IDEA Lab Workshop
Course Code: ME293
Contact: 0:0:3
Credits: 1.5

Course Objectives:

1. To learn all the skills associated with the tools and inventory associated with the IDEA Lab.
2. Learn useful mechanical and electronic fabrication processes.
3. Learn necessary skills to build useful and standalone system/ project with enclosures.
4. Learn necessary skills to create print and electronic documentation for the system/project

Course Content:

Module	Topic	
	Electronic	**Mechanical**
1	Electronic component familiarisation, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using EagleCAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and GitHub. Basic 2D and 3D designing using CAD tools such as FreeCAD, Sketchup, Prusa Slicer, FlatCAM, Inkspace, OpenBSP and VeriCUT.	Introduction to basic hand tools - Tape measure, combination square, Vernier calliper, hammers, fasteners, wrenches, pliers, saws, tube cutter, chisels, vice and clamps, tapping and threading. Adhesives Introduction to Power tools: Power saws, band saw, jigsaw, angle grinder, belt sander, bench grinder, rotary tools. Various types of drill bits,
2	Familiarisation and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) 'Manhattan' style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering	Mechanical cutting processes - 3-axis CNC routing, basic turning, milling, drilling and grinding operations, Laser cutting, Laser engraving etc. Basic welding and brazing and other joining techniques for assembly. Concept of Lab aboard a Box.

	iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.	
3	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types), Wireless power supply, USB PD, Solar panels, Battery types and charging	3D printing and prototyping technology – 3D printing using FDM, SLS and SLA. Basics of 3D scanning, point cloud data generation for reverseengineering. Prototyping using subtractive cutting processes. 2D and 3D Structures for prototype building using Laser cutter and CNC routers. Basics of IPR and patents; Accessing and utilizing patent information in IDEA Lab
4	Discussion and implementation of a mini project.	
5	Documentation of the mini project (Report and video).	

Laboratory Activities:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testiof the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modelling w
3.	3D scanning of computer mouse geometry surface. 3D printing of scanngeometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mthickness)/cardboard, MDF (2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardwasoftware and machined or 3D printed enclosure.

Department of Biomedical Engineering
JIS College of Engineering

Reference Books:

Sl. No.	Title
1	AICTE's Prescribed Textbook: Workshop / Manufacturing Practices (with LabManual), Khanna Book Publishing, New Delhi.
2	All-in-One Electronics Simplified, A.K. Maini; 2021. ISBN-13:978-9386173393, Khanna Book Publishing Company, New Delhi.
3	Simplified Q&A - Data Science with Artificial Intelligence, Machine Learningand Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
4	3D Printing & Design, Dr. Sabrie Soloman, ISBN: 978-9386173768, Khanna Book Publishing Company, New Delhi.
5	The Big Book of Maker Skills: Tools & Techniques for Building Great TechProjects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.
6	The Total Inventors Manual (Popular Science): Transform Your Idea into aTop-Selling Product. Sean Michael Ragan (Author). Weldon Owen; 2017. ISBN-13: 978-1681881584.
7	Make: Tools: How They Work and How to Use Them. Platt, Charles.Shroff/Maker Media. 2018. ISBN-13: 978-9352137374
8	The Art of Electronics. 3rd edition. Paul Horowitz and Winfield Hill. Cambridge University Press. ISBN: 9780521809269
9	Practical Electronics for Inventors. 4th edition. Paul Sherz and SimonMonk. McGraw Hill. ISBN-13: 978-1259587542
10	Encyclopedia of Electronic Components (Volume 1, 2 and 3). CharlesPlatt. Shroff Publishers. ISBN-13: 978-9352131945,978- 9352131952, 978-9352133703
11	Building Scientific Apparatus. 4th edition. John H. Moore, Christopher C. Davis, Michael A. Coplan and Sandra C. Greer. Cambridge University Press. ISBN-13: 978-0521878586
12	Programming Arduino: Getting Started with Sketches. 2nd edition.Simon Monk. McGraw Hill. ISBN-13: 978-1259641633
13	Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13: 978-1260019193.
14	Pro GIT. 2nd edition. Scott Chacon and Ben Straub. A press. ISBN-13 : 978-1484200773
15	Venuvinod, PK., MA. W., Rapid Prototyping – Laser Based and Other Technologies, Kluwer, 2004.
16	Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
17	Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

Department of Biomedical Engineering
JIS College of Engineering

2nd Year 3rd Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME301	Human Anatomy & Physiology	3	0	0	3	3
2	ENGG	Major	BME302	Biophysical Signals & Systems	3	0	0	3	3
3	ENGG	Major	BME303	Biomechanics- II	3	0	0	3	3
4	ENGG	Minor	EC(BME)301	Analog Electronic Circuit	3	0	0	3	3
5	ENGG.	Minor	EE(BME)301	Circuit Theory & Networks	3	0	0	3	3
B. PRACTICAL/ SESSIONAL									
6	ENGG	Major	BME391	Human Anatomy & Physiology Lab	0	0	3	3	1.5
7	ENGG	Major	BME392	Biophysical Signals & Systems Lab	0	0	3	3	1.5
8	ENGG	Skill Enhancement Course	EC(BME)391	Analog Electronic Circuit Lab	0	0	3	3	1.5
9	ENGG	Skill Enhancement Course	EE(BME)391	Circuit Theory & Networks Lab	0	0	3	3	1.5
10	HUM	Ability Enhancement Course	HU(BME)391	Technical Seminar Presentation	0	0	2	2	1
C. MANDATORY ACTIVITIES/ COURSES									
11	Mandatory Course	MC	MC381	Environmental Protection Initiatives or Learning an Art Form [vocal or instrumental, dance, painting, clay modeling, etc.]	0	0	0	0	0
Total of Theory & Practical								**29**	**22**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Human Anatomy and Physiology
Course Code: BME301
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

Basic knowledge of human anatomy, introductory biology, and fundamental biochemistry.

Course Objective(s):

The objective of the course is to make the students able to

1. To provide comprehensive understanding of the structure and physiological functions of major human organ systems.
2. To correlate physiological processes with biomedical parameters and diagnostic indicators.
3. To interpret the role of cellular and molecular mechanisms in organ system functions and their relevance to biomedical applications.
4. To prepare students for designing, integrating, and applying physiological knowledge in medical device development and clinical solutions.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the physiological mechanisms of major human organ systems and their interdependence.
CO2	Analyze molecular and cellular events behind physiological processes (e.g., muscle contraction, ESR).
CO3	Apply physiological principles to evaluate common disorders and interpret clinical test parameters.
CO4	Compare and evaluate physiological principles to inform the design of biomedical systems or devices.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	-	-	-	-	-	2	-	1
CO2	3	3	-	3	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	2	-	3	1	-	-	1	-	2	2	2
CO4	3	3	3	2	2	2	2	1	2	2	1	3	2	3
Avg.	3	2.75	2.5	2.33	2	2.33	1.5	1	2	1.5	1	2.25	2	2

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Blood Vascular System 6L

Composition and functions of blood. Plasma proteins – normal values, origin and functions. Brief idea on Bone marrow. Stem Cell Niches in Bone Marrow: Regulation of hematopoiesis. Formed elements of blood – origin, formation, functions and fate. Haemoglobin – functions, compounds and derivatives. Abnormal haemoglobin-overview. Erythrocyte sedimentation rate (ESR) and its significance. Molecular Mechanisms Behind ESR Variations in Diseases. Haematocrit. PCV, MCV, MCH, MCHC. Blood coagulation –factors, process. Blood groups – ABO systems and Rh factors. Rare Blood Groups and Their Clinical Significance. Hemodynamic Variability and Shear Stress in Arteries vs. Veins

Module- 2: Cardio Vascular System 6L

Structure and function of Heart, Anatomical position, Chambers of heart. Role of Extracellular Matrix in Cardiac Structural Integrity. Blood circulation through heart and. Special junctional tissue of heart. Cardiac cycle. Heart Sound. Systemic and pulmonary circulation. Cardiac output. Blood Pressure-regulation and controlling factors.

Module- 3: Muscular and Skeletal System 6L

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 fibres. 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 and fast muscle fibres, Isotonic and Isometric contraction.

Types of Bones, Structure and Composition of Bone, Classification of Joints, Structure of Synovial Joint, Cartilage, Tendon, Ligament

Module- 4: Renal System 4L

Function of kidney, Anatomy and Histology of Nephron and collecting duct. Urine formation mechanism (Filtration, reabsorption and secretion). Acidification of Urine. Counter-current system of urine concentration, Typical anomalies in renal and excretory system.

Module- 5: Digestive System 4L

Organization of GI system, Movement along GI tract, Function of Liver. Role of liver in managing lipid distribution, synthesis of lipoproteins, and cholesterol regulation through bile acids. Intestine and Pancreas. Differences in exocrine and endocrine function of the pancreas. Digestion and Absorption, Role of Enzymes in Digestion.

Module- 6: Respiratory System 4L

Respiratory Pathways, Mechanism of Respiration, Respiratory membrane and gaseous exchange, Lungs, Mechanisms that govern the lungs' ability to expand and contract, including the role of elastin, collagen, and surfactant in maintaining lung function. Role of Lungs in Oxygen and Carbon Dioxide Transport in Human Body.

Department of Biomedical Engineering
JIS College of Engineering

Module- 7: Neuro Physiology **6L**

Overview of Nervous system- CNS, PNS, ANS, Structure and function of neurons. Types of nerve fibres. 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. Reflex Action

Text Books:

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

Reference Books:

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biophysical Signals and Systems
Course Code: BME302
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

Basic understanding of mathematics (differential equations, linear algebra) and fundamentals of physics.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand and classify different types of signals and systems including linear time-invariant (LTI) systems.
2. Analyze and transform signals using Fourier, Laplace, and Z-transforms.
3. Explore signal sampling and reconstruction with practical insights into real-world biomedical signals.
4. Apply filtering and feedback control techniques in biomedical systems and evaluate their physiological relevance.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the characteristics of various signal types and classify systems based on their properties including LTI systems and convolution.
CO2	Apply Fourier, Laplace, and Z-transforms to analyze signals in time and frequency domains and interpret system behavior.
CO3	Evaluate sampling, reconstruction, and transformation techniques for signal analysis in biomedical systems.
CO4	Design and implement basic IIR and FIR filters and analyze signal flow in physiological systems using system modeling techniques.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	2	3	-	-	-	-	-	-	1	-	-
CO3	3	3	-	3	2	-	-	-	-	-	-	-	2	-
CO4	3	3	2	2	3	-	-	-	-	-	2	2	-	3
Avg	3	2.75	2	2.33	2.5	-	-	-	-	-	2	1.5	2	2

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Signals and systems **7L**

Continuous time (CT) signals, Discrete time (DT) signals, periodic, aperiodic, random, energy and power signals, energy and power of a signal, absolutely integrable signals, step, ramp, impulse and exponential function, mathematical relation between Step, Ramp and Impulse functions, properties of Impulse function, Transformation in independent variable of signals: time scaling, time shifting and time reversal, Introduction to systems and its properties, LTI systems, Convolution and its properties: Linear operation.

Module- 2: Signal analysis **6L**

Basic concepts of the Fourier series, Dirichlet Conditions, and Properties of continuous and discrete time Fourier series, Discrete Fourier transform (DFT) and its inverse (IDFT), Properties of Fourier Transform. Fast Fourier transformation (FFT): Decimation in time algorithm.

Module- 3: Sampling Theorem, Laplace Transforms and Z-Transforms **8L**

Representation of continuous time signals by its sample, Sampling theorem, Reconstruction of a Signal from its samples, aliasing, Nyquist criterion. Laplace transform: basics, properties, use of ROC and its basic properties, identification of the stability of system and absolutely integrable signals from ROC, inverse; z-transform: definition, properties, Poles and Zeros, inverse z-transform; Region of convergence (ROC), Representation of systems by differential equations and transfer functions.

Module- 4: Noise, Feedback and Control System **5L**

Noise: Sources and Types, Basic Feedback concept, Positive and Negative Feedback, Control system, Open and Closed Loop Control System, Control system with Feed Back, Application of feedback in physiological systems and its importance: Muscle Stretch Reflex. System Physiology versus Systems Biology.

Module- 5: Filtering Techniques **4L**

Basic concepts of IIR and FIR filters, difference equations, Realization of Filters using Direct form –I, II and Cascade Form, Design of IIR Filter using impulse invariant and bilinear transforms.

Module- 6: Application in Physiological System **6L**

Block diagram representation of cardio vascular system, Electrical analog of blood vessels and its transfer function, Electrical Analogue of Arterial Blood Pressure Signals: 3 elements Wind kessel Model, Characteristics of various bio-signals (ECG, EEG, EMG etc,) signal conditioning and noise handling.

Text Books:

1. P. Ramesh Babu , Digital Signal Processing, Scitech Publications (India) Pvt Ltd
2. John Proakis, Dimitris Manolakis, Digital Signal Processing, Pearson

Reference Books:

1. Gayakward - Opamps and Linear Integrated Circuits, Prentice Hall India
2. A. K. Sawhney -Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. (P) Ltd.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomechanics - II
Course Code: BME303
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge of engineering physics, mathematics, engineering mechanics and physiology.

Course Objective(s):

The objective of the course is to make the students able to

1. Explain the physical properties of fluids and fundamental laws of fluid dynamics relevant to biomedical systems.
2. Analyze fluid flow behaviors in biological systems such as blood vessels, joints, heart, lungs, and brain.
3. Introduce the rheological properties of biological fluids including blood and synovial fluid, and their physiological importance.
4. Evaluate the role of biofluid dynamics in health, disease conditions, and medical diagnostics or treatment strategies.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the fundamental properties of fluids, fluid classifications, and concepts like viscosity and capillarity.
CO2	Apply conservation laws and Bernoulli's principle to analyze fluid flow in both engineering and physiological systems.
CO3	Analyze blood rheology and flow characteristics in arteries, veins, capillaries, and brain circulation.
CO4	Evaluate biofluid dynamics in pathological conditions (e.g., cardiovascular, arthritic, neurological diseases) using fluid mechanics principles.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	2	1	1
CO2	3	3	2	2	-	-	-	-	-	-	-	3	2	2
CO3	3	3	2	2	2	2	-	-	-	-	-	3	2	3
CO4	3	3	2	3	2	3	2	1	1	1	-	3	2	3
Avg.	3	2.75	2	2.33	2	2.5	2	1	1	1	-	2.75	1.75	2.25

Course Content:

Module-I: Properties of Fluids **5L**

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 and Non-Newtonian Fluids.

Module- 2: Fluid Flow and Boundary Layer 7L

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, Compressible and Incompressible Flow, Fluid Acceleration and Pressure Distribution, Flow Resistance and Friction Factor.

Module- 3: Blood Rheology and Flow Dynamics in Blood Vessels 11L

Physical, Chemical and Rheological properties of blood, Effect of shear rate, Haematocrit, 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- steady flow and pulsatile flow, Wave propagation in elastic tubes, Forces that drive or resist blood flow, Importance of blood flow dynamics in cardiovascular health, 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.

Module- 4: Cardiac and Respiratory Flow Mechanics 5L

Overview of Cardiovascular system. Role of the heart and lungs in maintaining homeostasis and oxygen delivery, Blood Flow in the Cardiovascular System, Hemodynamics of Arteries and Veins, Cardiac Output and Its Regulation, Physics of cardiovascular diseases,

Respiratory system physiology. Mechanics of breathing. Airway Flow and Resistance. Pulmonary Compliance and Elastance. Gas Exchange and Diffusion.

Module- 5: Synovial Fluid Mechanics in Joints 5L

Overview of synovial fluid: definition, composition, properties and rheology, Function of synovial fluid, Diseases, Lubrication theory, Different types of lubrication in human joints, Application for synovial fluid flow, Arthritis, Knee and Hip injury.

Module- 6: Bio-fluid Dynamics in Human Brain 3L

Overview of bio-fluid dynamics and its importance in the human body; Cerebrospinal fluid. Cerebral blood flow. Blood brain barrier, Brain diseases.

Text Books

1. Introduction to Fluid Mechanics-James E.A. John and William L. Haberman, 2nd Edn, Prentice Hall, INC.
2. Y.C Fung, Biomechanics- Mechanical properties of living tissues, 2nd Edn, Springer Verlag, 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, TaylorandFrancis 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.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Analog Electronics
Course Code: EC(BME)301
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge about components (R, L, C). Network Theorems (Kirchhoff's law, Theremin's theorem, Norton's theorem, etc.). Basic knowledge about the operation of semiconductor devices (Diode, Transistor, JFET etc.), Basic idea of integrated circuits, and Voltage current equations. Basic knowledge of Differentiation, Integration, Differential equation, matrix, etc.

Course Objective(s):

The objective of the course is to make the students able to

1. Provide fundamental knowledge of transistor biasing, voltage regulation techniques, and amplifier configurations for understanding electronic circuit behavior.
2. Develop analytical skills for examining the performance of single-stage, multistage transistor/FET amplifiers, power amplifiers, and feedback circuits using circuit theory principles.
3. enhance the ability to evaluate and interpret the operation of oscillators and multivibrators based on stability and feedback criteria for signal generation.
4. Build proficiency in designing linear and nonlinear applications using operational amplifiers including active filters and waveform-shaping circuits.

Course Outcomes (COs):

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

COs	Statement
CO1	Illustrate the working principles of voltage regulator, transistor biasing, and multistage amplifiers, including their frequency response and stability considerations.
CO2	Analyze single-stage and multistage amplifiers, power amplifiers, and feedback circuits using transistors and FETs to determine various parameters.
CO3	Evaluate the performance of oscillators, multivibrators, and operational amplifier circuits by applying Barkhausen's criterion, and feedback principles.
CO4	Develop the circuits such as active filters, Schmitt triggers using operational amplifiers.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	-	-	-	-	-	-	2	1	1
CO2	3	3	2	1	1	-	-	-	-	-	-	3	2	2
CO3	3	3	2	2	1	-	-	-	-	-	-	3	2	3
CO4	2	3	3	2	2	-	-	-	1	1	1	3	3	3
Avg.	2.75	2.75	2	1.67	1.25	-	-	-	1	1	1	2.75	2	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module I: 10L

Rectifier and Single Stage Transistor Amplifier: Rectifier and filter, regulated power supply using Zener diode and IC, SMPS

Transistor Biasing techniques, Q-point & its Stability, Thermal Runaway, self-bias CE configuration, Bias Compensation techniques, and h-parameter model of transistors. Expression for voltage gain, current gain, input and output impedance, power gain, and Emitter follower circuit.

Multistage Amplifier: RC coupled amplifier, functions of all components, derivation of voltage gain, current gain, input impedance and output impedance, frequency response characteristics, bandwidth

Module II: 7L

Power Amplifiers: Class A, B Power amplifier – working principle, conversion efficiency.

Tuned amplifier – working principle

FET Amplifiers: Operating principle of JFET. drain and transfer characteristics of JFET (n-channel and p-channel), MOSFET – working principle CMOS – Basic Idea

Module III: 6L

Feedback Amplifiers: Feedback concept, negative & positive feedback, Gain calculation for positive and negative feedback condition, Advantages of negative feedback circuit.

Oscillators: Barkhausen criterion, RC Oscillators-Phase shift and Wien bridge oscillators, LC Oscillator-Colpitts, Hartley's, and Crystal oscillators.

Module IV: 4L

Multivibrators: Astable and Monostable operation using transistor and IC 555 timer.

Module V: 9L

Operational Amplifier & It's Applications: Configuration of inverting and non-inverting amplifier using Op-amp, virtual ground, closed loop voltage gains of inverting and noninverting amplifier, adder, subtracter, multiplier, integrator & differentiator circuit, Comparator & Schmitt Trigger, Low pass, high pass and band pass active filters.

Text Books:

1. Sedra & Smith-Microelectronic Circuits-Oxford Up
2. Millman & Halkais- Integrated Electronics, McGraw Hill.
3. Boylested & Nashelsky-Electronic Devices and Circuit Theory-Pearson/PHI
4. Rashid-Microeletronic Circuits-Analysis and Design- Thomson (Cenage Learning).
5. Franco- Design with Operational Amplifiers & Analog Integrated Circuits, 3/e, McGraw Hill.
6. Gayakwad R.A – OpAmps and Linear IC's, PHI

Reference Books:

1. Razavi- Fundamentals of Microelectronics-Wiley
2. J.B. Gupta- Electronic Devices and Circuits- S.K. Kataria & Sons
3. Malvino- Electronic Principles, 6/e, McGraw Hill

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Circuit Theory
Course Code: EE(BME)301
Contact: 3:0:0
Total Contact Hours: 36
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(s):

The objective of the course is to make the students able to

1. Introduce the fundamental electrical elements and their interconnections in complex networks.
2. Enable students to analyze electrical circuits using mesh and nodal techniques under DC and AC conditions.
3. Apply network theorems for simplification and analysis of linear electrical networks.
4. Understand graph theory concepts and their application in circuit analysis.
5. Introduce Laplace Transform techniques for analyzing transient and steady-state responses of electrical networks.
6. Illustrate the applications of circuit theory in biomedical instrumentation systems.

Course Outcomes (COs):

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

COs	Statement
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 andsolve related problems.
CO5	Understand Describe, Analyze and Design Coupled (Magnetic and Electromagnetic) Circuits, Resonating circuitand solve related problems.
CO6	Apply Laplace Transform and form Transfer Function for different kinds of electrical networks for analyzing themand solve related problems

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Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	-	-	-	-	2	1	1
CO2	3	3	2	1	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	-	-	-	-	-	-	-	2	2	2
CO4	2	2	3	2	-	-	-	-	-	-	-	2	3	2
CO5	3	3	2	2	1	-	-	-	-	-	-	3	2	3
CO6	2	2	1	2	3	2	2	1	-	-	-	3	3	3
Avg.	2.67	2.5	2.17	1.67	2	2	2	1	-	-	-	2.33	2.17	2.17

Course Content:

Module I: 8L

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.

Module II: 5L

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.

Module III: 5L

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.

Module IV: 6L

Coupled Circuits: Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, Solution of Problems.
Resonant Circuits: Series and Parallel Resonance, Impedance and Admittance Characteristics, Quality Factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Solution of Problems.

Department of Biomedical Engineering
JIS College of Engineering

Module V: 9L

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.

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.

Module VI: 3L

Introduction to Biomedical Instrumentation & Analog Circuits: Overview, Role of electronics in medical diagnostics, Signal acquisition from human body: ECG, EMG, EEG. Signal Conditioning, Analog-to-Digital Conversion (ADC) and resolution.

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.Ramesh Babu- Electrical Circuit Analysis- Scitech
6. Sudhakar: "Circuits & Networks:Analysis& Synthesis" 2/e TMH
7. M.S.Sukhija & T.K.Nag Sarkar- 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

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JIS College of Engineering

Course Name: Human Anatomy and Physiology Lab
Course Code: BME391
Contact: 0:0:3
Credit: 1.5

Prerequisites: Basic knowledge of human anatomy and physiology (theory), basic biology and biochemistry, familiarity with laboratory safety procedures.

Course Objective(s):

The objective of the course is to make the students able to

1. To provide hands-on experience in the examination of histological slides and physiological parameters.
2. To develop skills in performing basic hematological and cardiovascular investigations.
3. To train students in the proper use of biomedical laboratory equipment such as microscopes and ECG machines.
4. To encourage critical thinking and innovation in experimental design and clinical analysis.

Course Outcomes (COs):

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

COs	Statement
CO1	Describe and identify key histological structures and their relevance to human physiology.
CO2	Perform and interpret basic haematological and cardiovascular experiments.
CO3	Analyze physiological measurements (e.g., ECG, blood pressure, WBC count) and relate them to health conditions.
CO4	Design and execute innovative physiological experiments using lab resources effectively.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	1	-	-	-	-	-	2	-	1
CO2	3	3	2	2	-	2	1	-	1	-	-	2	2	2
CO3	3	3	2	3	-	2	2	1	1	1	-	3	2	3
CO4	3	3	3	3	3	2	3	2	2	2	1	3	3	3
Avg.	3	2.75	2.33	2.67	3	1.75	2	1.5	1.33	1.5	1	2.5	2.33	2.25

List of Experiments:

1. Study on Compound Microscope.
2. Identification of fixed histological slides: Cerebellum, Cerebral cortex, Spinal cord, Renal tissues, Blood vessels (artery and vein), Skin, Tongue, Liver.
3. Hemoglobin estimation.

4. Determination of blood pressure.
5. Blood film making and identification of different blood corpuscle.
6. ECG wave identification and study of physiological significance of the ECG wave.
7. Determination of Blood Group (ABO; Rh).
8. Measurement of Bleeding Time (BT) and Clotting Time (CT).
9. DC of WBC.
10. Innovative experiments.

Text Books/ Reference Books:

1. Essentials of Human Anatomy andamp; Physiology Laboratory Manual, 7th edition. Elaine N Marieb; Pamela B. Jackson. Pearson Publication.

2. diFiore's Atlas of Histology with Functional Correlations, 12th International Edition. Victor P. Eroschenko. Publisher-Lippincott Williams and Wilkins.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biophysical Signals and Systems Lab
Course Code: BME392
Contact: 0:0:3
Credit: 1.5

Prerequisites:

Engineering Mathematics and Basics of Vector theory and MATLAB.

Course Objective(s):

The objective of the course is to make the students able to

1. Learn signal generation and manipulation techniques using MATLAB and simulation tools.
2. Apply core mathematical transforms (Laplace, Z, Fourier) to analyze signals.
3. Understand the behavior of signals and systems through simulation and hardware circuits.
4. Design and analyze filtering circuits relevant to biomedical signal processing.

Course Outcomes (COs):

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

COs	Statement
CO1	Understand and generate different types of signals and basic functions using MATLAB.
CO2	Apply Laplace, Fourier, and Z-transforms to standard signal types using software tools.
CO3	Analyze the behavior of signals under convolution and transformations like CTFT/DTFT.
CO4	Design and evaluate analog filters (LPF, HPF, BPF and BRF) using RC circuits and Toolbox for biomedical applications.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	2	3	-	-	-	-	-	-	1	-	-
CO3	3	3	-	3	2	-	-	-	-	-	-	-	2	-
CO4	3	3	2	2	3	-	-	-	-	-	2	2	-	3
Avg	3	2.75	2	2.33	2.5	-	-	-	-	-	2	1.5	2	2

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 Convolutions (Linear and Circular).

4. To study Z- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
5. To study Laplace- transform (MATLAB) of: a) Sinusoidal signals b) Step functions.
6. To study Fourier- transform using MATLAB.
7. To study CTFT and DTFT using FFT algorithm
8. Development of LTI Discrete Time Model
9. To study LPF and HPF using RC circuits
10. Design BPF and BRF Filter using Filter Toolbox
11. Filter ECG Signal using Band Pass Filter
12. Innovative experiments

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Analog Electronics Lab
Course Code: EC(BME)391
Contact: 0:0:2
Credit: 1

Prerequisites: A basic course in Electronics Engineering Progresses from the fundamentals of electricity, active and passive components, basic electronics laws.

Course Objective(s):

The objective of the course is to make the students able to

1. Build a strong foundation in basic electronic circuit design by introducing students to voltage regulators, transistor-based amplifiers, and RC-coupled amplifier circuits.
2. Enable students to analyze and interpret the functioning of oscillators, multivibrators, and operational amplifier-based circuits through practical measurement and waveform observation.
3. Develop students' ability to assess and compare the performance of power electronic circuits and active filters by correlating experimental outcomes with theoretical analysis.
4. Cultivate innovation and problem-solving skills by integrating concepts from multiple experiments to design and implement functional electronic circuits for real-world applications.

Course Outcomes:

After completion of this course students will be able to

COs	Statement
CO1	Design and construct basic electronic circuits such as voltage regulators, single-stage amplifiers, and RC-coupled amplifiers.
CO2	Evaluate the behaviour of oscillators, multivibrators, and operational amplifier circuits by measuring output waveforms and frequency responses.
CO3	Assess the performance of active filters and power amplifiers by comparing experimental results with theoretical expectations.
CO4	Develop and implement an innovative electronic circuit by integrating concepts from multiple experiments.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	-	-	-	1	1	-	3	2	2
CO2	3	3	2	3	2	-	-	-	1	-	-	3	2	3
CO3	3	3	2	3	2	-	-	-	1	1	-	3	2	3
CO4	2	3	3	3	3	-	-	1	2	2	2	3	3	3
Avg	2.75	2.75	2.5	2.75	2.25	-	-	1	1.25	1.33	2	3	2.25	2.75

List of Experiments:

1. Design a voltage regulator using IC.

2. Study of single stage voltage amplifier & study of its frequency response.
3. Design of RC coupled amplifier in CE mode & study of its frequency response using BJT.
4. Design of class A power amplifier and measurement of its power conversion efficiency.
5. Design of class B amplifier and measurement of its power conversion efficiency.
6. Design an astable multivibrators circuit using IC 555.
7. Design of RC Phase shift oscillator using BJT and measurement of its output frequency.
8. Design of Integrator using OPAMP (IC-741) and study of its output waveform.
9. Design of Differentiator using OPAMP (IC-741) and study of its output waveform.
10. Design of low pass filter using OPAMP and study of its frequency response.
11. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Circuit Theory Lab
Course Code: EE(BME)391
Contact: 0:0:3
Credit: 1.5

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(s):

The objective of the course is to make the students able to

1. Introduce the fundamental electrical elements and their interconnections in complex networks.
2. Enable students to analyze electrical circuits using mesh and nodal techniques under DC and AC conditions.
3. Apply network theorems for simplification and analysis of linear electrical networks.
4. Understand graph theory concepts and their application in circuit analysis.
5. Introduce Laplace Transform techniques for analyzing transient and steady-state responses of electrical networks.
6. Illustrate the applications of circuit theory in biomedical instrumentation systems.

Course Outcomes (COs):

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

COs	Statement
CO1	Analyze the characteristics of series and parallel resonant circuits using simulation or hardware.
CO2	Apply network theorems for circuit simplification and validation through experimental methods.
CO3	Evaluate transient response of RL, RC, and RLC circuits using simulation or hardware tools.
CO4	Determine two-port network parameters (Z and Y) for electrical networks and validate them experimentally.
CO5	Generate and analyze standard signals and waveforms such as sinusoidal, exponential, and impulse using software tools.
CO6	Apply Laplace Transform techniques for analyzing and interpreting time-domain functions and system responses.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	-	-	-	-	3	3	2	3	2	2
CO2	3	3	2	2	-	1	-	2	3	2	-	2	2	2
CO3	3	3	3	2	-	3	-	3	3	3	-	3	2	3
CO4	2	3	2	2	-	1	-	3	2	3	2	3	2	3
CO5	2	2	2	3	1	3	1	-	3	3	-	2	3	2
CO6	3	3	3	2	1	3	1	-	2	2	2	3	3	3
Avg.	2.67	2.67	2.33	2	1	2.2	1	2.67	2.67	2.67	2	2.67	2.33	2.5

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

Department of Biomedical Engineering
JIS College of Engineering

2nd Year 4th Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME401	Biomaterials	3	0	0	3	3
2	ENGG	Major	BME402	Biosensors & Transducers	3	0	0	3	3
3	ENGG	Minor	EC(BME)402	Digital Electronics and Devices	3	0	0	3	3
4	SCI	Multidisciplinary	PH(BME)401	Medical Physics	3	0	0	3	3
5	SCI.	Minor	M(BME)401	Numerical Methods and Statistics	3	0	0	3	3
6	HUM	Value Added Course	HU404	Project Management and Finance	2	0	0	2	2
B. PRACTICAL/ SESSIONAL									
7	ENGG	Major	BME491	Biomaterials Lab	0	0	3	3	1.5
8	ENGG	Major	BME492	Biosensors & Transducers Lab	0	0	3	3	1.5
9	ENGG	Skill Enhancement Course	EC(BME)492	Digital Electronics and Devices Lab	0	0	3	3	1.5
10	SCI	Skill Enhancement Course	M(BME)491	Numerical Methods and Statistics Lab	0	0	3	3	1.5
C. MANDATORY ACTIVITIES/ COURSES									
11	Mandatory Course	MC	MC401	Constitution of India	0	0	0	0	0
Total of Theory & Practical								**29**	**23**
Total Credit in Second Year									**45**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomaterials
Course Code: BME401
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

1. Knowledge of engineering materials
2. Fundamentals of human anatomy and physiology
3. Basics of organic and inorganic chemistry

Course Objective(s):

The objective of the course is to make the students able to

1. To introduce the fundamentals of biomaterials and their classifications based on their applications and properties.
2. To study the physical, chemical, mechanical, and biological characteristics of metals, polymers, ceramics, and composites used in biomedical devices.
3. To understand the concept of biocompatibility and toxicological responses to implanted materials.
4. To explore sterilization techniques and their effects on biomaterials used in healthcare applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the fundamental classifications, requirements, and biological responses of different biomaterials.
CO2	Apply knowledge of material properties to evaluate suitability of metals, polymers, ceramics, and composites in biomedical applications.
CO3	Analyze biocompatibility, toxicity issues, and tissue responses to different biomaterials used in medical devices.
CO4	Evaluate the effects of sterilization methods and material combinations in designing effective, safe, and durable biomedical implants.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	-	-	-	-	-	2	-	1
CO2	3	3	2	-	2	2	-	-	-	-	-	3	2	2
CO3	3	3	3	2	-	3	2	1	1	1	-	3	2	3
CO4	3	3	3	3	3	3	3	2	2	2	2	3	2	3
Avg.	3	2.75	2.67	2.5	2.5	2.5	2.5	1.5	1.5	1.5	2	2.75	2	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Basics of Biomaterials **6L**

Definition of biomaterials, requirements and classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

Module- 2: Metallic Biomaterials **6L**

Stainless steel, Titanium and its alloys, Cobalt based alloy, Dental metals, Dental amalgam, Gold, Nickel, and Corrosion of the metals. Hard tissue replacement materials: Orthopedic implants, Dental implants. Soft tissue replacement materials: Percutaneous and skin implants, Vascular implants, Heart valve implants. Cutting-edge developments in soft tissue replacements, including advances in biocompatible materials for skin and heart valve prosthetics.

Module- 3: Polymeric Biomaterials **6L**

Polymerization and basic structure, Classification according to thermosets, thermoplastics and elastomers; Bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Biocompatibility of polymers, blood compatibility improvement, processing techniques for the polymers, Applications of polymers in medical field. Use of thermoplastic elastomers (TPEs) for medical applications, focusing on their flexibility, durability, and low toxicity for applications such as surgical tubing, seals, and implants.

Module- 4: Ceramic Biomaterials **6L**

Definition of bio-ceramics, Common types of bio-ceramics: Aluminium oxides, Glass ceramics, Carbons.Bio-inert Ceramics: Alumina, Carbon, Zirconia; Biodegradable Ceramics: Tri-Calcium phosphate, Aluminum-Calcium-Phosphate (ALCAP) Ceramics; Bioactive ceramics: Bio-glass, Hydroxyapatite, Importance of wear resistance and low fracture toughness, Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/ bone tissue reaction), Medical applications.

Module- 5: Composite Biomaterials **4L**

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 (Ex- Hydroxyapatite). Incorporation of various bioactive fillers, such as hydroxyapatite (HA), tricalcium phosphate (TCP), and bioactive glass, into polymers for enhanced osteogenic activity and improved bone regeneration in orthopedic implants. Clinical Applications.

Module- 6: Biocompatibility and toxicological screening of biomaterials **5L**

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity screening tests: acute and chronic toxicity studies (in situ implantation, tissue culture, hemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test),

sensitization, carcinogenicity, mutagenicity and special tests). Long-term toxicological effects of wear debris from orthopedic implants, such as metal ions and particulate matter, and how these materials trigger chronic inflammation, immune responses, and potential systemic toxicity. Standards and protocols applicable to biomaterials.

Module- 7: Sterilization of implantable biomaterials 3L

Dry heat, Autoclaving, ETO, Gamma radiation. Effects of sterilization on properties of various biomaterials.

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 and 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 and E. C. Ethridge, *Biomaterials - An Interfacial approach*.\
   Frederick H. Silver, Biomaterials, Medical devices and Tissue Engineering, Chapman and Hall.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biosensors & Transducers
Course Code: BME402
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Fundamental knowledge of human physiology & anatomy, engineering physics and basic electronics

Course Objective(s):

The objective of the course is to make the students able to

5. Understand the fundamental working principles, classifications, and medical applications of transducers and bio-potential electrodes.
6. Apply knowledge of signal transduction mechanisms in optical, radiation, and biological sensor systems.
7. Analyze the structure, function, and classification of biosensors and chemical sensors used in biomedical applications.
8. Design basic biomedical sensing systems with appropriate data acquisition and interfacing strategies.

Course Outcomes (COs):

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

COs	Statement
CO1	Describe the characteristics, working principle and medical applications of various biomedical transducers and electrodes..
CO2	Apply concepts of biosensor components, recognition events, and biomolecule immobilization in clinical diagnostics..
CO3	Analyze the function and operation of electrochemical, optical, and biological sensors used in physiological monitoring..
CO4	Design an integrated biomedical sensing solution using appropriate sensors, signal conditioning, and DAQ systems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	-	-	-	-	-	-	3	1	2
CO2	3	3	2	-	2	1	-	-	-	-	-	3	2	2
CO3	3	3	2	2	3	-	-	-	1	-	-	3	2	3
CO4	3	3	3	2	3	1	1	1	2	2	2	3	3	3
Avg.	3	2.75	2.33	2	2.25	1	1	1	1.5	2	2	3	2	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-I: Transducer's Principles and Medical Applications 8L

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. Medical Applications of Transducers.

Module- 2: Bio-potential Electrodes 6L

Origin and Propagation of Bio-potentials; Electrode theory, Electrode electrolyte interface, polarizable and 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 (for ECG, EMG & EEG).

Module- 3: Biosensors 6L

Definition, various components of biosensors, working principle of biosensors, types of biosensors, Bio-catalysis based biosensors, Bio-affinity based biosensors and Microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions, Various recognition, Techniques, Recognition event: Catalytic, Single and multiple enzymes, Bio Affinity: Labeled and Label free, whole cellsensing – bacteria, yeast, mammalian cell, Generation of Biosensor; Biomolecule Immobilization techniques. Enzyme Kinetics Advantages and limitations.

Module- 4: Chemical Biosensors 5L

Electrochemical transducers (amperometric, potentiometric, conductometric); Electrochemical sensors for ions and dissolved gases measurement, Reference electrodes - Hydrogen electrodes - silver-silver chloride electrodes- Calomel electrodes. Measurement of pH- Glass pH electrodes. Measurement of pO2, Measurement of pCO2 -catheter tip electrodes for the measurement of pO2 and pCO2, conductivity measurement transducer, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors. Transcuteneous arterial oxygen tension and carbon dioxide tension monitoring enzyme electrode.

Module- 5: Optical Sensor and Radiation Detectors 4L

Principles of optical sensors, optical fiber sensors, indicator mediated transducers, ptical fiber temperature sensors, Types of Radiation detectors: Proportional counter, Gas-ionization chamber, Geiger counters, Scintillation detectors.

Department of Biomedical Engineering
JIS College of Engineering

Module- 6: Biological sensors **3L**

Overview of bio-fluid dynamics and its importance in the human body; Cerebrospinal fluid. Cerebral blood flow. Blood brain barrier, Brain diseases.

Module- 7: Design of Sensing Systems/ Solutions **4L**

Overview of Sensing Systems and their Applications; Basic design considerations for interfacing sensors with microcontrollers, Analog and Digital Temperature Sensor Design, Basics of Sensor Networks, Data Acquisition Systems (DAS) and Design.

Text Books:

1. S.C. Cobbold, "Transducers for Biomedical Instruments", Prentice Hall.
2. Rao and Guha, Principles of Medical Electronics and Biomedical Instrumentation, University Press, India.
3. Carrand Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.

Reference Books:

1. A.V.S. De Renck , "Touch Heat and Pain", Churchill Ltd. London.
2. Harry Thomas, "Handbook of Bio Medical Instrumentation", Reston, Virginia.
3. L. Wise, "Applied Bio Sensors", Butterworth, London.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Digital Electronics and Devices
Course Code: EC(BME)402
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Basic knowledge of Electrical Circuits and Electronics.
- Familiarity with basic mathematics (binary operations, Boolean algebra).
- Introductory understanding of semiconductor devices**.**

Course Objective(s):

The objective of the course is to make the students able to

1. Explain number systems, codes, and logic gate fundamentals in digital electronics.
2. Apply Boolean algebra, logic minimization, and combinational/sequential circuit design techniques.
3. Analyze the operation and design of digital circuits including logic families, counters, and registers.
4. Interpret memory and data conversion techniques used in digital systems.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain number systems, codes, and basic logic gate operations.
CO2	Apply Boolean algebra and minimization techniques to design combinational logic circuits.
CO3	Analyze sequential circuits including flip-flops, counters, and registers with state diagrams.
CO4	Analyze memory types and data converters for digital system applications.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	1	1	1	2	1	1
CO2	3	3	3	2	2	1	-	-	1	1	2	3	2	2
CO3	3	3	3	3	2	1	-	-	2	1	2	3	2	3
CO4	3	3	2	3	3	1	-	-	1	1	2	3	3	3
Avg.	3	3	2.5	2.25	2	1	-	-	1.25	1	1.75	2.75	2	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Number systems and Computer codes 4L

Binary, Octal, Decimal and Hexadecimal representation and their conversions; Signed binary number representation and operations with 1's and 2's complement methods; BCD, Gray codes, ASCII, EBDIC.

Module- 2: Basic Logic Gates and Logic Families 4L

Various Logic gates- their truth tables and circuits; Introduction to different logic families, TTL, MOS and CMOS logic gates, working principles, relative merits and demerits.

Module- 3: Boolean Switching algebra and Minimization technique 4L

Basics of Boolean Algebra and its various laws, Representation in SOP and POS forms; Minimization of logic expressions by algebraic method, K-map method.

Module- 4: Combinational Logic Circuits and Arithmetic Logic Circuits 8L

Adder (Full and Half), Subtractor (Full and Half), Encoder and its various types, Decoder, Comparator, Multiplexer, De-Multiplexer and Parity Generator.

Programming logic devices and gate arrays (PLAs, PLDs, FPGA).

Module- 5: Sequential Logic Circuits 12L

Basic memory element: Latches: Active High and Active Low Latches.

Flip Flops: S-R, J-K, D and T Flip Flops, Race Around Condition of JK Flip Flops, Master and Slave JK Flip Flops, Registers: Types, Counters: Types, Johnson Counter, Ring Counter, State table and state transition diagram, Sequential circuits design methodology.

Module- 6: Memories and Data Converter 4L

Basics of RAM, ROM, EPROM, EEROM, AD Converter, DA Converter.

Text Books:

1. Sedra and Smith-Microelectronic Circuits- Oxford UP
2. Boylested and Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
3. S. Salivahanan, S. Aribazhagan, Digital Circuit and Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
4. Anand Kumar, Fundamentals of Digital Circuits- PHI
5. Kharate- Digital Electronics- Oxford

Reference Books:

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Medical Physics
Course Code: PH(BME)401
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Fundamental knowledge of physics (especially electromagnetism, wave theory, and atomic structure)

Course Objective(s):

The objective of the course is to make the students able to

1. To introduce students to the principles and types of ionizing radiation and their interaction with matter.
2. To develop understanding of radiation measurement, dosimetry, and protection principles.
3. To familiarize students with the physics and instrumentation of X-ray, CT, ultrasound, and radiation therapy systems.
4. To enable evaluation of image quality metrics and regulatory practices in medical imaging and therapy.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the types, interactions, and production of ionizing radiation relevant to medical applications.
CO2	Apply concepts of radiation detection and dosimetry to measure radiation dose and ensure safety.
CO3	Analyze the working principles and image formation in X-ray, CT, and ultrasound systems.
CO4	Evaluate image quality, safety protocols, and regulations for medical imaging and therapeutic radiation applications.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**2**	**-**	**1**
CO2	**3**	**2**	**-**	**2**	**1**	**3**	**2**	**2**	**-**	**-**	**-**	**2**	**1**	**2**
CO3	**3**	**3**	**-**	**2**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**2**	**1**	**1**
CO4	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**2**	**2**	**2**
Avg.	**2.75**	**2.66**	**2**	**2.33**	**1.33**	**2.5**	**2**	**2.5**	**-**	**-**	**-**	**2**	**1.33**	**1.5**

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-I: Introduction & Radiation Physics **6L**

Types and properties of ionizing radiation (α, β, γ, X-rays, neutrons), Interaction mechanisms with matter (photoelectric effect, Compton scattering, pair production), Radioisotopes and their production

Module- II: Radiation Measurement & Dosimetry **7L**

Ionization chambers, Geiger-Müller counters, scintillation detectors, semiconductor detectors, Dosimetry concepts: absorbed dose, equivalent dose, exposure, dose rate, Shielding calculations and radiation protection principles

Module-III: Physics of X-Ray Imaging & Computed Tomography **5L**

X-ray tube physics, attenuation, image formation, contrast, resolution, Film/screen radiography vs. digital radiography, CT scanner geometry, slice reconstruction, artifacts, dose considerations.

Module-IV: Ultrasound Physics **8L**

Piezoelectric effect, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe structure, probe types, beam steering, transducers, acoustic impedance, Modes (A, B, M, Doppler), resolution, artifacts, Types of US Imaging, Real- time ultrasonic imaging systems, electronic scanners, Doppler ultrasound and Colour velocity mapping, duplex ultra sound, image artifacts, bio-effects and safety levels,

Module-V: Therapeutic Radiation Physics **6L**

External beam radiotherapy: linear accelerators, beam shaping, dose planning, Brachytherapy sources and applications, Hyperthermia, proton therapy basics.

Module-VI: Image Quality, Safety & Regulations **4L**

Metrics: spatial resolution, contrast-to-noise ratio, modulation transfer function, ALARA principle, regulatory bodies (AERB in India, ICRP global), standards

Text Books:

1. R.S. Popple, Medical Physics and Biomedical Engineering, Academic Press.
2. J.R. Johns and J.R. Webster (eds.), The Physics of Radiology, 5th ed.
3. M. Suetens, Fundamentals of Medical Imaging, Cambridge University Press.

Reference Books:

1. K.R. Khan, The Physics of Radiation Therapy, Lippincott.
2. C.R. Khan & A.W. Motz, Introduction to Radiological Physics and Radiation Dosimetry.
3. E. Bushberg et al., The Essential Physics of Medical Imaging, 4th ed.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Numerical Methods and Statistics
Course Code: M(BME)401
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

The students to whom this course will be offered should have a fundamental understanding of (10+2) standard algebra, elementary probability, set theory, functions, along with basic numerical computation skills and familiarity with concepts like error estimation, significant digits, and round-off errors.

Course Objective(s):

The objective of the course is to make the students able to –

4. Develop the ability to apply numerical methods for solving algebraic and transcendental equations, and systems of linear equations commonly encountered in engineering and applied sciences.
5. Gain statistical insight by analyzing datasets through measures of central tendency, dispersion, correlation, and regression for effective data interpretation.
6. Build foundational knowledge in inferential statistics and estimation techniques to assess population parameters and make informed decisions based on sample data.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply numerical techniques to obtain approximate solutions to algebraic, transcendental equations and systems of linear equations relevant to engineering and scientific problems.
CO2	Apply statistical methods to compute and interpret measures of central tendency, dispersion, correlation, and regression for solving real-world data-driven problems.
CO3	Analyze the accuracy and convergence of numerical solutions obtained through iterative methods in the context of engineering problems.
CO4	Analyze sampling distributions, estimation procedures, and confidence intervals to draw statistical inferences from data and assess the reliability of estimates.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	1	2	3	2
CO2	3	2	-	-	-	-	-	-	-	-	1	2	2	3
CO3	3	3	1	1	-	-	-	-	-	-	2	2	3	3
CO4	3	3	1	1	-	-	-	-	-	-	2	2	2	3
Avg.	3	2.5	1	1	-	-	-	-	-	1.5	1.5	2	2.5	2.75

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-I: Solution of Algebraic Polynomial and Transcendental Equations **[8L]**

Bisection method, Regula-Falsi method, Secant method, Fixed Point Iteration method, Newton-Raphson method.

Module-II: Numerical Solution of System of Linear Equations **[6L]**

Gauss-Elimination method, Tridiagonal system, LU Factorization method, Gauss-Seidel iterative method.

Module-III: Descriptive Statistics **[10L]**

Measures of Central Tendency: Mean, Median, Mode. **[4L]**

Measures of Dispersion: Range, Mean deviation, Variance, Standard deviation. **[2L]**

Correlation: Bivariate Data, Scatter Diagram, Methods of studying correlation – Karl-Pearson's
coefficient of correlation. **[2L]**

Regression: Regression lines, Regression equations, Regression coefficients. **[2L]**

Module-IV: Inferential Statistics **[12L]**

Sampling Theory: Random sampling, Parameter & Statistic, Standard error of statistic, Sampling distribution of sample mean and variance in random sampling from a normal distribution, Central limit theorem and related problems. **[6L]**

Estimation of Parameters: Unbiased and consistent estimators, Point estimation, Interval estimation, Maximum likelihood estimation of parameters (Binomial, Poisson and Normal), Confidence intervals and related problems. **[6L]**

Text Books:

1. Numerical Methods, Gupta, S. and Dey, S., Mc. Grawhill Education Pvt. Ltd.
2. Statistical Methods, Das, N. G., TMH.

Reference Books:

1. Numerical Mathematical Analysis, Scarborough, J. B., Oxford and IBH Publishing
2. Numerical Methods (Problems and Solution), Jain, M. K., Iyengar, S. R. K. and Jain, R. K., New age International Publisher.
3. Statistics Theory, Method & Application, Sancheti, D. S. and Kapoor, V. K., Sultan Chand & sons, New Delhi.
4. Numerical Methods, Balagurusamy, E. Scitech. TMH.
5. Numerical Analysis, Shastri, S. S. PHI.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Project Management and Finance
Course Code: HU(EC)701
Contact: 2:0:0
Total Contact Hours: 28
Credit: 2

Prerequisite:

Course Objectives:

The objective of the course is to make the students able to

1. Understand the fundamental concepts and components of Project Management.

2. Develop the ability to perform preliminary project screening and appraisal, enabling students to identify viable project opportunities and assess their potential.

3. Gain knowledge and analytical skills for conducting comprehensive feasibility studies.

4. Impart foundational knowledge of Financial Management principles.

5. Enhance decision-making abilities related to financial management, particularly in areas such as investment analysis, cost control, and project financing.

Course Outcomes:

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

COs	Statement
CO1	Understand and explain the fundamental principles, tools, and techniques of project management including planning, scheduling, monitoring, and control in engineering projects.
CO2	Apply project screening and feasibility analysis methods to assess the technical, market, and operational viability of engineering projects.
CO3	Analyze financial data to evaluate project investments, including concepts such as time value of money, break-even analysis, and risk-return trade-off.
CO4	Demonstrate decision-making capabilities in project financing and resource allocation, using basic financial management principles and tools.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	2	3	2	2	-
CO2	-	3	2	-	-	2	-	-	-	-	3	3	-	2
CO3	2	3	-	2	-	-	-	-	-	-	3	-	2	2
CO4	-	-	2	-	-	-	-	2	2	2	3	2	-	3
Avg.	2.5	2.67	2	2	-	2	-	2	2	2	3	2.33	2	2.33

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-I: **Basics of Project Management** **2L**

Meaning, Definition and scope and Need for Project Management - The Project Life Cycle - Phases of Project Management Life Cycle - Project Management Processes.

Module-II: **Project Identification and Selection** **3L**

Preliminary Screening of Projects. Project Identification Process- Sources of Financial resources - Pre-Feasibility Study - Feasibility Studies: Market Feasibility, Financial Feasibility and Technical Feasibility.

Module-III: **Project Organization and Planning** **3L**

Project manager, Cross-functional team, Dedicated project organization, Influence project organization, Matrix organization, Advantages and disadvantages of project organizations, Selection of project organization, Work Breakdown Structure (WBS), Integration of project organization and WBS, WBS and responsibility matrix.

Module-IV: **Project Scheduling and Resource Management** **4L**

Gant chart, Milestone chart, Network techniques: PERT and CPM, AON and AOA representation.

Module-V: **Nature and Scope of Financial Management** **2L**

Role of financial management in business decision, the Firm and its Environment: Forms of business ownership.

Module-VI: **Balance Sheet and Profit and Loss Statements** **6L**

Tools of Financial Analysis: Funds flow analysis - sources and uses of funds, measurements of cash flow, Revenue costs. **3L**

Investment Management: Capital Budgeting Techniques. PBP, ARR, Time Value of Money, NPV v/s IRR. Risk Analysis. **3L**

Module-VII: **Profit Relationships** **8L**

Break even analysis, ratio analysis, of operating and financial leverages, Working Capital Management, Credit Policy. **3L**

Financial Decision Making: Sources of raising capital, Internal financing, Cost of capital, Balanced Capital Structure. Capital Structure Theories, Dividend Policy & its Theories. **5L**

Textbooks:

1. R. Paneerselvam, P. Senthil Kumar, Project Management, PHI.

2. S. N. Maheshwari, Financial Management: Principles and Applications , Sultan Chand & Sons

Reference Books:

1. Prasanna Chandra, Projects, Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill Pvt. Ltd., New Delhi.

2. K. Nagrajan, Project Management, New Age International Publishers,

3. Vasanth Desai, Project Management, Himalaya Publications.

4. Clifford F. Gray, Erik W. Larson, Project Management, the Managerial Emphasis, Tata McGraw Hill.

6. 7. M.Y. Khan and P. K. Jain, Financial Management: Text, Problems and Cases, Tata McGraw Hill Pvt. Ltd., New Delhi.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomaterials Lab
Course Code: BME491
Contact: 0:0:3
Credit: 1.5

Prerequisites:

1. Basic knowledge of engineering materials
2. Fundamentals of biomaterials (theory)
3. Understanding of laboratory safety and measurement procedures

Course Objective(s):

1. The objective of the course is to make the students able to
2. To provide practical exposure to mechanical and surface property evaluation of biomaterials.
3. To develop skills in testing the compatibility and performance of materials in simulated physiological environments.
4. To enhance understanding of body fluid–material interactions via pH, conductivity, and viscosity analysis.
5. To promote innovation through design and validation of experiments involving advanced biomaterials characterization.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the basic testing methods for evaluating physical and mechanical properties of biomaterials.
CO2	Perform mechanical, surface, and non-destructive testing of metallic and polymeric biomaterials.
CO3	Analyze and interpret experimental data related to biomaterial compatibility and body fluid properties.
CO4	Design and execute innovative experiments for assessing novel or composite biomaterials in simulated environments.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**–**	**–**	**–**	**1**	**–**	**–**	**–**	**–**	**–**	**2**	**–**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**–**	**–**	**1**	**–**	**–**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**–**	**3**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**
Avg.	**3**	**2.75**	**2.67**	**2.67**	**2.33**	**2**	**2.5**	**1.5**	**1.33**	**1.5**	**2**	**2.75**	**2.33**	**2.25**

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Mechanical Characterization of Biomaterials
2. Hardness Testing of Metallic Biomaterials
3. Hardness Testing of Polymeric Biomaterials
4. Surface Roughness Measurement
5. *Invitro* Hemocompatibility Study of Biomaterials
6. pH Measurement of Body Fluid
7. Conductivity Measurement of Body Fluid
8. Viscosity Measurement of Body Fluid
9. Non-Destructive Testing of Biomaterials
10. Innovative Experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biosensors & Transducers Lab
Course Code: BME492
Contact: 0:0:3
Credit: 1.5

Prerequisites: Basic knowledge of human physiology and biomedical signals (ECG, EMG, EEG), along with foundational understanding of analog and digital electronics, electrical circuits including Ohm's Law, and fundamental principles of sensors and transducers such as resistive, capacitive, and piezoelectric types.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the working principles and applications of biomedical and industrial transducers.
2. Develop hands-on skills to measure physical quantities like temperature, pressure, displacement, and torque using different types of transducers.
3. Analyze the characteristics and behavior of bio-transducers and bio-electrodes under various physiological conditions.
4. Evaluate transducer-based measurement systems in terms of sensitivity, linearity, hysteresis, and application-specific suitability.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the operational principles and application of various biomedical and industrial transducers.
CO2	Apply appropriate transducers to measure physical and physiological parameters effectively.
CO3	Analyze transducer output characteristics such as linearity, sensitivity, and hysteresis.
CO4	Evaluate the performance and suitability of transducers and electrodes for specific biomedical applications..

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2	-	-	-	-	-	-	3	2	2
CO2	3	3	2	2	3	1	-	-	-	-	-	3	2	2
CO3	3	3	2	2	2	-	-	-	-	-	-	2	2	3
CO4	3	3	2	3	2	2	1	1	1	1	-	3	2	3
Avg.	3	2.75	1.75	2.33	2.25	1.5	1	1	1	1	-	2.75	2	2.5

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

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 and characterization of bio-transducers – Pressure, Temperature, Humidity
10. Study and characterization of bio-electrodes – ECG, EMG, EEG
11. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Digital Electronics and Devices Lab
Course Code: EC(BME)492
Contact: 0:0:3
Credits: 1.5

Prerequisite:

- Basic understanding of electricity and electronics (voltage, current, resistance).
- Familiarity with number systems and binary arithmetic.
- Knowledge of basic logic gate symbols and truth tables.
- Ability to interpret simple circuit diagrams**.**

Course Objectives:

The objective of the course is to make the students able to

1. Understand the operation and realization of various logic gates and their implementation using universal gates.
2. Apply logic simplification techniques to design combinational circuits such as adders, subtractors, decoders, multiplexers, parity generators, and comparators.
3. Analyze sequential circuits including flip-flops and counters for digital system applications.
4. Evaluate and verify the performance of designed combinational and sequential circuits through practical realization.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the working principle of basic and universal logic gates and implement basic gates using universal gates.
CO2	Construct combinational logic circuits such as adders, subtractors, decoders, multiplexers, parity generators, and comparators using logic gates.
CO3	Analyze the operation of sequential circuits including R-S, J-K, and D flip-flops and various counter circuits.
CO4	Evaluate the correctness and efficiency of designed combinational and sequential circuits through testing and troubleshooting.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	1	-	-	-	-	1	-	2	3	2
CO2	3	3	3	2	2	-	-	-	1	1	1	3	3	2
CO3	3	3	2	3	2	1	-	-	1	2	1	3	2	3
CO4	3	3	2	3	3	1	-	1	2	2	2	2	3	3
Avg.	3	2.75	2	2.67	2	1.5	-	1	1.33	1.5	1.33	2.5	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Realization of different gates like AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR and Realization of basic gates using universal logic gates.
2. Gray Code to Binary Code Conversion and Vice Versa.
3. Construction of simple arithmetic circuits- Adder, Subtractor.
4. Construction of simple Decoder and Multiplexer circuits using logic gates.
5. Construction of Four-bit parity generator and comparator circuits.
6. Realization of R-S, J-K and D flip-flops using Universal logic gates.
7. Realization of Counter Circuits
8. Innovative experiments

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Constitution of India
Course Code: MC401
Contact: 2:0:0
Total Contact Hours: 24
Credits: 0

Prerequisite: None

Course Objectives:

The objective of the course is to make the students able to

1. Understand the historical background, salient features, and the preamble of the Indian Constitution.
2. Explain the Fundamental Rights, Duties, and Directive Principles of State Policy and their significance in Indian democracy.
3. Apply the knowledge of Union and State Government structures to comprehend the functioning of different constitutional bodies and emergency provisions.
4. Analyze the powers and functions of various constitutional authorities (President, Prime Minister, Judiciary, Governor, Chief Minister) and evaluate their roles within the federal framework.

Course Outcomes (COs):

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

COs	Statement
CO1	Recall the historical development, salient features, and preamble of the Indian Constitution.
CO2	Describe and interpret Fundamental Rights, Duties, and Directive Principles of State Policy with reference to their constitutional articles.
CO3	Illustrate the structure and functioning of the Union and State Government, including emergency provisions and amendment procedures.
CO4	Compare and evaluate the roles, powers, and functions of key constitutional authorities at the Union and State levels and their impact on governance.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	2	-	2	1	2	-	-	-	2
CO2	2	2	-	-	-	3	-	3	1	2	-	-	-	3
CO3	2	2	2	1	-	3	-	2	2	2	1	1	1	2
CO4	1	3	2	3	-	3	-	3	2	2	2	1	1	3
Avg.	1.75	2	2	2	-	2.75	-	2.5	1.5	2	1.5	1	1	2.5

Course Content

Module 1: Introduction: 4L

"Constitution"- Historical Background of the Constituent Assembly, Indian Constitution and its Salient Features, the Preamble of the Constitution.

Department of Biomedical Engineering
JIS College of Engineering

Module 2: Fundamental Rights, Fundamental Duties, Directive Principles of State Policy **8L**

The Right to Equality

The Right to Freedom: I (Article 19)

The Right to Freedom: II (Articles 20, 21 and 22)

The Right against Exploitation

The Right to freedom of Religion

Cultural and Educational rights

The Right to Property

The Right to Constitutional Remedies

The Directive Principles

Fundamental Duties

Module 3: Union Government and its Administration **6L**

Structure of the Indian Union, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

Module 4: The Machinery of Government in the State **6L**

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges

State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

Text / Reference Books:

1) Indian Constitution by D.D.Basu, The Publisher, LexisNexis
2) Constitution of India by Subhas C Kasyap, Vitasta Publishing
3) The Constitution of India, P.M Bakshi, Universal Law Publishing Co.Ltd, New Delhi, 2003.
4) Indian Constitution Text Book - Avasthi, Avasthi,Publisher: LAKSHMI NARAIN AGARWAL

Department of Biomedical Engineering
JIS College of Engineering

3rd Year 5th Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME501	Biomedical Instrumentation	3	0	0	3	3
2	ENGG	Major	BME502	Analytical & Diagnostic Equipment	3	0	0	3	3
3	ENGG	Major	BME503	Medical Imaging Systems	3	0	0	3	3
4	ENGG	Major	BME504	Biophysics and Biochemistry	3	0	0	3	3
5	ENGG	Major	BME505A	Communication Systems and Biotelemetry	3	0	0	3	3
			BME505B	Bioelectrical and Bioelectronics Measurement					
			BME505C	Biomedical Informatics					
6	ENGG.	Minor	CS(BME)506A	Data Structure and Algorithm	3	0	0	3	3
			EC(BME)506B	VLSI and Embedded System					
			EE(BME)506C	Measurement and Control System					
B. PRACTICAL/ SESSIONAL									
7	ENGG	Major	BME591	Biomedical Instrumentation Lab	0	0	3	3	1.5
8	ENGG	Major	BME592	Analytical & Diagnostic Equipment Lab	0	0	3	3	1.5
9	ENGG	Major	BME595A	Communication Systems and Biotelemetry Lab	0	0	2	2	1
			BME595B	Bioelectrical and Bioelectronics Measurement Lab					
			BME595C	Biomedical Informatics Lab					
10	ENGG	Skill Enhancement Course	CS(BME)596A	Data Structure and Algorithm Lab	0	0	2	2	1
			EC(BME)596B	VLSI and Embedded System Lab					
			EE(BME)596C	Measurement and Control System Lab					
11	PRJ	Project	PR591	Minor Project	0	0	4	4	2
C. MANDATORY ACTIVITIES/ COURSES									
12	MC	Mandatory Course	MC501	Intellectual Property Rights	0	0	0	0	0
Total of Theory & Practical								**32**	**25**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomedical Instrumentation
Course Code: BME501
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Analog and Digital electronics.

Course Objective(s):

The objective of the course is to make the students able to

1.Understand the fundamentals of biomedical signals and medical instrumentation systems.

2.Explore the characteristics, constraints, and design considerations of biomedical measurement systems.

3.Analyze bioelectric signals, electrode systems, and amplification techniques used in medical instrumentation.

4.Study different types of patient monitoring systems and their clinical significance.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the origin of biomedical signals and structure of medical instrumentation systems.
CO2	Describe the characteristics and performance of medical measurement systems.
CO3	Analyze the role of operational amplifiers, electrodes, and amplifiers in bio-signal acquisition.
CO4	Evaluate the working principles of biomedical recording systems and their components.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	1	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	1	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	1	3	3
CO4	3	2	3	2	3	-	-	-	-	-	-	1	3	3
Avg.	3	2.5	2.5	1.5	1.75	-	-	-	-	-	-	1	2.75	2.5

Course Content:

Module- 1: Medical Instrumentation **6L**

Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors and Computers in medical instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices. Wearable Medical Devices and Health Monitoring Systems.

Department of Biomedical Engineering
JIS College of Engineering

Module- 2: Measurement Systems **6L**

Specifications of instruments, Static and Dynamic characteristics of medical instruments, Classification of errors, Statistical analysis, Reliability, Accuracy, Fidelity, Speed of response, Linearization of technique, Data Acquisition System. Real-time monitoring and control of bioelectronics devices, Signal Conditioning and Amplification.

Module- 3: The Operational Amplifier and Oscillator **8L**

Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Instrumentation amplifiers, Special features of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector. Bio impedance Amplifiers.

Module- 4: Biomedical Recording Systems **10L**

Basic Recording systems, General consideration for signal conditioners, Preamplifiers, Differential Amplifier, Isolation Amplifier, Electro cardiograph, Phonocardiograph, Electro encephalograph, Electromyography, Digital stethoscope Other biomedical recorders, Biofeedback instrumentation, Electrostatic and Electromagnetic coupling to AC signals, Proper grounding, Patient isolation and accident prevention. bio electromagnetism concept of electric fields and magnetic fields in the human body.

Module- 5: Patient Monitoring Systems **6L**

System concepts, Selection of system parameters, Cardiac monitor, Bedside monitors, Central monitors, Heartrate meter, Pulse rate meter, Measurement of respiration rate, Holter monitor and Cardiac stress test, Catheterization Laboratory Instrumentation, Organization and Equipment used in ICCU and ITU. Modern Patient Monitoring Systems and its applications.

Text Books:

1. R.S. Khandpur “Handbook of Bio-Medical Instrumentation”,2nd Edition, Tata McGraw Hill.
2. J.J. Carr and J.M. Brown, “Introduction to Biomedical Equipment Technology” PearsonEducation, Asia.
3. Cromwell, Weibell and Pfeiffer, “Biomedical Instrumentation and Measurement”, PrenticeHall, India

Reference Books:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg., Boston. J.Webster, “Bioinstrumentation”, Wileyand Sons.
2. Joseph D. Bronzino, “The Biomedical Engineering handbook”, CRC Press.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Analytical & Diagnostic Equipment
Course Code: BME502
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge of human physiology, electronics, instrumentation, and fundamental physics and mathematics.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the principles and components of various clinical, biochemical, and optical instruments used in diagnostic laboratories.
2. Apply the operational concepts of instruments used in cardiac and pulmonary function measurement.
3. Analyze the function and working mechanisms of endoscopic and computer-based instruments used in diagnosis and imaging.
4. Evaluate the suitability, performance, and clinical relevance of different analytical and diagnostic equipment in various healthcare settings.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the principles and applications of photometric, spectroscopic, and microscopic instruments in clinical diagnostics.
CO2	Apply the working principles of cardiac and pulmonary diagnostic equipment in physiological monitoring and assessment.
CO3	Analyze the structure, function, and usage of endoscopic systems and cell counting technologies in clinical practice.
CO4	Evaluate the performance, integration, and applicability of computer-based and automated medical instruments.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	3	2	2
CO3	3	3	2	3	3	1	-	-	1	-	-	3	-	3
CO4	3	3	3	3	3	2	1	1	2	2	2	2	3	3
Avg.	3	2.75	2.33	2.67	2.75	1.5	1	1	1.5	2	2	2.5	2.33	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-1: Clinical Equipment **10L**

Principles of photometric measurement, Optical filters, Colorimeter, Spectrometer, Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer- Autoanalyzer, 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.

Module- 2: Cardiac Function Measurement **10L**

Blood pressure apparatus, Blood Gas Analyzers and Oximeters
Principles of Blood pressure measurement, Types of Blood Pressure apparatus: Sphygmomanometer, Automated indirect and specific direct method of B.P. monitor. Principles of Blood gas analysis. Types of Blood Gas Analyzers: Electrochemical sensors (pH sensor, pCO2 sensor and pO2 sensor), Fiber optic based blood gas sensors, Oximeter and 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.

Module- 3: Pulmonary Function Measurement **6L**

Respiratory volumes and capacities, Compliance and related pressure, Spirometer, Diffusion Capacity of the Lungs for Carbon Monoxide (DLCO), Peak Flow Measurement, Pneumotachometer- different types, Measurement of respiration rate-impedance pneumograph / plethysmograph, apnea detector.

Module- 4: Endoscopy **6L**

Overview of Endoscopy, Types of Endoscopy, Components of Endoscope, 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.

Module- 5: Computer Based Instruments **4L**

Overview of Computer-Based Instruments, Components of Computer Based Instruments, Types, Computer Interfacing and protocol, Computerized Medical Instruments.

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. Car and J.M. Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
4. Cromwell, Weibell and Pfeiffer, "Biomedical Instrumentation and Measurement",

Prentice Hall, India.

Reference Books:

4. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg . , Boston.
5. J. Webster, “Bioinstrumentation”, Wiley and Sons.
6. Joseph D. Bronzino, “The Biomedical Engineering handbook”, CRC Press.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Medical Imaging Systems
Course Code: BME503
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

Knowledge of basic physics of medical imaging

Course Objective(s):

The objective of the course is to make the students able to

1. To explain the physical principles and system components behind various advanced medical imaging modalities like CT, MRI, PET, SPECT, and more.
2. To understand system configurations, image reconstruction methods, and hardware design for CT and MRI scanners.
3. To explore modern non-invasive diagnostic imaging systems such as thermography, OCT, and retinography.
4. To provide knowledge on the role of computers in medical imaging including DICOM standards, PACS, teleradiology, and hospital information systems.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the principles and system configurations of X-Ray, CT, PET, SPECT, and MRI scanners including their components.
CO2	Apply image reconstruction techniques and hardware concepts in evaluating performance of imaging systems.
CO3	Analyze the working principles, safety concerns, and clinical utility of emerging imaging technologies.
CO4	Evaluate integration of information systems, data formats, and digital communication standards in radiological practice.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	2	-	1	-	-	-	-	-	-	-	-
CO3	3	3	2	3	-	1	-	-	-	-	-	-	2	2
CO4	3	2	2	2	-	-	-	-	-	-	-	3	-	1
Avg.	3	2.5	2	2.33	-	1	-	-	-	-	-	3	2	1.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: X-Ray and Computed Tomography 12L

Cathode: Biased and Unbiased, Stationary and Rotating Anode tube, Focal Spot and Anode Heel Effect, 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.

CT Generations and its progress, Scanning Systems, Detectors in CT, Data Acquisition System and Processing, Storing and Viewing System, Gantry Geometry, Different Information from 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

Module- 2: Radionuclide Imaging 4L

Basic principles of Rectilinear scanners, Gamma Camera, PET, SPECT, Scintigraphy, Dual isotope imaging.

Module- 3: Magnetic Resonance Imaging (MRI) 11L

Principles of nuclear magnetism, Transverse field and its effect, RF magnetic field and resonance, magnetic resonance (MR) signal, nuclear spin relaxations and T2* Relaxation with simple case study/examples, gradient pulse, slice selection, phase encoding, frequency encoding, spin echoes, gradient echoes, K-space data acquisition and image reconstruction. MRI scanner hardware: magnet, gradient coil, RF pulse transmission and RF signal reception. Diagnostic utility and clinical MRI, functional MRI, magnetic resonance angiography (MRA), magnetic resonance spectroscopy (MRS), diffusion MRI, bio-effects and safety levels.

Module- 4: Modern Diagnostic Imaging Systems 6L

Fluoroscopy, Angiography: Types, Infrared (IR) Imaging, Thermography – Scanning systems, Liquid Crystal Thermography, Microwave Thermography: types and modes, Optical Coherence Tomography (OCT), Electro-oculography, Retinography – Basic Principles and Applications.

Module- 5: Computers in Imaging Systems 3L

Computer systems: operating systems and its various generations and transfer of images: file formats; Radiological Information System, Hospital Information System, Picture archiving and communication systems, internet and intranet, teleradiology, medical image processing system-basic introduction.

Text Books:

1. Carr and 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 and Sons

Reference Books:

1. Dowsett, Kenny and Johnston, "The Physics of Diagnostic Imaging", Chapman and Hall Medical, Madras/London.
2. Brown, Smallwood, Barber, Lawford and Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
3. Massey and Meredith, "Fundamental Physics of Radiology", John Wright and Sons.
4. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biophysics and Biochemistry
Course Code: BME504
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

1. Basic understanding of Physics, Chemistry, and Human Biology at the +2 level
2. Familiarity with biological systems and general cell physiology

Course Objective(s):

The objective of the course is to make the students able to

1. To understand the physical principles governing biological systems and their applications in medicine.
2. To explain the bioelectric phenomena and electrical activity in various organs.
3. To introduce the structural and functional aspects of biomolecules and metabolic pathways.
4. To correlate molecular biochemistry with physiological processes and biomedical applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the basic biophysical principles such as membrane transport, radioactivity, and body fluid dynamics.
CO2	Illustrate and analyze electrical signals such as ECG, EEG, EMG, and their physiological significance.
CO3	Analyze biochemical pathways like glycolysis, TCA cycle, and fatty acid metabolism for energy production.
CO4	Evaluate enzyme kinetics and the molecular processes of DNA replication and protein synthesis.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	–	2	–	1	–	–	–	–	–	2	–	1
CO2	3	3	2	3	2	2	–	1	–	–	–	3	2	2
CO3	3	3	3	3	2	2	1	–	–	1	–	3	2	3
CO4	3	3	3	3	3	2	2	1	1	1	1	3	3	3
Avg	3	2.75	2.67	2.75	2.33	1.75	1.5	1	1	1	1	2.75	2.33	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Biological Principles **5L**

Composition and properties of cell membrane, membrane transport, body fluid, electrolytes, filtration, diffusion, osmosis, electrophoresis, plasmapheresis, radioimmunoassay, Photochemical reaction, laws of photochemistry, fluorescence, phosphorescence.

Module- 2: Bioelectricity **5L**

Membrane potential, Action potential, Electrical properties of membrane, capacitance, resistance, conductance, dielectric properties of membrane.

Module- 3: Electrical Stimulus and Biophysical Activity **6L**

Patient safety, electrical shock and hazards, leakage current, Electrical activity of heart (ECG), Electrical activity of brain (EEG), Electroretinogram (ERG), Electro-occulogram (EOG), Electromyogram (EMG).

Module- 4: Radioactivity **4L**

Ionizing radiation, U-V and IR radiations, Production of radioisotopes, Radioactive decay, Half-life period.

Module- 5: Macromolecules **8L**

Classification and functions of carbohydrate. Glycolysis. TCA cycle. ATP synthesis. Classification and functions of proteins. Architecture of protein. Classification of amino acid. Oxidative and non-oxidative deamination, transamination. Classification and functions of lipids. Biosynthesis of long chain fatty acid. Oxidation and degradation of fatty acid.

Module- 6: Enzymes and Nucleic acid **8L**

Chemical nature and broad classification of enzymes, M-M kinetics, Isozymes and Allosteric enzymes. Enzyme Inhibition. Structure of DNA, DNA Replication, Transcription, Translation.

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 and Charlotte W Pratt- Wliey, 2nd Edition (March 31, 2005).
3. The Biomedical Engineering Hand Book- 3rd Edition- (Biomedical Engineering Fundamentals)- Joseph D Bronzino- CRC Press- Taylor Francis- 2006 (Section III- Bio-Electrical Phenomena).

Reference Books

1. Lehninger Principles of Biochemistry by David L Nelson and 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.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: COMMUNICATION SYSTEMS AND BIOTELEMETRY
Course Code: BME505A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Fundamental knowledge of Mathematics, Digital Electronics, Signal Theory.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the basic principles of analog and digital communication relevant to biomedical applications.
2. Familiarize students with data communication protocols and their role in biomedical systems.
3. Explain the fundamentals of biotelemetry systems and their clinical applications.
4. Explore modern communication technologies such as mobile systems, telemedicine, and video conferencing in healthcare

Course Outcomes (COs):

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

COs	Statement
CO1	Understand the principles and applications of analog and digital communication in medical contexts.
CO2	Explain the OSI model, networking devices, and basics of data communication and cryptography..
CO3	Describe the structure, function, and types of biotelemetry systems used in patient monitoring.
CO4	Demonstrate knowledge of modern biomedical communication systems and Telemedicine including GSM, WLAN, and Bluetooth.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	2	1	1
CO2	3	2	2	1	-	-	-	-	-	-	-	2	1	2
CO3	3	3	2	-	2	-	-	-	-	-	-	3	2	3
CO4	3	2	2	-	2	-	-	-	-	-	-	2	2	3
Avg.	3	2.25	1.15	1	2	-	-	-	-	-	-	2.75	2.25	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Analog and Digital Communication 12L

Introduction to Communication Systems, Modulation: Types; Need for Modulation; Theory of Amplitude Modulation: 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. Basic concepts of digital modulation, Pulse code Modulation (PCM): Sampling, Quantization, Companding, Coding; Amplitude Shift Keying (ASK): Basic idea, Modulation and Demodulation; Frequency Shift Keying (FSK): Basic idea, Modulation and Demodulation

Module- 2: Data Communication 8L

Data Communication: OSI Model – Basic working principle of each layer, LAN, WAN; Modem – Working Principle, Speed calculation; Switch and Router – Working Principle; Cryptography – Basic idea of Error Detection and Correction –Hamming code, cyclic code.

Module- 3: Biotelemetry 8L

Bio-Telemetry System: Components of telemetry system, bio-telemetry and its importance, single and multi-channel biotelemetry, ECG telemetry system, temperature telemetry system, telemetry of ECG and respiration, sports telemetry, multi-patient telemetry, ambulatory patient monitoring, implantable telemetry systems, transmission of physiological signals over telephone line, telemedicine and applications.

Module- 4: Modern Communication System 8L

Introduction, Principles of Video Conferencing, Telemedicine, Mobile communication – GSM Architecture and working principle; Bluetooth; WLAN.

Text Books:

1. B. P. Lathi, “Modern Analog and Digital Communication Systems”, 3rd Edition, OxfordUniversity Press.
2. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley and Sons.
3. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, PearsonEducation.
4. R.S. Khandpur; “Handbook of Bio-Medical Instrumentation”, 2nd Ed.; TMH

Reference Books:

1. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, PearsonEducation.
2. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, PearsonEducation.
3. Blake, “Electronic Communication Systems”, Thomson Delmar Publications.
4. Martin S.Roden, “Analog and Digital Communication System”, 3rd Edition, Prentice Hallof India.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Bioelectrical and Bioelectronics Measurement
Course Code: BME505B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge of human physiology and anatomy, fundamentals of electronics and electrical circuits, introductory knowledge of biomedical instrumentation and measurement systems.

Course Objective(s):

The objective of the course is to make the students able to

1. Familiarize students with the origin and nature of bioelectric potentials and their physiological significance.
2. Explain the principles of transport processes and their role in bioelectrical signal generation and propagation.
3. Develop understanding of various measurement techniques for ECG, EEG, and EMG and their applications in diagnosis.
4. Introduce applications of bioelectronics in prosthetic devices, neural interfaces, and patient monitoring systems.

Course Outcomes:

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

COs	Statement
CO1	Explain the sources, types, and propagation mechanisms of bioelectric potentials in physiological systems.
CO2	Apply the principles of transport processes and bioelectrical potential balances to describe electrical activity in living tissues.
CO3	Analyze ECG, EEG, and EMG signals to identify normal and abnormal physiological conditions.
CO4	Evaluate the design and functionality of bioelectronic devices and patient monitoring systems for clinical applications.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	-	-	1	1	-	3	2	2
CO2	3	3	2	2	2	1	1	-	1	1	1	3	2	3
CO3	3	3	2	3	3	1	-	1	2	2	1	3	3	3
CO4	3	3	3	3	3	2	1	2	2	2	2	3	3	3
Avg.	3	2.75	2	2.25	2.25	1.25	1	1.5	1.5	1.5	1.33	3	2.5	2.75

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Introduction to Bioelectric Potentials 6L

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 bio-signals, Development of Bioelectric potential measurement, Problems encountered in measuring a living system.

Module- 2: Transport Processes 6L

Basic concepts of transport processes, Propagation of electrical impulse through ion exchange, Chemical balances, force balances, general bioelectrical potential balances, Kirchhoff's laws, Conservation of mass and energy.

Module- 3: Measurement of Bioelectrical Phenomenon 10L

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.

Module- 4: Overview of Bioelectronics 8L

Interactions between electronics and biomedical science; fundamental properties of ions in the solution; electrical properties of cellular components: lipid bilayer and membrane proteins; Natural nano-conductors: ion channels and pumps; Single channel recording: the measurement and the noise; Patch clamp amplifier -the electronics of low noise current detection.

Module- 5: Bioelectronics in Prosthetic Devices and Patient Monitoring 6L

Brain-computer interface, Neural implants, Retinal Implants, Bionic arm, Cochlear implants/ Bionic ear, - lung machine, Nerve – muscle stimulator, Requirement of Continuous Monitoring of Bioelectrical Signals, Elements of intensive care monitoring, Patient monitoring displays, Multi-parameter Monitoring Device, Automated Diagnosis of Bioelectrical Signals.

Text Books:

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

Reference Books:

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomedical Informatics
Course Code: BME505C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic understanding of biology, particularly molecular and cellular biology; fundamentals of genetics and biochemistry; introductory knowledge of computer science concepts and basic algorithms.

Course Objective(s):

The objective of the course is to make the students able to

1. Explain the fundamental concepts of cellular biology, genetic material, and molecular processes in living organisms.
2. Introduce bioinformatics tools, databases, and search engines for biological data retrieval and analysis.
3. Develop knowledge of DNA sequence analysis techniques and alignment algorithms.
4. Understand and apply probabilistic models and computational techniques for solving problems in bioinformatics.

Course Outcomes:

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

COs	Statement
CO1	Explain the structure and functions of cellular components, DNA, RNA, and molecular processes like transcription and translation.
CO2	Apply bioinformatics tools and database search techniques to retrieve and analyze biological sequence data.
CO3	Analyze DNA sequence data using alignment algorithms and interpret results for biological significance.
CO4	Evaluate probabilistic models and classification methods for solving computational biology problems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	1	1	1	-	2	1	2
CO2	3	3	2	2	3	1	-	1	1	2	1	2	3	3
CO3	3	3	2	3	3	1	-	1	2	2	1	2	3	3
CO4	3	3	3	3	3	2	1	2	2	2	2	2	3	3
Avg.	3	2.75	2	2.25	2.25	1.25	1	1.25	1.5	1.75	1.33	2	2.5	2.75

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Introduction to Cellular Biology 6L

Concepts of Cell, types of cells, components of cell, organelle. Functions of different organelles. Basic Structure of DNA; Double Helix structure, Watson and Crick model. Exons and Introns and Gene Concept. Basic structure, Difference between RNA and DNA. Types of RNA. Basic components and structure. Transcription and Translation; Introduction to Metabolic Pathways.

Module- 2: Introduction to Bioinformatics and Search Engines 8L

Recent challenges in Bioinformatics. Data Warehouse, Data models, Database Management Concepts. Different Bioinformatics database types. Protein Sequence Databases: PDB, SWISS-PROT database.

DNA sequence data bases: DDBJ, Gen bank.

Sequence database search program slike BLAST and FASTA. NCBI different modules: Gen Bank; OMIM, Taxonomy browser, Pub-Med.

Module- 3: DNA Sequence Analysis 12L

DNA Mapping and Assembly: Size of Human DNA, Copying DNA: Polymerase Chain Reaction (PCR), Hybridization and Microarrays, Cutting DNA into Fragments, Sequencing Short DNA Molecules, Mapping Long DNA Molecules. DeBruijn Graph. Sequence Alignment: Introduction, local and global alignment, pairwise and multiple alignments, Dynamic Programming Concept. Alignment algorithms: Needleman and Wunsch algorithm, Smith-Waterman.

Module- 4: Introduction Probabilistic Models Used in Computational Biology 10L

Probabilistic Models; Hidden Markov Model: Concepts, Architecture, Transition matrix, estimation matrix. Application of HMM in Bioinformatics: Gene finding, profile searches, multiple sequence alignment and regulatory site identification. Bayesian networks Model: Architecture, Principle, Applications in Bioinformatics.

Biological Data Classification and Clustering

Assigning protein function and predicting splice sites: Decision Tree

Text/Reference Books:

1. Bioinformatics and Molecular Evolution by Paul G. Higgs and Teresa K. Attwood
2. Bioinformatics Computing by Bryan Bergeron
3. Bioinformatics and Functional Genomics by Jonathan Pevsner
4. Gene Cloning and DNA Analysis by T.A. BROWN

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Data Structure and Algorithm
Course Code: BME506A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic knowledge of Programming Languages (like C/C++).
- Fundamentals of Mathematics (sets, functions, logic, recursion).
- Understanding of Problem-Solving Techniques and algorithmic thinking.
- Familiarity with Computer Organization concepts such as memory and storage.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the fundamental concepts of data structures and algorithms and their role in problem solving.
2. Develop the ability to implement linear and non-linear data structures and analyze their performance.
3. Enhance skills in applying searching, sorting, and hashing algorithms to real-world computational problems.
4. Foster the ability to analyze, evaluate, and optimize algorithms in terms of time and space efficiency.

Course Outcomes:

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

COs	Statement
CO1	Explain the principles of abstract data types, arrays, linked lists, stacks, queues, and trees with their applications.
CO2	Apply suitable linear and non-linear data structures in developing solutions to computational problems.
CO3	Analyze the performance of searching, sorting, and hashing algorithms in terms of time and space complexity.
CO4	Evaluate and compare different data structures and algorithms for problem solving in terms of efficiency and suitability.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	1	2	-	2	2	2
CO2	3	3	2	1	2	-	-	-	2	2	1	3	3	2
CO3	3	3	2	2	3	-	-	-	1	2	2	2	3	3
CO4	3	3	3	2	3	1	1	2	2	3	2	2	3	3
Avg.	3	2.75	2	1.5	2.5	1	1	1.5	1.5	2.25	1.67	2.25	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Introduction 8L

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.

Module- 2: Stack and Queue 6L

Stack and its implementations (using array, using linked list), applications. Queue, circular queue, de-queue. 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.

Module- 3: Trees 12L

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 only). B- Trees – operations (insertion, deletion with examples only).

Module- 4: Sorting Algorithms and Searching 10L

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

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: VLSI and Embedded System
Course Code: BME506B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic knowledge of Electronic Devices & Circuits (Diodes, BJTs, MOSFETs).
- Fundamentals of Digital Electronics (logic gates, flip-flops, combinational and sequential circuits).
- Understanding of Basic Computer Organization & Architecture.
- Introductory programming knowledge in C or Assembly.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the fundamentals of Integrated Circuits (ICs), scaling principles, and VLSI design methodologies.
2. Develop an understanding of digital and analog VLSI circuit design techniques with memory structures.
3. Provide knowledge of embedded processors, architectures, and system components for embedded system design.
4. Familiarize students with embedded sensors, actuators, and communication standards for real-world applications.

Course Outcomes:

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

COs	Statement
CO1	Explain the principles of ICs, MOSFET scaling, VLSI design flow, and embedded system architecture.
CO2	Apply CMOS design styles, analog MOS subcircuits, and memory elements to design basic VLSI and embedded system circuits.
CO3	Analyze the performance of digital/analog VLSI circuits, sequential logic, embedded processors, and communication protocols.
CO4	Evaluate the efficiency, applicability, and limitations of VLSI circuits, embedded architectures, and networking standards in system design.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	1	2	-	2	2	2
CO2	3	3	3	2	3	-	-	-	2	2	2	3	3	2
CO3	3	3	2	2	3	1	1	1	2	2	2	2	3	3
CO4	3	3	3	2	3	2	1	2	2	3	3	2	3	3
Avg.	3	2.75	2.25	1.75	2.75	1.5	1	1.33	1.75	2.25	2.33	2.25	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module 1: Introduction to IC **5L**

Integrated Circuits – Advantages, disadvantages, limitations; Scale of Integration – SSI, MSI, LSI, VLSI, ULSI; Moor's Law; Scaling of MOSFET-Constant field scaling and constant voltage scaling, Short Channel Effects; VLSI design flow, Y-Chart, IC Classification – Standard IC and ASIC, PAL, PLA.

Module 2: Digital VLSI Circuit Design **10L**

Inverter Characteristics **2L**

Resistive load inverter – Voltage transfer characteristics (VTC, significance of parameters (only expression, no derivation) –VIL, VIH, VOL, VOH, Vth; CMOS inverter - VTC, Noise margin and aspect ratio of symmetric CMOS inverter.

Combinational Logic Circuit Design **4L**

Circuit design using Static CMOS style – basic gates, design of circuit for product of sum (POS) and sum of product (SOP) expression, full adder; Circuit design using pseudo NMOS logic, TG Logic, Pass Transistor Logic, Complementary pass transistor logic, Dynamic logic, domino logic, NORA logic.

Sequential Circuit and Semiconductor Memory Design **4L**

Bistable Circuit -Design of CMOS S-R and J-K Latch, CMOS Clocked SR and JK Latch /Master –slave JK Flip- flop, CMOS D Flip-flop; 6T SRAM cell and 3T DRAM cell design, EEPROM, Flash Memory.

Module 3: Analog VLSI Circuit Design **7L**

Small Signal model of MOSFET; Analog sub-circuits -MOS Switch, Active resistors/MOS Diode, Current source and Sink, Current Mirror; Current and voltage references-voltage divider, Band gap reference (Basic Principle); Switch- Capacitor Circuit – resistance emulation of series; CMOS differential amplifier – design parameters; Output amplifier (basic circuit).

Module 4: Introduction to Embedded System **7L**

General purpose processors, RISC and CISC processors, ALU, Von-Neumann and Harvard architecture, MULTI-CORE, Atmega8/16/328P processor, ARM Cortex-III processor, Raspberry Pi, CPLD, FPGA

Module 5: Introduction to Embedded Sensors, Actuators, Networking Standard 7L

Sensor interfacing **3L**

Pressure, Temperature, Acceleration, Image, Rain, Proximity, Hall-effect, Ultra-sonic;

Embedded Networking and Standards **4L**

RS232, RS485, SPI, USB, PCI, I2C, CAN, Bluetooth, Zigbee

Text Books:

1. Digital Integrated Circuit, J.M. Rabaey, Chandrakasan, Nicolic, Pearson Education.

2. CMOS Digital Integrated Circuits Analysis and Design, S.M.Kang and Y.Leblebici, TMH.
3. CMOS Analog Circuit Design, Allen and Holberg , Oxford
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi , TMH .
5. Embedded Systems Architecture, Programming and Design, Ral Kamal, TMH, 2008.
6. An Embedded Software Primer, D.E. Simon., Pearson Education, 1999.
7. Design with PIC Microcontrollers, J.B. Peatman, Pearson Education, 1998

Reference Books:

1. Microelectronic Circuits, Sedra and Smith, Oxford
2. Introduction to VLSI Circuits and System, Uyemura , Wiley
3. VLSI Design, Debaprasad Das, Oxford
4. VLSI Design and EDA Tools, Angsuman Sarkar, Swapnadip De, C.K. Sarkar, Scitech
5. VLSI Design Techniques for Analog and Digital Circuits, Geiger, Allen, Strader, TMH
6. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes,
7. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001.
8. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Measurement and Control System
Course Code: BME506C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic knowledge of Physics (electricity, magnetism, mechanics, thermodynamics).
- Fundamentals of Electrical and Electronic Circuits.
- Introductory knowledge of Mathematics (differential equations, Laplace transforms).
- Elementary programming/simulation exposure (e.g., MATLAB/Scilab, Proteus, or equivalent).

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the concepts of measurement systems, instruments, and errors.
2. Provide knowledge of transducers, signal conditioning circuits, and pilot devices used in measurement and automation.
3. Develop understanding of control system basics, mathematical modeling, and system representation.
4. Enable students to analyze and evaluate system responses, stability, and control actions.

Course Outcomes:

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

COs	Statement
CO1	Explain the working principles of measuring instruments, transducers, and pilot devices with their applications.
CO2	Apply signal conditioning techniques, mathematical modeling, and block diagram representation to physical and electrical systems.
CO3	Analyze the time-domain performance and stability of first and second-order control systems using standard criteria.
CO4	Evaluate the effectiveness of controllers (PI, PD, PID) and error constants in improving system performance.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	-	1	1	2	-	3	2	2
CO2	3	3	2	2	3	-	-	-	2	2	2	2	3	2
CO3	3	3	2	3	3	1	1	-	2	2	2	2	2	3
CO4	3	3	3	2	3	2	1	2	2	3	3	3	2	3
Avg.	3	2.75	2	2	2.75	1.33	1	1.5	1.75	2.25	2.33	2.5	2.25	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Basic Measuring Instruments **5L**

Measurements: Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Errors in measurement.

Analog meters: General features, Construction, Principle of operation and torque equation of Moving coil and Moving iron type instruments. Ammeters, voltmeters, Extension of instrument range and multiplier.

Module- 2: Transducers **8L**

Concept of Transducers, Classification of Transducers Primary and Secondary Transducers, Electrical and Mechanical Transducers, Analog and Digital Transducers, Active and passive Transducers. Construction, working principle and application (with diagram and explanation) of RTD, Thermistor, Thermocouple. Potentiometers, Strain gauge, Types of strain gauges, Bridge circuit for strain gauge, Bourden tube, Bellows, Diaphragm. LVDT, measurement for displacement. Capacitive transducers, Application in pressure measurement. Load cell. Tachometer.

Module- 3: Signal Conditioning **5L**

Concept of signal conditioning. Block diagram of AC and DC signal conditioning and working. V to I converter, I to V converter, V to F converter. Instrumentation Amplifier. Filters – Types, frequency response and circuits.

Module- 4: Pilot Devices **3L**

Definition of pilot devices, Function of pilot devices. List of different pilot devices. Construction, working and applications of: Push Button, Limit Switch, Electromagnetic Relay, Pressure switch, Proximity switch.

Module- 5: Introduction to Control Systems **2L**

Concept of feedback and Automatic control, Types and examples of feedback control systems, Definition of transfer function. Poles and Zeroes of a transfer function.

Module- 6: Mathematical modelling **5L**

Writing differential equations and determining transfer function of model of various physical systems including - Translational and Rotational mechanical systems, Basic Electrical systems and transfer function, Electrical analogy of Spring – Mass Dashpot system. Block diagram representation of control systems. Block diagram algebra.

Module- 7: Time domain analysis **8L**

Time domain analysis of a standard first and second order closed loop systems. Determination of time domain specifications of systems. Step response of first and second order systems. 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.

Text Books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Control System Engineering, I. J. Nagrathand M. Gopal. New Age International Publication.

3. Control System Engineering, D. Roy Choudhury, PHI
4. Automatic Control Systems, B.C. Kuoand F. Golnaraghi, 8th Edition, PHI
5. A.K.Sawhney, Electrical and Electronics Measurement and Instrumentation, Dhanpat Rai and Co.
6. H.S.Kalsi, Electronic Instrumentation, Tata McGraw Hill.

Reference Books:

1. Control Engineering Theory and Practice, Bandyopadhyaya, PHI.
2. K. Lal Kishore, Electronic Measurement and Instrumentation, Pearson.

Department of Biomedical Engineering
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Course Name: Analytical & Diagnostic Lab
Course Code: BME592
Contact: 0:0:3
Credit: 1.5

Prerequisites: Basic knowledge of human physiology, biomedical signals (ECG, respiration, BP), analog and digital electronics, and the working principles of medical diagnostic and therapeutic instruments.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the working principles of commonly used diagnostic biomedical instruments.
2. Apply the use of biomedical devices such as pulse meters, colorimeters, spirometers etc., in clinical simulations.
3. Analyze biomedical circuit behavior and calibration procedures for accurate physiological measurements.
4. Evaluate the performance, safety, and effectiveness of biomedical instrumentation in patient monitoring applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the functional principles and clinical applications of diagnostic and therapeutic biomedical instruments.
CO2	Operate and calibrate biomedical instruments such as BP meters, pacemakers, and pulse rate monitors.
CO3	Analyze circuit behavior and signal responses of biomedical systems like spirometers and diathermy units.
CO4	Evaluate the accuracy, reliability, and safety of biomedical instruments used for physiological monitoring.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2	2	-	1	-	-	-	3	2	2
CO2	3	3	2	2	3	-	-	-	-	-	-	3	2	2
CO3	3	3	2	3	2	-	-	-	-	-	-	3	2	3
CO4	3	3	2	3	2	3	1	2	1	1	-	3	2	3
Avg.	3	2.75	1.75	2.67	2.25	2.5	1	1.5	1	1	-	3	2	2.5

Department of Biomedical Engineering
JIS College of Engineering

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 ratemeterand apnea detection
8. Study on diathermy unit (ultrasoundand short-wave)
9. Study of ultrasonic devices -transmitter and detector
10. Study on blood flow velocity measurement-ultrasonic method
11. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Communication Systems and Biotelemetry Lab
Course Code: BME595A
Contact: 0:0:2
Credit: 1

Prerequisites:

- Basic knowledge of analog and digital communication systems (AM, FM, PM).
- Understanding of modulation and demodulation concepts (AM, FM, PAM, PCM, PSK, FSK, TDM).
- Familiarity with electronic components and instruments such as oscilloscopes, function generators, spectrum analyzers, and communication trainer kits.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the fundamental principles and techniques of analog and digital modulation and demodulation.
2. Measure key parameters (modulation index, bandwidth) of modulated signals using communication trainer kits.
3. Familiarize with multiplexing techniques and digital communication schemes like PCM, PSK, and FSK.
4. Enhance students' practical skills in setting up, analyzing, and troubleshooting communication circuits and systems.

Course Outcomes (COs):

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

COs	Description
CO1	Explain and demonstrate the working principles of analog and digital modulation techniques (AM, FM, PAM, PCM, PSK, FSK).
CO2	Perform experiments to measure key parameters such as modulation index and bandwidth using standard laboratory equipment.
CO3	Compare and analyze the performance of various modulation/demodulation and multiplexing techniques in terms of efficiency and signal quality.
CO4	Design and evaluate simple communication systems or subsystems using the studied modulation, demodulation, and multiplexing techniques.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	2	1	-	1	1	2	-	3	2	1
CO2	3	3	-	3	3	-	-	1	1	2	1	3	2	1
CO3	3	3	2	3	3	1	-	-	1	2	1	3	3	2
CO4	3	3	3	3	3	1	-	1	2	3	2	3	3	3
Avg.	3	2.75	2.5	2.75	2.75	1	-	1	1.25	2.25	1.33	3	2.5	1.75

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Measurement of MI of an AM signal,
2. Study of SSB modulation and demodulation technique,
3. Study of DSB modulation and demodulation technique,
4. Measurement of bandwidth of a FM signal,
5. Study of phase locked loop(PLL),
6. Study of PAM modulation and demodulation technique,
7. Study of PCM coder and decoder,
8. Study of PSK modulation and demodulation technique,
9. Study of FSK modulation and demodulation technique,
10. Study of time division multiplexing (TDM) and demultiplexing.
11. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Bioelectrical and Bioelectronics Measurement Lab
Course Code: BME595B
Contact: 0:0:2
Credit: 1

Prerequisites: Fundamentals of Basic Electronics and Human Physiology

Course Objective(s):

The objective of the course is to make the students able to

1. Gain hands-on experience in using electronic and biomedical measurement instruments.
2. Familiarize with electrical characteristics of bioelectronics devices.
3. Understand the principles and calibration of biomedical sensors and transducers.
4. Develop skills in data acquisition, analysis, and troubleshooting.

Course Outcomes (COs):

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

COs	Statement
CO1	Operate standard electrical and biomedical measurement instruments for experimental purposes
CO2	Measure electrical and physiological parameters using appropriate sensors and transducers.
CO3	Analyze acquired biomedical signals to extract relevant information.
CO4	Document experimental procedures, results, and interpretations in a structured technical format.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	1	-	1	1	1	-	3	2	1
CO2	3	3	-	2	3	1	-	1	1	1	-	3	2	2
CO3	3	3	2	3	3	1	-	1	2	2	1	3	3	3
CO4	2	2	2	2	2	-	-	1	2	3	2	2	2	2
Avg.	2.75	2.5	2	2.25	2.75	1	-	1	1.5	1.75	1.5	2.75	2.25	2

List of Experiments:

Part A – Electrical Measurements & Instrumentation

1. Study and calibration of measuring instruments – Voltmeter, Ammeter, Wattmeter.
2. Measurement of resistance using Wheatstone bridge and Kelvin double bridge.
3. Measurement of inductance and capacitance using AC bridges.
4. Measurement of frequency and phase using Lissajous figures on CRO.
5. Use of Digital Storage Oscilloscope (DSO) for time and frequency domain measurements.

6. Calibration of a function generator and study of waveform parameters.

Part B – Bioelectronics & Biomedical Measurements

7. Study of biomedical sensors – temperature, pressure, and displacement transducers.
8. Measurement of skin resistance (GSR – Galvanic Skin Response).
9. Measurement of bio-potentials – ECG signal acquisition and analysis.
10. Measurement of EMG signals using surface electrodes.
11. Measurement of EEG signals – basic setup and data interpretation.
12. Pulse rate measurement using photoplethysmography (PPG) sensor.
13. Temperature measurement using thermistor/thermocouple and signal conditioning.
14. Study of instrumentation amplifier for biomedical signal acquisition.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomedical Informatics Lab
Course Code: BME595C
Contact: 0:0:2
Credit: 1

Prerequisites:

- Basic understanding of molecular biology concepts – DNA, RNA, proteins, genes, and their structures.
- Familiarity with computers and operating systems – basic file handling, web browsers, and software installation.
- Introductory knowledge of bioinformatics databases and sequence formats (FASTA, GenBank, PDB).
- Basic statistics and data analysis skills (mean, variance, hypothesis testing).

Course Objective(s):

The objective of the course is to make the students able to

1. Know the key biological databases and data retrieval tools for genomic, proteomic, and clinical information.
2. Perform sequence analysis, annotation, and structural visualization of biological macromolecules.
3. Develop skills in biomedical literature search, text mining, and clinical data pre-processing for research purposes.
4. Familiarize with statistical and machine learning techniques for analyzing and modeling biomedical datasets.

Course Outcomes (COs):

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

COs	Statement
CO1	Retrieve and analyze biological sequences and structures from public databases using appropriate tools.
CO2	Perform sequence alignment, phylogenetic analysis, and functional annotation to interpret biological significance.
CO3	Pre-process, normalize, and statistically analyze large-scale biomedical or clinical datasets.
CO4	Build basic predictive models and map clinical terms to standard ontologies to support biomedical research.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	2	3	1	-	1	1	1	-	3	3	2
CO2	3	3	2	3	3	1	-	1	1	2	-	3	3	3
CO3	3	3	2	3	3	1	-	2	2	2	1	3	3	3
CO4	3	3	3	3	3	1	-	2	2	3	2	3	3	3
Avg.	3	2.75	2.33	2.75	3	1	-	1.5	1.5	2	1.5	3	3	2.75

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Exploration of Biological Databases (NCBI, UniProt, PDB)
2. Retrieval and Analysis of DNA/Protein Sequences in FASTA Format
3. Performing BLAST Search for Gene/Protein Annotation
4. Multiple Sequence Alignment and Phylogenetic Tree Construction
5. Biomedical Literature Search and Text Mining using PubMed
6. Microarray / RNA-Seq Data Normalization and Differential Expression Analysis
7. Visualization of Protein 3D Structures using PyMOL/Chimera
8. Clinical/EHR Data Pre-processing and Basic Statistical Analysis
9. Predictive Modeling of Biomedical Datasets using Machine Learning Tools
10. Mapping Clinical Terms to Standard Ontologies (ICD, SNOMED CT, MeSH)

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JIS College of Engineering

Course Name: Data Structure and Algorithm Lab
Course Code: CS(BME)596A
Contact: 0:0:2
Credits: 1

Prerequisite:

- Knowledge of arrays, linked lists, and queues
- Basic understanding of memory management in Operating Systems
- Familiarity with searching and insertion/deletion operations

Course Objectives:

The objective of the course is to make the students able to

1. Develop problem-solving skills by applying data structure concepts to real-world problems.
2. Understand the working principle of page replacement strategies and their applications.
3. Implement an efficient algorithm using appropriate data structures for memory management.
4. Analyze and evaluate the performance of the implemented algorithm in terms of time and space complexity.

Course Outcomes:

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

COs	Statement
CO1	Apply array, queue, and linked list concepts to design a program for simulating page replacement.
CO2	Analyze the sequence of page references to determine the number of page faults for a given memory size.
CO3	Evaluate the performance of LRU algorithm compared to FIFO or Optimal page replacement.
CO4	Design and develop an efficient C program that simulates LRU page replacement with minimal faults.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	-	-	-	1	1	-	2	2	1
CO2	2	3	2	2	2	-	-	-	1	1	-	2	2	2
CO3	2	3	2	2	2	1	-	1	1	2	-	2	2	2
CO4	3	3	3	2	3	1	-	1	2	2	1	3	3	3
Avg.	2.5	2.75	2.25	1.75	2.25	1	-	1	1.25	1.5	1	2.25	2.25	2

List of Experiments:

1. Program to Find the Number of Elements in an Array
2. Develop and Implements 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 and display element from single linked list
11. Program to create add remove and display element from double linked list
12. Program to count number of nodes in linear linked list
13. Program to create add remove and display element from circular linked list
14. Programs to implement stack and queues using linked representation
15. Program to concatenate two linear linked lists
16. Program to accept a singly linked list of integers and 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 and deletion in c
20. Program for pre-order, post-order and 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

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Course Name: VLSI and Embedded System Lab
Course Code: EC(BME)596B
Contact: 0:0:2
Credits: 1

Prerequisite:

- Basic knowledge of digital electronics (logic gates, flip-flops, counters).
- Understanding of CMOS circuit design principles.
- Fundamentals of VHDL programming and HDL simulation tools.
- Awareness of microcontrollers/embedded platforms (ATmega, Raspberry Pi) and basic sensor–actuator interfacing.

Course Objectives:

The objective of the course is to make the students able to

1. Develop the ability to design and simulate CMOS logic circuits using SPICE at schematic level.
2. Understand and implement combinational and sequential digital circuits using VHDL with various modelling styles.
3. Acquire practical skills in embedded system programming for microcontrollers and Raspberry Pi.
4. Integrate sensors, actuators, and communication protocols for the development of mini-projects addressing real-world applications.

Course Outcomes:

After completion of this course students will be able to

COs	Statement
CO1	Apply SPICE and VHDL tools to design and implement combinational and sequential digital circuits.
CO2	Analyze the functionality and performance of CMOS circuits, FSMs, and embedded applications through simulation and hardware testing.
CO3	Evaluate different design methodologies, interfacing techniques, and communication protocols for efficient embedded system solutions.
CO4	Design and develop a functional mini-project (e.g., home automation, weather monitoring, drip irrigation) by integrating digital design, microcontrollers, and IoT concepts.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	1	1	-	2	3	2
CO2	3	3	2	3	3	-	-	-	1	1	-	2	2	2
CO3	2	3	2	3	3	1	-	1	2	2	1	2	3	3
CO4	3	3	3	2	3	2	1	1	3	3	2	3	3	3
Avg.	2.75	2.75	2.25	2.5	3	1.5	1	1	1.75	1.75	1.5	2.25	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. SPICE simulation of CMOS inverter to plot voltage transfer characteristics (VTC) for different values of ratio for VDD=1 V and nano dimensional channel length

2. Design and testing of functionality of the following gate and combinational circuit with the help of SPICE tools at schematic level.

a) CMOS AND/NAND, OR/NOR, XOR/XNOR gate

b) CMOS full adder circuit

3. Design and simulation with the help of VHDL applying suitable modelling style (structural, behavioural, dataflow, mixed) for the following combinational circuits

a) Logic gates b) Full adder using half adder c) 4:1 MUX using 2:1 MUX

4. Design using VHDL for the following Sequential circuits

a) S-R Flip-Flop

b) 8-bit synchronous counter

c) 8 Bit bi-directional register with tri-stated input output

5. VHDL implementation of Finite State Machine.

6. LED blinking using ATMEGA16/ ATMEGA328P/ Raspberry Pi (automatic and switch controlled).

7. Different sensor interfacing with ATMEGA16/ ATMEGA328P/ Raspberry Pi.

8. Different actuator interfacing with ATMEGA16/ ATMEGA328P/ Raspberry Pi.

9. Establishment of different communication protocols like USART/ UART, SPI, I2C, CAN, bluetooth etc.

10. Execution of mini projects like home automation, weather monitoring, drip irrigation etc.

Text Books:

1. Digital Integrated Circuit, J.M.Rabaey, Chandrakasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuits Analysis and Design, S.M.Kang and Y.Leblebici,TMH.
3. CMOS Analog Circuit Design, Allen andHolberg , Oxford
4. Design of Analog CMOS Integrated Circuits, Behzad Razavi , TMH .
5. Embedded Systems Architecture, Programming and Design, Ral Kamal, TMH, 2008.
6. An Embedded Software Primer, D.E. Simon., Pearson Education, 1999.
7. Design with PIC Microcontrollers, J.B. Peatman, Pearson Education, 1998

Reference Books:

1. Microelectronic Circuits, Sedraand Smith, Oxford
2. Introduction to VLSI Circuits and System, Uyemura , Wiley
3. VLSI Design, Debaprasad Das, Oxford
4. VLSI Design and EDA Tools, Angsuman Sarkar, Swapnadip De, C.K. Sarkar, Scitech

5. VLSI Design Techniques for Analog and Digital Circuits, Geiger, Allen, Strader, TMH
6. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes,
7. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001.
8. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002

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Course Name: Measurement and Control System Lab
Course Code: EE(BME)596C
Contact: 0:0:2
Credits: 1

Prerequisite:

- Fundamentals of control systems (open-loop, closed-loop, time-domain analysis).
- Basic understanding of transducers (LVDT, strain gauge).
- Knowledge of Op-amp applications and signal conditioning circuits.
- Familiarity with MATLAB/Simulink tools for system simulation.

Course Objectives:

The objective of the course is to make the students able to

1. Provide hands-on experience in measuring displacement and signal conditioning using transducers and op-amp circuits.
2. Enable students to simulate and analyze control system responses using MATLAB/Simulink.
3. Study the frequency response characteristics of active filters and system performance under different controllers.
4. Integrate theory with practical applications by designing and tuning controllers for real-time control system processes.

Course Outcomes:

After completion of this course students will be able to

COs	Statement
CO1	Apply LVDT, strain gauge, and signal conditioning circuits to measure and process physical parameters.
CO2	Analyze the step and impulse response of first-order, second-order, and higher-order control systems using MATLAB/Simulink.
CO3	Evaluate the performance of active filters and PID controllers by comparing simulated and experimental results.
CO4	Design and implement control strategies for a servomotor position control system and validate its performance experimentally.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	1	1	-	2	2	1
CO2	3	3	2	3	3	-	-	-	1	1	-	2	2	2
CO3	2	3	2	3	3	1	-	1	2	2	1	2	3	3
CO4	3	3	3	3	3	2	1	1	3	3	2	3	3	3
Avg.	2.75	2.75	2.25	2.75	3	1.5	1	1	1.75	1.75	1.5	2.25	2.5	2.25

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. To measure linear displacement by LVDT and plot characteristics.
2. To measure displacement by Strain gauge and plot characteristics.
3. To study the following signal conditioning circuits and observe and plot the output (i) V to I Converter, (ii) I to V Converter, (iii) V to F Converter using Op-AMP 741.
4. To plot frequency response of Active filters (any two):- I) Low pass filter II)High pass filter III) Band pass filter Iv) Band stop filters using KIT/ MATLAB.
5. Familiarization with MATLAB control system tool box, MATLAB - simulink tool box.
6. Determination of Step response for first order and Second order system with unity feedback using MATLAB
7. Simulation of Step response and Impulse response for type-0, type-1 and Type-2 system with unity feedback using MATLAB.
8. To study the position control system using servomotor.
9. Determination of PI, PD and PID controller action of first order simulated process using KIT/ MATLAB.

Department of Biomedical Engineering
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Course Name: Intellectual Property Right
Course Code: MC 501
Contacts: 2:0:0
Total Contact Hours: 24
Credit: 0

Prerequisite: None

Course Objectives:

The objective of the course is to make the students able to

1. Understand the concept, need, and types of Intellectual Property Rights (IPR), their genesis, and the role of international organizations/treaties.
2. Explain the legal aspects of patents, trademarks, copyrights, geographical indications, industrial designs, and their protection processes in India and abroad.
3. Apply knowledge of IPR to identify patentable inventions, prepare patent/trademark applications, and recognize infringement issues and remedies.
4. Analyze India's National IPR Policy 2016, government initiatives, and the implications of IPR in real-world scenarios including cyber law and career opportunities.

Course Outcomes:

After completion of this course students will be able to

COs	Statement
CO1	Recall the fundamentals of Intellectual Property Rights, their types, need for protection, and the roles of national and international agencies.
CO2	Describe the processes and legal requirements for patents, trademarks, copyrights, geographical indications, and industrial designs including rights and duties of holders.
CO3	Demonstrate the ability to search, draft, and file patent or trademark applications and identify infringement cases with possible remedies.
CO4	Evaluate India's National IPR Policy 2016, government schemes, and case studies to understand the present scenario and career prospects in IPR.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	1	3	-	1	1	1	1	2
CO2	3	3	2	-	1	3	1	3	-	2	2	2	1	2
CO3	2	3	3	2	3	2	1	3	2	2	3	3	3	2
CO4	2	3	2	3	2	3	2	3	2	3	3	3	2	3
Avg.	2.5	2.75	2.33	2.5	2	2.5	1.25	3	2	2	2.25	2.25	1.75	2.25

Course Content:

Module-1: Overview of the IPR **4L**

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and

Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India: Genesis and development – IPR in abroad - International organizations. agencies and treaties,

Module-2: Patents **4L**

Trips Definition, kind of inventions protected by Patent-Patentable and Non patentable inventions. Elements of Patentability: Novelty, Non Obviousness (Inventive Steps), Le8al requirements for patents — Granting of patent - Rights of a patent-exclusive right. Patent application process: Searching a patent- Drawing of a patent- Filing of a patent- Types of patent applications- Parent document: specification and Claims.

Registration Procedure, Rights and Duties of Patentee, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies and Penalties.

Module-3: Trademarks **4L**

Trademarks-Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies and Penalties – trademark registration processes.

Module-4: Copyrights **4L**

Right and protection covered by copyright- Law of copy rights: Fundamental of copyright law. originality **of material,** rights of reproduction, rights to perform the worth publicly, copy right ownership issues, obtaining copy right registration, notice of copy right. International copyright law. Infringement of Copyright under Copyright Act

The Role Arid Liabilities of lPRs in India – Cyber law issues: Criminal law. data safety, online privacy. Health privacy, Freedom of expression and human rights, net neutrality, national security.

Module-5: Geographical Indication of Goods **4L**

Types, why and how GI need protection and GI laws. Indian GI act.

Industrial Designs: protection. Kind of protection provided by industrial designs. Integrated Circuits

Module-6: India`s New National IP Policy- 2016 **4L**

Govt. of India step towards promoting IPR – Govt. Schemes IPR – Career Opportunities in IP - IPR in current scenario with case studies.

Text Books:

1. Fundamentals of lP for Engineers: K. Bansl and P. Bansal

2. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

3. Neeraj, P., and Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Reference Books:

1. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.

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3rd Year 6th Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME601	Therapeutic Equipment	3	0	0	3	3
2	ENGG	Major	BME602	Biomedical Signal Processing	3	0	0	3	3
3	ENGG	Major	BME603A	Hospital Engineering and Management	3	0	0	3	3
			BME603B	Biomedical Hazards and Safety					
			BME603C	Radiotherapy and Nuclear Medicine					
4	ENGG	Major	BME604A	Modeling of Physiological Systems	3	0	0	3	3
			BME604B	Tissue Engineering					
			BME604C	Nanobiotechnology					
5	ENGG.	Minor	CS(BME)605A	Database Management System	3	0	0	3	3
			EC(BME)605B	Microprocessor and Microcontroller					
			CS(BME)605C	Soft Computing					
B. PRACTICAL/ SESSIONAL									
6	ENGG	Major	BME691	Therapeutic Equipment Lab	0	0	3	3	1.5
7	ENGG	Major	BME692	Biomedical Signal Processing Lab	0	0	3	3	1.5
8	ENGG	Major	CS(BME)695A	Database Management System Lab	0	0	2	2	1
			EC(BME)695B	Microprocessor and Microcontroller Lab					
			CS(BME)695C	Soft Computing Lab					
9	PRJ	Project	PR691	Project- I	0	0	6	6	3
C. MANDATORY ACTIVITIES/ COURSES									
10	MC	Mandatory Course	MC601	Entrepreneurship and Innovation Skill	0	0	0	0	0
Total of Theory & Practical								**29**	**22**
Total Credit in Third Year									**47**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Therapeutic Equipment
Course Code: BME601
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Basic knowledge of human physiology, biomedical instrumentation, and electrical/electronic circuits.

Course Objective(s):

The objective of the course is to make the students able to

5. Understand the principles and clinical applications of therapeutic devices such as pacemakers, defibrillators, and ventilators.
6. Apply engineering concepts to the operation and analysis of electrotherapy and physiotherapy equipment.
7. **Analyze** the mechanisms, waveforms, and patient interfaces of surgical diathermy and LASER-based therapeutic technologies.
8. **Evaluate the performance, safety, and clinical efficacy of patient care systems and assistive therapeutic equipment.gs.**

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the working principles, components, and classifications of pacemakers, defibrillators, and ventilators used in clinical settings.
CO2	Apply concepts of therapeutic instrumentation to operate and assess physiotherapy and electrotherapy equipment.
CO3	Analyze the operating mechanisms and safety aspects of surgical diathermy and LASER systems used in medical treatment.
CO4	Evaluate the integration, functionality, and safety features of patient care and assistive therapeutic devices.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	2	2	-	1	-	-	-	3	2	2
CO2	3	3	2	2	3	1	-	-	-	-	-	3	2	2
CO3	3	3	2	3	3	2	1	2	-	-	-	3	2	3
CO4	3	3	2	3	2	3	2	3	1	1	1	3	2	3
Avg.	3	2.75	1.75	2.67	2.5	2	1.5	2	1	1	1	3	2	2.5

Course Content:

Module-1: Cardiac Pacemakers and Defibrillators **10L**

Need for pacemaker, External pacemakers, implantable pacemakers and types; Programmable pacemakers; Codes for pacemakers; Pulse generator: sensing, output and timing circuits. Power sources,

electrodes and leads system, pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, Types of defibrillator electrodes, energy requirements, synchronous operation, implantable defibrillators, defibrillator safety and analyzers, Implantable Cardioverter (ICD), RF ablation treatment for arrhythmia.

Module- 2: Ventilators and Anaesthetic System 7L

Basic principles of ventilators, Ventilators and types, different generators, inspiratory phase and expiratory phase, different ventillatory adjuncts, neonatal ventilators, p-based ventilator, ventilator testing. Anaesthesia: Need of anaesthesia, gas used and their sources, gas blending and vaporizers, anaesthesia delivery system, breathing circuits.

Module- 3: Physiotherapy and Electrotherapy Equipment 7L

IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy; Electrotherapy and different waveforms, Electrode system, Electrical stimulators and types, Strength-duration curve, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulators, peripheral nerve stimulator, Ultrasonic stimulators, pain relief through electrical stimulators.

Module- 4: Surgical Diathermy and LASER 8L

Principles and applications of surgical diathermy, Electrosurgery machine, electrosurgery circuits, solid state electrosurgery generator circuits, electrosurgery safety, testing electrosurgery units, basic principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter. Principle operation of LASER, various application of CO2, argon, He -Ne, Nd – YAG and pulsed ruby LASER, Application of LASER in surgery.

Module- 5: Patient Care and Assistive Systems 4L

Overview of Computer-Based Instruments, Components of Computer Based Instruments, Types, Computer Interfacing and protocol, Computerized Medical Instruments.

Text Books:

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

Reference Books:

1. Joseph Bronzino, “Biomedical Engineering and Instrumentation”, PWS Engg., Boston.
2. Cromwell, Weibell and Pfeiffer, “Biomedical Instrumentation and Measurement”, Prentice Hall, India
3. Harry Bronzino E, “Handbook of Biomedical Engineering and Measurements”, Reston, Virginia.
4. Jacobson and Websler, “Medicine and Clinical Engg.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biosignal Processing
Course Code: BME602
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Biomedical Signal and Systems.

Course Objective(s):

The objective of the course is to make the students able to

1.Introduce various biomedical signals and their properties.

2.Familiarize students with signal and system analysis tools used in bio signal processing.

3.Enable the use of Fourier and Z-transform techniques for spectral analysis of biomedical signals.

4.Design and implement digital filters and signal classification methods for biomedical applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Identify and classify different types of biomedical signals and systems.
CO2	Apply Fourier series and transform techniques to analyze periodic and aperiodic signals.
CO3	Analyze and model biomedical signals using DFT, Z-transforms, and difference equations.
CO4	Design and implement digital filters (FIR and IIR) using various methods and evaluate filter performance.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	-	-	-	-	-	-	-	-	1	3	2
CO2	3	3	3	2	-	-	-	-	-	-	-	1	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	1	3	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3
Avg.	3	2.75	2.75	1.75	2	-	-	-	-	-	-	1.25	3	2.5

Course Content:

Module- 1: Concept of Bio signal **8L**

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, classification and properties of systems, LTI systems - convolution and stability, physiological signals and their properties, Time invariant and time varying physiological systems. Introduction to Digital Signal Processing and Practical considerations for choosing sampling rates in medical systems.

Module- 2: Signal, System and Spectrum Analysis 8L

Characteristics of some dynamic signals, Basic concepts and development of the Fourier Series, Determination of the Fourier series representation of Continuous and Discrete time periodic signal, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), ECG signal analysis Filters- IIR and FIR filters. Linear phase filter, Estimation of convolution of real time and discrete signals. Modern Trends in Spectrum Analysis for Biomedical Signals and its Challenges and Future Directions.

Module- 3: Discrete Time Modeling of Signals and Design of Digital Filters 10L

Evaluation of DFT, Properties of DFT, Circular convolution using DFT, IDFT, Realization of Digital Filters: Applications of Z – Transforms, Solution of Difference Equations of Digital Filters, System Function, Digital filter design, Difference equation, Direct form –I, Direct form-II, Cascaded Form. Adaptive filtering techniques for real-time noise reduction

Module- 4: Bio signal Analysis 10L

Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques – Finite word length effects in digital Filters: Errors, Limit Cycle, Noise Power Spectrum, Back propagation neural network-based classification. Application in Normal versus Ectopic ECG beats. Classification and Feature Extraction of Bio signal and Advanced Techniques in Bio Signal Analysis

Text Books:

1. S. Sharma, Digital Signal Processing, S K 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 Signaland Image Processing, Wiley.
3. S.K. Mitra, Digital Signal Processing, TMH.
4. J.G. Proakis and D.G. Manolakis, Digital Signal Processing

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Hospital Engineering and Management
Course Code: BME603A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

1. Basic understanding of hospital functions, healthcare systems, and biomedical instrumentation.
2. Introductory knowledge of management principles and healthcare technologies.

Course Objective(s):

The objective of the course is to make the students able to

1. To understand the structure and functioning of the healthcare system and hospital classifications.
2. To introduce key hospital engineering services and safety systems, including biomedical engineering roles.
3. To familiarize students with Hospital Management Information Systems (HMIS) and digital health data management.
4. To explain healthcare regulations, quality certifications, and hospital planning guidelines in India.

Course Outcomes (COs):

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

COs	Statement
CO1	Describe the structure of the Indian healthcare system and hospital organization.
CO2	Apply engineering principles for planning hospital services such as power, gas, air conditioning, and safety systems.
CO3	Analyze the role and architecture of Hospital Management Information Systems in improving healthcare efficiency.
CO4	Evaluate standards and regulations (like FDA, NABH, ISO) in planning new healthcare facilities.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	–	2	–	2	1	–	–	2	–	1
CO2	3	3	3	2	2	2	1	2	–	–	–	3	1	2
CO3	2	3	3	3	3	2	2	2	–	1	–	2	3	2
CO4	3	3	2	3	2	3	3	3	1	1	1	2	2	3
Avg.	2.75	2.75	2.5	2.25	2.33	2.25	2	2.25	1	1	1	2.25	2	2

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Healthcare System **4L**

Health organization of the country, Indian hospitals- challenges and strategies, modern techniques of hospital management.

Module- 2: Hospital Organization **9L**

Classification of hospital, Hospital- social system, location of hospital, site selection of new hospital, Line services, Supportive services and Auxiliary services of hospital.

Module- 3: Engineering Services of Hospital **12L**

Biomedical engineer's role in hospital, Maintenance department, MRO, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system.

Module- 4: Hospital Management and Information System **7L**

Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system.

Module- 5: Regulation and planning of new hospital/Laboratory **4L**

FDA regulation, ISO certification, Fire protection standard, NABH, NABL

Text Books:

1. R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India, 1993.
2. Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries, Z report Eschbom, 1986.

Reference Books:

1. Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press, 1977.
2. Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice Hall Inc. Englewood Cliffs, 1979.
3. Jacob Kline, Handbook of Bio Medical Engineering, Academic Press, San Diego 1988.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biomedical Hazards and Safety
Course Code: BME603B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Basic knowledge of human anatomy, physiology, and hospital practices.
- Fundamentals of biomedical instrumentation and electrical engineering concepts.
- Awareness of hazards related to electricity, fire, radiation, and medical devices.
- Introductory knowledge of quality management and healthcare standards.

Course Objective(s):

The objective of the course is to make the students able to

1. Familiarize with safety hazards in hospitals including electrical, fire, laser, and radiation risks.
2. Develop understanding of hospital safety protocols, security measures, and biomedical waste management.
3. Provide insights into quality assurance systems like TQM, QA, and SOPs for better medical care.
4. Introduce regulatory and accreditation standards (FDA, JCI, NABH, NABL) for healthcare institutions.

Course outcome:

After completion of the course the students will be able to

COs	Statement
CO1	Explain the causes, effects, and preventive measures of electrical, fire, laser, and radiation hazards in hospitals.
CO2	Analyze hospital safety management practices including patient, staff, property security, radiation safety, and biomedical waste disposal.
CO3	Evaluate quality assurance systems such as TQM, Six Sigma, and SOPs in diagnostic and therapeutic services for patient safety.
CO4	Compare and integrate regulatory requirements like FDA, NABH, JCI, NABL, and national guidelines for effective healthcare delivery.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	2	2	-	-	-	2	-	2
CO2	-	3	-	-	-	2	2	1	2	-	-	3	-	2
CO3	-	2	-	3	-	-	2	2	-	2-	-	2	-	3
CO4	3	2	-	-	-	2	-	3	-	-	2	2	2	2
Avg.	3	2.33	-	3	-	2	2	2	2	2	2	2.25	2	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Electrical & Fire Safety 7L

Electrical Hazards, Causes of Electrical Shock, Effect of Shocks, Macro & Micro shocks - Hazards, monitoring and interrupting the Operation from leakage current, Use of Isolation amplifier, Safety precautions for electrical hazards; Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital.

Module- 2: Laser and Ultraviolet Radiation Safety 7L

Classification of UV radiation, Sources of UV, Biological effects of UV radiation, UV control measures, Safety management of UV. Classifications of LASER and its radiation hazards-control measures, Emergencies and incident procedures.

Module- 3: Hospital Safety 7L

Security & Safety of Hospital -Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Ethics and Safety measures on Disposal of healthcare waste.

Module- 4: Standardization of Quality Medical Care in Hospitals 6L

Define Quality- Need for Standardization & Quality Management**,** TQM in Health care organization- Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment, Medical device safety and risk management, Effectiveness/performance of medical devices, the role of each participant/stakeholder, Shared responsibility for medical device safety and performance.

Module- 5: Assessing Quality Health Care 4L

Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals SOPs – Patient Orientation for Total Patient Satisfaction. 5S techniques.

Module- 6: Regulatory Requirement for Health Care 5L

FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, National Guidelines for Infection Prevention and Control in Healthcare Facilities, Health protocol guidelines on unforced emerging issues, Other regulatory Codes.

Text Books:

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

Reference Books:

1. B. M. Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P)Ltd.
2. K. Shridhara Bhat, Quality Management, Himalaya PublishingHouse.

3. Karen Parsley, Karen Parsley Philomena Corrigan‖ Quality improvement in Healthcare, 2nd edition, Nelson Thrones Pub, 2002
4. Sharon Myers ―Patient Safety & Hospital Accreditation - A Model for Ensuring Success‖ Springer Publishers 2012
5. Joseph F Dyro ―Clinical Engineering Handbook― Elsevier Publishers,2004

Department of Biomedical Engineering
JIS College of Engineering

COURSE NAME: Radiotherapy and Nuclear Medicine
COURSE CODE: BME603C
CONTACT: 3:0:0
TOTAL CONTACT HOURS: 36

CREDIT: 3

Prerequisite:

- Basic knowledge of Physics (atomic structure, radiation, nuclear physics)
- Fundamentals of Human Anatomy & Physiology
- Introductory concepts of Biomedical Instrumentation.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the principles and techniques of radiation therapy and nuclear medicine with emphasis on biological effects and safety.
2. Explain the radiation chemistry, radiobiological concepts, and dose–response relationships for clinical applications.
3. Familiarize students with the construction, operation, and applications of radiation detectors and radioactive sources in healthcare.
4. Evaluate nuclear medicine procedures, benefits, limitations, and instrumentation for diagnostic and therapeutic purposes.

Course outcome:

After completion of the course the students will be able to

COs	Statement
CO1	Explain the principles of radiation therapy, radiation protection, and biological side effects.
CO2	Analyze the mechanisms of radiation chemistry, radiobiology, survival curves, and dose–response relationships in biological systems.
CO3	Evaluate the working principles, calibration, and applications of radiation detectors and radioactive sources used in biomedical applications.
CO4	Compare and assess nuclear medicine procedures (PET, SPECT, Scintigraphy, RIA, ELISA) for their benefits, limitations, and clinical applications..

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	3	3	2	1	2	1	3	1	2
CO2	3	3	2	3	2	2	3	2	1	2	1	3	2	3
CO3	3	3	3	3	2	2	2	2	2	3	2	3	2	3
CO4	3	3	2	3	2	3	2	2	2	3	2	3	2	3
Avg.	3	2.75	2	2.75	1.75	2.5	2.5	2	1.5	2.5	1.5	3	1.75	2.75

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Introduction 5L

Physical aspects of radiation therapy, radiotherapy treatment planning, Radiation sources and their properties, Radiotherapy equipment, Radiotherapy Techniques, Radiation protection, Side effects on Biological System, Safety measures.

Module- 2: Radiation Chemistry 8L

Characteristicsandbehaviorofradioactivetracersinbiologicalprocess-(Physical and Biological), Absorption of radiation, Survival curves-theory, Oxygen effect, Chemical modifiers of radiation damage, Cell cycle dependence of radio sensitivity, Repair phenomena, Solid tumor radiobiology, Cell and tumor kinetics, Tissue radio sensitivity, Dose Rate effects, Acute and late effects, Partial and Whole-Body Radiation, Time, Dose and Fractionation relationships, Biology of Hyperthermia.

Module- 3: Radiation Detectors 7L

Construction and Principles of Operation of Ionization Chamber, Isotope calibrator, Proportional Counter, Geiger Muller counter, Voltage calibration of a Geiger Mueller tube, optimum operating condition–Dead time correction–Uses of Gas filled detectors, Semiconductor detectors, Scintillation detectors.

Module- 4: Radioactivity 8L

Natural and artificial radioactivity, alpha decay, beta decay and gamma emission, positron decay, exponential decay, half-life, unit of activity, Radiation sources- natural and artificial, Production of radioisotopes. Nuclear reactors, Cyclotron Unit, Linac, Fission products, Gamma ray source for medical uses.

Module- 5: Nuclear Medicine Procedure and its applications in biomedical field 8L

Basics of nuclear medicine, Design and description of NM department, NM equipment, Nuclear medicine procedure- PET, SPECT etc., Some common uses of nuclear medicine procedure, benefits and risks of nuclear medicine procedure, limitations of nuclear medicine, examples of general nuclear medicines,

Scintigraphy, Bone scintigraphy, RIA and ELISA techniques and their applications, Tracer dose, Uptake monitoring instruments.

Text Books:

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

Reference Books:

1. Nuclear Radiation Detection –William J. Price, McGraw –Hill Book Company.

2. Principles of Nuclear Medicine –Henry N. Wagner, W.B. Saunders company, London.
3. Essentials of Nuclear Medicine Imaging, Fred A Metter, Milton J W B Saunders company, London.
4. Clinical Nuclear Medicine M N Masey, K E Britton and D L Gilday, Chapman and Hall medicals.
5. Nuclear Medicine Technology and Techniques- Donald R. Bernier, Paul E. Christian and James K. Langan Mosby.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Modelling of Physiological System
Course Code: BME604A
Contact: 3:0:0
Total Contact Hours: 36
CREDIT: 3

Prerequisites:

- Basic knowledge of Human Anatomy and Physiology.
- Fundamentals of Electrical Circuits and Electronics.
- Understanding of Signals, Systems, and Control Theory.
- Introductory knowledge of Mathematics for Engineers (differential equations, Laplace transforms).

Course Objective(s):

The objective of the course is to make the students able to

1. Explain the fundamental concepts of physiological systems and their mathematical modelling approaches.
2. Apply electrical and mechanical analogies to model different physiological processes.
3. Analyze various linear and nonlinear models for physiological systems and interpret their functional behavior.
4. Evaluate and simulate advanced physiological models to study system dynamics and predict responses.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the structure, properties, and variables of physiological systems with respect to modelling techniques.
CO2	Apply equivalent electrical/mechanical models to represent and simulate physiological phenomena such as blood flow, muscle contraction, and eye movements.
CO3	Analyze the behavior of linear and nonlinear physiological models, including their stability and performance under various conditions.
CO4	Evaluate complex multi-system physiological models (cardio-pulmonary, immune response) for prediction, simulation, and optimization.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1	-	-	1	1	1	2	2	2
CO2	2	3	3	3	2	1	1	1	1	1	2	3	3	2
CO3	2	3	3	3	3	2	1	1	2	1	2	3	3	3
CO4	1	2	3	3	3	2	1	1	3	2	3	3	3	3
Avg.	2	2.75	2.75	2.5	2.25	1.5	1	1	1.75	1.25	2	2.75	2.75	2.5

Course Content:

Module- 1: Basic Concepts of Physiological System **8L**

Introduction to physiological system and mathematical modelling of physiological system, the techniques of mathematical modelling, classification of models-black box and building block, parametric and non-parametric, lumped and distributed models, linear and non-linear, characteristics of models, Purpose of physiological modelling and signal analysis, linearization of nonlinear models. Engineering system and physiological system, System variables and properties- Resistance, Compliance and their analogy. Time invariant and time varying systems for physiological modelling.

Module- 2: Equivalent Circuit Model **8L**

Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron.

Module- 3: **Linear Model** **4L**

Respiratory mechanics and muscle mechanics, Huxley model of isotonic muscle contraction, modelling of EMG, motor unit firing: amplitude measurement, motor unit and frequency analysis.

Module- 4: Modelling of Blood flow and Urine formation **5L**

Electrical analogue of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop.

Module- 5: Linearized model of the immune response **3L**

Germ, Plasma cell, Antibody, system equation and stability criteria.

Module- 6: Cardio-Pulmonary Modelling **4L**

Cardiovascular system and pulmonary mechanics modelling and simulation, Model of Cardiovascular Variability, Model of Circadian Rhythms.

Module- 7: Eye Movement Model **4L**

Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model.

Department of Biomedical Engineering
JIS College of Engineering

Text Books:

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

Reference Books:

1. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001.
2. Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rdedition, 2006.
3. Christof Koch, "Biophysics of Computation", Oxford University Press, 28-Oct-2004.
4. Modeling and Simulation in Medicine and the Life Sciences (2nd Edition), by F.C. Hoppensteadt and C.S. Peskin, Springer (2002) ISBN: 0-387-95072-9.
5. John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan and Claypool Publishers, 2010.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Tissue Engineering
Course Code: BME604B
Contact: 3:0:0
Total Contact Hours: 36
CREDIT: 3

Prerequisites:

- Basic understanding of Human Anatomy and Physiology.
- Fundamentals of Cell Biology and Biochemistry.
- Knowledge of Biomaterials (metals, ceramics, polymers) and their properties.
- Introductory concepts in Biotechnology and Material Science.

Course Objective(s):

The objective of the course is to make the students able to

1. Explain the fundamental concepts, principles, and terminology used in tissue engineering.
2. Apply knowledge of biomaterials, scaffolds, and cell culture techniques for tissue regeneration.
3. Analyze the structure-function relationships of engineered tissues and evaluate cell-material interactions.
4. Evaluate recent advances in nanotechnology and biomimetic approaches for tissue repair and regeneration.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the basic principles of tissue engineering, biomaterials, and cell-based therapies.
CO2	Apply scaffold fabrication methods, cell culture techniques, and biomaterial selection strategies for engineered tissues.
CO3	Analyze the performance of cardiovascular, skin, and liver tissue engineering models considering biocompatibility, oxygen transport, and vascularization.
CO4	Evaluate nanotechnology-based and biomimetic strategies for enhancing tissue repair and regeneration.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1	1	1	1	1	1	2	1	2
CO2	2	3	3	3	3	2	2	1	2	1	2	3	2	2
CO3	2	3	3	3	3	2	2	2	2	1	2	3	2	3
CO4	1	2	3	3	3	2	3	2	3	2	3	3	2	3
Avg.	2	2.75	2.75	2.5	2.5	1.75	2	1.5	2	1.25	2	2.75	1.75	2.5

Course Content:

Module- 1: Introduction to Tissue Engineering 6L

Introduction – definitions - basic principles - structure-function relationships –Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies –Tissue Morphogenesis and Dynamics- Stem Cells and Lineages - Cell-Cell Communication.

Module- 2: Tissue Culture Basics 7L

Primary cells vs. cell lines - sterile techniques – plastics – enzymes - reactors and cryopreservation - Synthetic Biomaterial Scaffolds- Graft Rejection – Immune Responses-Cell Migration-Controlled Drug Delivery- Micro Technology Tools.

Module- 3: Scaffold Formation 8L

Oxygen transport - Diffusion - Michalies-Menten kinetics - oxygen uptake rates -limits of diffusion - Principals of self-assembly - Cell migration - 3D organization and angiogenesis - Skin tissue engineering –Introduction - scar vs. regeneration - split skin graft -apligraft. Engineered Disease Models- Tissue Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring, Hernia.

Module- 4: Cardiovascular Tissue Engineering 8L

Blood vessels structure – vascular grafts – Liver tissue engineering – Bioartificial liver assist device – shear forces – oxygen transport – plasma effects – Liver tissue engineering – Self-assembled organoids – decelluarized whole livers – Stem cells – basic principle – embryonic stem cells – Induced pluripotent stem cells -Material Biocompatibility – Cell Mechanics – Vascularization- Stem Cell Therapies.

Module- 5: Patterning of Biomimetic Substrates 8L

Patterning of biomimetic substrates with AFM lithography primarily focusing on DPN-Nano templating polymer melts - Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments - Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications -Nanotopography techniques for tissue-engineered scaffolds.

Text Books:

1. Ketul Popat *"Nanotechnology in Tissue Engineering and Regenerative Medicine"* CRC Press Taylor and Francis 2011.

2. Cato T. Laurencin, Lakshmi S *"Nanotechnology and Tissue Engineering: The Scaffold* "CRC Press Taylor and Francis 2008.

Reference Books:

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Nanobiotechnology
Course Code: BME604C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic knowledge of Cell Biology and Molecular Biology.
- Fundamentals of Biomaterials and Biochemistry.
- Introductory understanding of Nanotechnology concepts and material properties.
- Familiarity with genetic engineering techniques and computational biology tools.

Course Objectives:

The objective of the course is to make the students able to

1. Explain the fundamental principles and natural examples of bio-nano machines and biomolecular interactions.
2. Apply molecular synthesis techniques and computational modeling tools for nanobiotechnology applications.
3. Analyze functional principles of nanobiotechnology, including molecular motors, self-assembly, and biomolecular sensing.
4. Evaluate protein/DNA-based nanostructures and emerging applications in nanomedicine, agriculture, and biosensing.

Course Outcomes:

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

COs	Statement
CO1	Explain the principles, components, and natural examples of bio-nano machines and their biological significance.
CO2	Apply recombinant DNA techniques, molecular modeling, and interphase system concepts for nanobiotechnology applications.
CO3	Analyze functional mechanisms of biomolecular motors, self-assembly processes, and biomaterial flexibility for targeted applications.
CO4	Evaluate protein and DNA-based nanostructures, hybrid nanomaterials, and nanobiotechnology applications in medicine, agriculture, and biosensing.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1	1	1	1	1	1	2	3	2
CO2	2	3	3	3	3	2	2	1	2	1	2	3	3	2
CO3	2	3	3	3	3	2	2	2	2	1	2	3	2	3
CO4	1	2	3	3	3	2	3	2	3	2	3	3	2	3
Avg.	2	2.75	2.75	2.5	2.5	1.75	2	1.5	2	1.25	2	2.75	2.5	2.5

Course Content:

Module- 1: Bio-Nano machines and Their Basics 5L

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 Synthetase, ATP synthetase, Actin and myosin, Opsin, Antibodies and Collagen.

Module- 2: Synthesis of Biomolecules and Interphase Systems 8L

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**.**

Module- 3: Functional Principles of Nano biotechnology 7L

Information driven nanoassembly, Energetic, Role of enzymes in chemical transformation, allosteric motion and covalent modification in protein activity regulation, Structure and functional properties of Biomaterials, Bimolecular motors: ATP Synthetase and flagellar motors, Traffic across membranes: Potassium channels, ABC Transporters and Bactreriorhodapsin, Bimolecular sensing, Self-replication, Machine-Phase Bionanotechnology Protein folding; Self-assembly, Self-organization, Molecular recognition and Flexibility of biomaterials.

Module- 4: Protein and DNA based Nanostructures 8L

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.

Module- 5: Applications of Nano biotechnology 8L

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.

Text Books:

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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Database Management System
Course Code: CS(BME)605A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic Computer Concepts – Understanding of computer hardware, operating systems, and file systems.
- Programming Fundamentals – Ability to write, compile, and debug programs in C/C++/Java or similar languages.
- Data Structures – Familiarity with arrays, linked lists, stacks, queues, trees, and basic searching/sorting algorithms.
- Discrete Mathematics – Knowledge of sets, relations, functions, logic, and basic combinatorics.
- Mathematical Foundations – Understanding of basic algebra, probability, and graph theory for query optimization concepts.

Course Objectives:

The objective of the course is to make the students able to

1. Understand the fundamental concepts, architecture, data models, and indexing methods in database management systems.
2. Apply query processing, optimization techniques, transaction management, concurrency control, and recovery mechanisms for efficient database operations.
3. Analyze database design issues and improve database structures using normalization and dependency concepts.
4. Design and evaluate database solutions by developing ER models, translating them to relational schemas, implementing them using SQL, and ensuring data integrity and security.

Course Outcomes:

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

COs	Statement
CO1	Explain the fundamental concepts of a DBMS, compare relational and E-R models, and describe file organization with appropriate index structures.
CO2	Apply query optimization techniques, transaction management, concurrency control, and recovery mechanisms to solve database operation problems.
CO3	Analyze database designs to identify anomalies and improve them through normalization techniques.
CO4	Design and implement ER diagrams for given scenarios, convert them into relational schemas, create and populate databases, and write SQL queries to retrieve and manipulate data.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	1	2	-	1	2	1
CO2	3	3	2	2	3	-	-	1	1	2	1	1	3	2
CO3	3	3	3	2	3	-	-	1	1	2	1	2	3	2
CO4	3	3	3	3	3	-	1	2	2	3	2	3	3	3
Avg.	3	2.75	2.25	2	2.75	-	1	1.25	1.25	2.25	1.33	1.75	2.75	2

Course Content:

Module- 1: Introduction **2L**

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module- 2: Entity-Relationship and Relational Database Model **7L**

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features, case study on E-R Model. Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module- 3: SQL and Integrity Constraints **6L**

Concept of DDL, DML, DCL. Basic Structure, set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Module- 4: Relational Database Design **8L**

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF, Case Study.

Module- 5: Internals of RDBMS **7L**

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, Dead Lock handling.

Module- 6: File Organization & Index Structures **6L**

File & Record Concept, placing file records on Disk, Fixed and Variable Sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes.

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. Fundamentals of Database Systems”, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing.
2. Ramakrishnan: Database Management System, McGraw-Hill

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Microprocessor and Microcontroller
Course Code: EC(BME)605B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic understanding of digital electronics (logic gates, flip-flops, counters, registers).
- Familiarity with number systems (binary, octal, hexadecimal) and basic Boolean algebra.
- Basic knowledge of computer organization and programming fundamentals (variables, loops, conditional statements).
- Ability to interpret simple circuit diagrams and data sheets.

Course Objectives:

The objective of the course is to make the students able to

1. Understand the architecture, features, and operation of different microprocessors and microcontrollers.
2. Apply assembly language programming concepts to solve computational problems on microprocessor/microcontroller platforms.
3. Analyze hardware interfacing requirements for various peripherals and I/O devices with microprocessors/microcontrollers.
4. Evaluate and compare the performance and applicability of microprocessors and microcontrollers in real-world applications.

Course Outcomes:

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

COs	Statement
CO1	Explain the architecture, instruction set, and addressing modes of 8085, 8086, 8051, and PIC microcontrollers.
CO2	Apply assembly language programming to perform arithmetic, logical, data transfer, and control operations using microprocessors/microcontrollers..
CO3	Analyze interfacing techniques for ADC/DAC, memory modules, and peripheral ICs (8255, 8253, 8251) with microprocessors/microcontrollers.
CO4	Evaluate different microprocessor and microcontroller architectures for suitability in specific embedded system applications..

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	-	1	-	2	1	1
CO2	3	3	3	2	3	-	-	1	1	2	-	3	2	2
CO3	3	3	3	3	3	-	1	1	1	2	1	3	3	2
CO4	3	3	3	3	3	1	2	2	2	3	1	3	3	3
Avg.	3	2.75	2.5	2.25	2.75	1	1.5	1.25	1.33	2	1	2.75	2.25	2

Course Content:

Module- 1: Introduction to Microcomputer based system 10L

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 microprocessors, Classification of instruction, addressing modes, and timing diagram of the instructions (a few examples).

Module- 2: 3L

Assembly language programming with examples, Interrupts of 8085 processors, programming using interrupts, Stack and Stack Handling, Call and subroutine, DMA, Memory interfacing with 8085

Module- 3: 8086 Microprocessor 8L

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 and smallest number etc.

Module- 4: 8051 Microcontroller 4L

8051 architectures, hardware, input/output pins, ports, external memory, counters and timers, instruction set, addressing modes, serial data i/o, interrupts, Memory interfacing, ADC / DAC interfacing.

Module- 5: Assembly language Programming using 8051 4L

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.

Module- 6: Support IC chips 5L

8255, 8253 and 8251: Block Diagram, Pin Details, Modes of operation, control word(s) format.

Module-7: Brief introduction to PIC microcontroller (16F877) 2L

Architecture, PIN details, memory layout.

Text Books:

1. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International
2. The 8051 microcontroller - K. Ayala, Thomson
3. Microprocessors and interfacing – D. V. Hall,Tata McGraw-hill
4. Ray and Bhurchandi, Advanced Microprocessors and 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

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Soft Computing
Course Code: CS(BME)605C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisite:

- Basic knowledge of Biomedical Engineering principles
- Fundamentals of Mathematics, Probability, and Statistics
- Basic programming skills in MATLAB/Python
- Understanding of signals, systems, and image processing concepts.

Course Objectives:

The objective of the course is to make the students able to

1. Understand the fundamental principles of soft computing techniques and their distinction from hard computing.
2. Apply fuzzy logic, neural networks, and evolutionary computation for solving problems in biomedical engineering.
3. Analyze biomedical systems using computational intelligence methods and optimization algorithms.
4. Evaluate and design hybrid intelligent systems for real-world biomedical applications.

Course Outcomes:

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

COs	Statement
CO1	Explain the principles, components, and applications of fuzzy logic, neural networks, and evolutionary computation in biomedical engineering.
CO2	Apply soft computing algorithms such as fuzzy inference, neural network learning, and genetic algorithms for solving biomedical problems.
CO3	Analyze biomedical datasets and system models using computational intelligence techniques to derive patterns and make decisions.
CO4	Evaluate and integrate hybrid intelligent systems (Neuro-Fuzzy, GA-ANN) for performance improvement in biomedical engineering applications.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	1	1	2	-	2	2	1
CO2	3	3	2	2	3	-	-	1	1	2	1	3	3	2
CO3	3	3	3	2	3	-	-	1	1	2	1	3	3	3
CO4	3	3	3	3	3	-	1	2	2	3	2	3	3	3
Avg.	3	2.75	2.25	2	2.75	-	1	1.25	1.25	2.25	1.33	2.75	2.75	2.25

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-1: Introduction to Soft Computing 4L

Overview of Soft Computing, Fuzzy Logic Systems, Neural Networks, Evolutionary Computation, Hybrid Systems, Applications of Soft Computing in Biomedical Engineering, Difference between Hard and Soft computing, Applications of Soft Computing.

Module-2: Fuzzy Logic in Biomedical Systems 10L

Basics of Fuzzy Logic, Fuzzy Sets and Membership Functions, Fuzzy Inference Systems, Applications in Medical Diagnosis, Fuzzy Control in Biomedical Systems, Case Studies. Fuzzy Relation, Fuzzification, Min-max Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

Module-3: Neural Networks 10L

Introduction to Artificial Neural Networks (ANN), Supervised Learning in Neural Networks,

Learning rules and various activation functions, Single layer Perceptron, 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. Unsupervised Learning and Self-Organizing Maps, Neural Networks for Pattern Recognition, Applications in Medical Imaging, Deep Learning in Biomedical Engineering.

Module-4: Evolutionary Computation in Biomedical Optimization 10L

Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Multi objective Gas, Genetic Programming (GP), Evolutionary Strategies, Applications in Parameter Optimization, Evolutionary Computation in Medical Image Processing.

Module-5: Hybrid Systems and Biomedical Applications 8L

Integration of Fuzzy Logic, Neural Networks, and Evolutionary Computation, Neuro-Fuzzy Systems, Hybrid Intelligent Systems in Healthcare, Case Studies and Real-world Applications, Ethical Considerations in Soft Computing in Biomedical Engineering.

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.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Therapeutic Equipment Lab
Course Code: BME691
Contact: 0:0:3
Credit: 1.5

Prerequisites: Foundational knowledge of human physiology, biomedical signals (e.g., ECG, EMG), analog and digital electronics, and basic principles of sensors, circuits, and measurement techniques.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce students to diagnostic and therapeutic biomedical equipment and their operating principles.
2. Provide hands-on training in the measurement of physiological parameters using biomedical instruments.
3. Develop skills in circuit handling, device calibration, and safety protocols in biomedical applications.
4. Analyze and interpret outputs from therapeutic instruments for biomedical assessment and decision-making.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the functional principles and clinical applications of diagnostic and therapeutic biomedical instruments.
CO2	Operate and calibrate biomedical instruments such as BP monitors, pacemakers, and pulse rate meters.
CO3	Analyze circuit behaviour and signal responses of biomedical systems like spirometers and diathermy units.
CO4	Evaluate the performance, accuracy, and reliability of biomedical instruments used for monitoring and diagnosis..

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	1	-	1	-	2	3	2
CO2	2	2	2	2	3	1	-	-	2	2	1	3	3	2
CO3	3	3	2	3	3	-	1	1	2	2	1	3	2	3
CO4	3	3	2	3	3	2	2	2	2	2	1	3	2	3
Avg.	2.75	2.5	2	2.67	2.25	1.5	1.5	1.33	2	1.75	1	2.75	2.5	2.5

Department of Biomedical Engineering
JIS College of Engineering

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 and apnea detection
8. Study on diathermy unit (ultrasound and short-wave)
9. Study of ultrasonic devices -transmitter and detector
10. Study on blood flow velocity measurement-ultrasonic method
11. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biosignal Processing Lab
Course Code: BME692
Contact: 0:0:3
Credits: 1.5

Prerequisite: Basic knowledge of Digital Signal Processing.

Course Objective(s):

The objective of the course is to make the students able to –

1. To understand the physiological origin and nature of various bio signals.

2.To apply digital signal processing methods for noise removal and signal enhancement.

3.To extract meaningful features from bio signals for interpretation and diagnosis.

4.To design and implement real-time DSP systems using tools like MATLAB or DSP hardware.

Course Outcomes (COs):

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

CO1	Understand the origin and characteristics of major bio signals (ECG, EEG, EMG, etc.).
CO2	Apply preprocessing techniques to remove artifacts and noise from bio signals.
CO3	Implement signal processing algorithms (filtering, DFT/FFT, feature extraction)..
CO4	Analyze and interpret biomedical signals for diagnostic applications.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	3	2	1
CO2	3	3	2	2	2	-	-	-	-	-	-	3	3	2
CO3	3	3	3	2	2	-	-	-	-	-	-	3	2	2
CO4	3	2	2	3	3	-	-	-	1	1	1	3	3	3
Avg.	3	2.5	2	2	2.25	-	-	-	1	1	1	3	2.5	2

List of Experiments:

1. Study on generalized Waveforms and Plot.
2. Study on Biomedical Signal Database.
3. Frequency Domain Description of Signals: FFT (sinusoidal signals).
4. Frequency Domain Description of Signals: DFT (sinusoidal signals).
5. Design and Application of Digital Filters: FIR low pass Filters.
6. Design and Application of Digital Filters: FIR High pass Filters
7. Design and Application of Digital Filters: IIR low pass Filters.
8. Design and Application of Digital Filters: IIR High pass Filters
9. Implementation of a Practical DSP System for bio signals. (ECG Signals, EMG

Signals, EEG Signals)

10. Implementation of signal processing technique on the data acquired through DAQ.
11. Implementation of DSP in biomedical signal processing throughTMS3206713.
12. Innovative experiment

Text Books/ Reference Books:

1. Practical Biomedical Signal Analysis Using MATLAB by Kunal Pal and U. Rajendra Acharya.
2. Biomedical Signal Processing Laboratory Manual by Dr. K. P. Soman, Dr. Deepa Thomas.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Database Management System Lab
Course Code: CS(BME)695A
Contact: 0:0:2
Credits: 1

Prerequisite:

- Knowledge of basic SQL commands (DDL, DML, DCL, TCL).
- Understanding of RDBMS concepts (tables, constraints, relationships).
- Familiarity with E-R modeling and normalization.
- Basic knowledge of programming (C/Java/VB) for embedded SQL and application development.

Course Objective(s):

The objective of the course is to make the students able to

1. Provide hands-on experience in designing and manipulating databases using Oracle SQL and PL/SQL.
2. Develop the ability to use advanced database features such as cursors, triggers, procedures, and functions.
3. Enhance skills in database design using E-R models and normalization techniques.
4. Integrate databases with front-end applications for developing real-time projects.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply SQL, PL/SQL commands and database features (cursors, triggers, procedures, functions) to design and manipulate relational databases.
CO2	Analyze E-R models and normalization techniques to design efficient database schemas.
CO3	Evaluate database applications by testing embedded SQL and control structures for correctness and performance.
CO4	Design and develop a mini-project application integrating Oracle database with a front-end tool (e.g., Visual Basic).

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	-	-	-	1	1	-	2	3	2
CO2	3	3	2	2	2	-	-	-	1	1	-	2	2	2
CO3	2	3	2	3	3	1		1	2	2	1	2	3	3
CO4	3	3	3	2	3	2	1	1	3	3	2	3	3	3
Avg.	2.75	2.75	2.25	2	2.25	1.5	1	1	1.75	1.75	1.5	2.25	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

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

Text Books:

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

Reference Books:

2. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw Hill.
3. SQL & PL/SQL for Oracle 10g, Black Book, Dr.P.S. Deshpande.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Microprocessor and Microcontroller Lab
Course Code: EC(BME)695B
Contact: 0:0:2
Credits: 1

Prerequisite:

- Fundamentals of 8085/8086 assembly language programming.
- Basics of 8051 microcontroller architecture and instruction set.
- Knowledge of I/O interfacing (8255A, LCD, 7-segment display, DIP switches).
- Understanding of digital-to-analog and analog-to-digital conversion (ADC/DAC).

Course Objective(s):

The objective of the course is to make the students able to

1. Apply microprocessor and microcontroller instructions in real-time embedded system applications.
2. Develop the ability to interface sensors and I/O devices with processors and microcontrollers.
3. Evaluate the performance of assembly language programs through debugging, flowcharting, and hardware interfacing.
4. Create innovative solutions by integrating hardware and software for embedded applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Apply 8085/8086/8051 instruction sets to develop programs for arithmetic, logical, and interfacing applications.
CO2	Analyze sensor data and I/O port behavior during microcontroller-based interfacing experiments.
CO3	Evaluate assembly programs and interfacing techniques for correctness, efficiency, and hardware compatibility.
CO4	Design and implement an innovative microcontroller-based application (e.g., temperature monitoring system) integrating sensors, displays, and communication modules.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	-	1	1	2	2	1
CO2	2	3	2	3	2	-	1	-	-	1	1	2	3	2
CO3	2	3	3	3	3	-	-	1	-	2	2	2	3	3
CO4	2	2	3	3	3	-	2	2	2	3	3	3	3	3
Avg.	2.25	2.5	2.5	2.75	2.5	-	1.5	1.5	2	1.75	1.75	2.25	2.75	2.25

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Write a program in 8085 microprocessors to swap the content of two register B and C containing the values 08H and 06H respectively.
2. Write a program in 8085 microprocessors to add two number 09H and 08H and store the result in 9085H location
3. Write a program in 8085 microprocessors 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 microprocessors to multiply 08H with 03H and store the result in 9065H location.
5. Write a program in 8085 microprocessors to divide 07H by 03H and store the quotient in 9075H and reminder in 9076H memory location.
6. Write a program in 8085 microprocessors 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 microprocessors of shifting block of five (5) data from 9055H location to 9080H location.
8. Write a program in 8085 microprocessors 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 microprocessors 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 microcontrollers to add 07H and 09H and store the result in RAM address 45H and draw the flow chart.

17. Write a program in 8051 microcontrollers 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 microcontrollers to multiply 06H by 05H and store the result in RAM address 46H.
19. Innovative experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Soft Computing Lab
Course Code: CS(BME)695C
Contact: 0:0:2
Credits: 1

Prerequisite:

- Basic knowledge of mathematics (linear algebra, trigonometry, calculus).
- Fundamentals of programming concepts (loops, conditional statements).
- Familiarity with signals, systems, and logic functions.
- Introduction to fuzzy logic and neural network basics.

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce fundamentals of MATLAB programming for mathematical computations and problem solving.
2. Develop skills in implementing matrix operations, function plotting, and number-based algorithms.
3. Gain hands-on experience in neural network learning rules and fuzzy logic operations.
4. Apply soft computing techniques using MATLAB to solve biomedical and engineering problems.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain and demonstrate MATLAB fundamentals, matrix operations, and basic program structures for numerical problems.
CO2	Apply MATLAB programming to solve problems involving functions, series, and matrix-based operations.
CO3	Analyze and implement neural network learning rules (Hebb's, LMS, McCulloch OR) and fuzzy logic operations.
CO4	Evaluate and integrate fuzzy set operations, max-min/max composition, and defuzzification methods for decision making.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	-	-	-	-	1	-	2	2	1
CO2	2	3	3	2	2	-	-	-	-	1	-	3	3	2
CO3	2	3	3	3	2	-	1	-	-	2	-	3	3	3
CO4	2	3	3	3	3	1	2	1	1	3	2	3	3	3
Avg.	2.25	2.75	2.75	2.25	2	1	1.5	1	1	1.75	2	2.75	2.75	2.25

Course Content:

List of programs

- Overview of Matrix, Matrix Operations, Giving input to Matrix, Displaying elements of Matrix.
- Performing Operations on Matrix like Addition, Subtraction, and Multiplication.
- Performing Transpose Operations on Matrix.
- Plotting of mathematical functions like log(x), sin(x), cos(x). etc
- Write a Program in MATLAB to check whether a number is even or odd
- Write a program in MATLAB to find out the sum of "N" natural numbers.
- Write a Program in MATLAB to generate the fibonacci series upto N , where N is the desired value input by user
- Write a MATLAB program to solve MATRIX based problems.
- Write a MATLAB Program to implement LMS Learning rule.
- Write a MATLAB program to verify McCulloch OR Function.
- Write a MATLAB program to verify Hebb's Rule.
- 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)
- 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]
- Implementation of Union, Intersection, Complement, XOR Operation and Demorgan's Law
- 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]
- Write a MATLAB program to implement Deffuzification of α-cut method
- For the following fuzzy set
- F = (0.6/a) + (0.3/b) + (0.7/c) + (1.0/d).

Project assigned by instructor to model real world problems.

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.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Entrepreneurship and Innovation Skill
Course Code: MC601
Contacts: 2:0:0
Total Contact Hours: 24
Credit: 0

Prerequisite: None

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the fundamentals of entrepreneurship, including traits, characteristics, and challenges of entrepreneurs.
2. Explain the entrepreneurial process, decision-making approaches, and the role of entrepreneurial ecosystems in opportunity identification.
3. Apply tools such as the Business Model Canvas, lean startup principles, and business pitching to develop innovative business ideas.
4. Analyze entrepreneurial ventures, organizational structures, financing options, and policy initiatives to evaluate business opportunities and challenges.

Course Outcomes:

After completion of this course students will be able to

COs	Description
CO1	Recall key concepts of entrepreneurship, including entrepreneurial personality, intentions, and challenges.
CO2	Describe and explain the entrepreneurial process, decision-making approaches (effectuation and causation), and the entrepreneurial ecosystem.
CO3	Develop and present business models and value propositions using Business Model Canvas and lean startup methodologies for real-life ventures.
CO4	Evaluate entrepreneurial ventures or case studies to identify problems, assess financial/organizational strategies, and recommend improvements..

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	-	-	-	1	-	1	2	2	1	-	-	1
CO2	2	2	-	-	1	2	-	1	2	2	1	-	-	2
CO3	1	2	3	2	2	2	-	-	3	3	2	2	2	2
CO4	1	3	2	3	1	2	-	2	2	2	3	2	2	3
Avg.	1.5	2	2.5	2.5	1.33	1.75	-	1.33	2.25	2.25	1.75	2	2	2

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module 1: Introduction to Entrepreneurship **4L**

Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioral; entrepreneurial challenges. Entrepreneurial Opportunities: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering.

Module 2: Entrepreneurial Process and Decision Making **4L**

Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision making process and approaches, Effectuation and Causation; Advantage and Limitations of Entrepreneurship; Process of Entrepreneurship.

Module 3: Crafting business models and Lean Start-ups **4L**

Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Module 4: Organizing Business and Entrepreneurial Finance **4L**

Forms of business organizations; organizational structures; Evolution of Organization, sources and selection of venture finance options and its managerial implications. Policy Initiatives and focus; role of institutions in promoting entrepreneurship.

Module 5: Entrepreneurs as problem solvers **4L**

Innovations and Entrepreneurial Ventures – Global and Indian; Role of Technology – E-commerce and social media; Social Entrepreneurship – Concept; Entrepreneurship – The Indian Scenario

Module 6: Project/Case Study: (Any One) **4L**

1. Visit of the District Industries Centre and prepare a report of activities and programs undertaken by them

2. Conduct a case study of any entrepreneurial venture in your nearby area.

3. Field Visit: Visit any business firm near your locality; interact with the owner of the business firm and prepare a field report on parameters like: type of business, scale of business, product/service dealing in, target customer, problems faced and measures to solve the faced challenges. 4. Know your State Handicraft and Handlooms as a means of economic activity

Text Books:

1. Bessant, J. (2003) High Involvement Innovation: Building and Sustaining Competitive Advantage Through Continuous Change. Chicester: John Wiley and Sons.
2. Bygrave, W and Zackarakis, A (2013) Entrepreneurship, 3rd Edition, John Wiley and Co.
   Drucker, P. (1999) Innovation and Entrepreneurship, Butterworth Heinemann, Oxford.
3. Fagerberg, J, Mowery, DC and Nelson, RR (2005) The Oxford Handbook of Innovation, Oxford University Press, NY.
4. Hisrich, R.D., Peters, M.P., and Shepherd, D. (2013) Entrepreneurship, McGraw-Hill

Irwin, Boston.

5. Kuratko, D. (2013) Entrepreneurship: Theory, Process, and Practice, 9th Edition, Wiley online library.
6. Moore, Geoffrey, (1999) Crossing the Chasm, Harper and Collins.
7. Porter, ME, Competitive Advantage: Creating and Sustaining Superior Performance, Free Press, New York, NY, 1985.

Department of Biomedical Engineering
JIS College of Engineering

4th Year 7th Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
A. THEORY									
1	ENGG	Major	BME701	Artificial Organs & Rehabilitation Engineering	3	0	0	3	3
2	ENGG	Major	BME702A	Medical Image Processing	3	0	0	3	3
			BME702B	Medical Robotics and Automation					
			BME702C	Neural Network and Genetic algorithm					
3	ENGG	Major	BME703A	Biological Control System	3	0	0	3	3
			BME703B	Computational Methods for Biomolecules					
			BME703C	Drug Delivery System					
4	ENGG.	Minor	CS(BME)704A	Artificial Intelligence in Clinical Science	3	0	0	3	3
			CS(BME)704B	IOT and Telehealth Technology					
			CS(BME)704C	Deep Learning and Machine Learning in Health Care					
B. PRACTICAL/ SESSIONAL									
5	ENGG	Major	BME791	Artificial Organs & Rehabilitation Engineering Lab	0	0	3	3	1.5
6	ENGG	Major	BME792A	Medical Image Processing Lab	0	0	3	3	1.5
			BME792B	Medical Robotics and Automation Lab					
			BME792C	Neural Network and Genetic algorithm Lab					
7	PRJ	Project	PR791	Project-II	0	0	12	12	6
Total of Theory & Practical								**30**	**21**

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Artificial Organs & Rehabilitation Engineering
Course Code: BME701
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Foundational knowledge of human physiology, engineering materials, basic biomedical instrumentation, and fluid biomechanics.

Course Objective(s):

The objective of the course is to make the students able to

1. Understand the need, classification, and design principles of artificial organs and their integration with human physiology.
2. Analyze the working principles, types, and biomechanical considerations of key artificial organs such as kidneys, heart-lung machines, and liver support systems.
3. Apply computer-based technologies and rehabilitation techniques for sensory and motor impairments in clinical and home-care settings.
4. the ethical, legal, economic, and environmental implications involved in the development and use of artificial organs and rehabilitation devices.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the fundamental principles behind various artificial organs and their biomedical applications.
CO2	Apply the concepts of hemodialysis, oxygenation, and computer interfacing to artificial organ systems and rehabilitation equipment.
CO3	Analyze the design and operational features of artificial kidneys, heart-lung machines, and prosthetic systems.
CO4	Evaluate the performance, suitability, and societal implications of artificial organs and rehabilitation solutions in real-world clinical contexts.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	1	2	1	1	-	-	-	2	1	1
CO2	3	3	2	2	2	-	-	-	-	-	-	3	2	2
CO3	3	3	3	3	2	1	1	-	-	-	-	3	2	3
CO4	2	3	2	2	1	3	2	2	1	1	1	3	1	3
Avg.	2.75	2.75	2.33	2.33	1.5	2	1.33	1.5	1	1	1	2.75	1.5	2.25

Course Content:

Module-1: Introduction to Artificial Organ **6L**

Introduction, Substitutive medicine, Clinical problems requiring implants for solution, outlook for organ replacement, Types of Artificial Organs, Engineering Principles of Artificial Organs: Biomechanical design, Materials used, Biocompatibility and Tissue Engineering.

Module- 2: Artificial Kidney **10L**

Kidney Filtration and Basic methods of waste removal, Types of Artificial Kidneys, Biomechanics of Artificial kidney. Hemodialysis, Equation for artificial kidney and middle molecule hypothesis, Different types of Hemodialyzers (Flat-Plate, Coil Type and Hollow Fiber Type), Analysis of mass transfer in dialyzers (cross current and counter current flow), regeneration of dialysate, Wearable Artificial Kidney Machine.

Module- 3: Artificial Heart-Lung Machine and Liver Support System **6L**

Brief of lungs gaseous exchange, Artificial heart-lung device, different types of Oxygenators (bubble, film, membrane).

Artificial Pancreas; Artificial Blood and Artificial Skin

Module- 4: Audiometry **4L**

Introduction, Principle, Types: Air and Bone Conduction, Masking, Functional Diagram of Audiometer, Different types of Hearing Aids; IABP Principle and application.

Module- 5: Rehabilitation Engineering **10L**

Overview of Computer-Based Instruments, Components of Computer Based Instruments, Types, Computer Interfacing and protocol, Computerized Medical Instrument Measurement and Assessment of Impairments, Disabilities and Handicaps, Engineering concepts in communication disorders, sensory and motor rehabilitation. Rehabs for locomotion, visual, speech and hearing, Artificial Limb, Prosthetic Heart Valve, Myo-electric Hand and Arm Prosthesis, MARCUS Intelligent Hand Prosthesis, Spinal rehabilitation. Ethical, economical, environmental and legal aspects in artificial organs domains.

Text Books:

4. Handbook of Biomedical Engineering. Bronzino Joseph.
5. Handbook of Biomedical Instrumentation. R.S. Khandpur, TMH.
6. Artificial Organs. Erie.D. Blom, Howard.B. Rotham.

Reference Books:

1. Biomedical Engineering Principles (Volume-II). David O.Cooney.,Marcel Dekker Inc.
2. Rehabilitation Engineering. Robbinson C.J., CRC press1995.
3. Rehabilitation Engineering. IOS press1993.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Medical Image Processing
Course Code: BME702A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites: Knowledge of Bio Signal Processing.

Course Objective(s):

The objective of the course is to make the students able to

1.To provide fundamental knowledge of how medical images are formed, processed, and analyzed.

2.To explore mathematical transformations and enhancements used in medical imaging.

3.To introduce compression, restoration, and segmentation techniques for medical images.

4.To understand various edge detection techniques, morphological operations, and color models.

Course Outcomes (COs):

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

COs	Statement
CO1	Understand fundamentals of medical imaging and compare different imaging modalities.
CO2	Apply image transformation techniques such as Fourier and Wavelet transform in medical imaging.
CO3	Enhance and compress medical images using spatial and frequency domain methods..
CO4	Perform restoration, segmentation, and edge detection on medical images..

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	3	2	3	1	2	-	-	-	-	-	-	2	2	3
CO4	3	3	2	2	-	-	-	-	-	-	-	2	1	3
Avg.	3	2.25	2.25	1.25	2	-	-	-	-	-	-	2.25	1.75	2.5

Course Content:

Module- 1 **8L**

Medical Imaging Fundamentals:

Image formation in human eye, Basic idea of images and medical images, Comparison of different imaging modalities, Mathematical and Logical operation of Medical Images.

Transform of Medical Images:

Importance of Medical Image Transform, Fourier Transform of Medical Image (DFT), Inverse Fourier Transform (IDFT), Fast Fourier Transform, Inverse Fast Fourier Transform, Applications of Medical Image Transform in different area. Multimodal Image Fusion and Transformation.

Module- 2 **9L**

Medical Image Enhancement:

Importance of Medical Image enhancement, enhancement in spatial and frequency domain, bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Medical Images, Frequency domain filtering in Medical Images– LPF, HPF and BPF.

Medical Image Compression:

Importance of Medical Image Compression, Types of Image Compression, Fidelity criteria, Lossless and Lossy compression, Compression in spatial domain (up and down sampling), compression using Huffman coding and compression using DPCM; DCT and Wavelet based medical image compression. Image Resampling and Interpolation.

Module- 3 **10L**

Medical Image Restoration:

Importance of Medical Image Restoration, Reason for Image degradation, Inverse filtering, Weiner filtering.

Segmentation of Medical Images:

Importance of Medical Image Segmentation, Segmentation based on Region Growing, Clustering, Watershed algorithm, Otsu method, Application of different types of segmentation methods.

Edge detection in Medical Image Processing:

Importance of Edge detection in Medical Image Processing, Types of Edge Detection, Mathematical Equation of each operator. Multi-Scale Edge Detection

Module- 4 **9L**

Color Models and Morphology:

Color models in Images, Noise in color images. Concept of morphology in image processing, some basic morphological algorithms.

Medical Image Security:

Water marking of medical images, Different Types of Watermarking, Introduction to Steganography and Cryptography used in medical images.

Algorithm used in Medical Image Processing:

Importance of Medical Image Reconstruction, Tomography, Reconstruction using Fan Beam Projection and Parallel Beam Projection, Radon Transform, Medical Image Reconstruction in frequency Domain. Advanced Techniques in Medical Image Transformation.

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JIS College of Engineering

Text Books:

1. Digital Image Processing– R C Gonzalez and Woods – 3rd Edition
2. Digital Image Processing–S Sridhar
3. Digital Image Processing–S Jayaraman, T Veerakumar, S Esakkirajan
4. Fourier Optics and Computational Imaging –Kedar Khade

Reference Books:

1. Medical Image Processing-Concept and Application –Sinha, Patel
2. Digital Image Processing for Medical Applications–G Dougherty
3. Digital Image Processing–Jain

Department of Biomedical Engineering
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Course Name: Medical Robotics and Automation
Course Code: BME702B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Fundamentals of mechanics, electronics, and control systems
- Basic knowledge of sensors, actuators, and kinematics
- Familiarity with mathematics (linear algebra, differential equations)
- Introductory knowledge of healthcare technologies / biomedical engineering

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the fundamentals, subsystems, and applications of robotics in healthcare.
2. Provide understanding of actuators, grippers, and feedback models in robotic systems.
3. Explain the construction, kinematics, and control of robotic manipulators.
4. Familiarize students with power sources, sensors, and machine vision for robotics.
5. Expose learners to applications of robotics in various medical and surgical fields.
6. Develop problem-solving and evaluation skills for medical robotic systems in real-world scenarios.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the basic concepts, subsystems, degrees of freedom, configurations, and medical applications of robotics.
CO2	Apply knowledge of actuators, grippers, and feedback control to design robotic mechanisms for biomedical use.
CO3	Analyze manipulator kinematics, dynamics, and sensor integration for precise robotic motion and medical task execution.
CO4	Evaluate the performance and effectiveness of medical robotic systems such as surgical robots, tele-surgical platforms, and nanorobotics.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	2	1	2	1	3	2	2
CO2	3	3	3	2	3	2	1	2	2	2	1	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	2	3	3	3
CO4	3	3	3	3	3	3	2	3	2	3	3	3	3	3
Avg.	3	2.75	2.75	2.5	2.75	2.25	1.5	2.25	1.75	2.25	1.75	3	2.75	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Introduction of Robotics 7L

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine.

Module- 2: Actuators and Grippers 7L

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models.

Module- 3: Manipulators and Basic Kinematics 6L

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Module- 4: Power Sources and Sensors 8L

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging – Laser- Acoustic, Magnetic fiber optic and Tactile sensor.

Module- 5: Robotics in Medicine 8L

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

Text Books:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, “Robotics, control”, sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.

Reference Books:

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, First edition, 2005.
2. Philippe Coiffet, Michel Chirouze, “An Introduction to Robot Technology”, Tata McGraw-Hill, First Edition, 1983.
3. Jacob Rosen, Blake Hannaford and Richard M Satava, “Surgical Robotics: System Applications and Visions”, Springer 2011.
4. Barbara Webb and Thomas R Consi, “BioRobotics: Methods and Applications”, Barbara Webb and Thomas R Consi, AAAI Press/MIT Press, First Edition, 2001.
5. Constantinos Mavroidis, Antoine Ferreira, “Nanorobotics: Current approaches and Techniques”, Springer 2011

Department of Biomedical Engineering
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Course Name: Neural Network and Genetic algorithm
Course Code: BME702C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Basic knowledge of Linear Algebra, Probability, and Statistics
- Fundamentals of Signals, Systems, and Data Structures
- Basic Programming Skills (MATLAB, Python, or C++)
- Understanding of Optimization methods and calculus

Course Objective(s):

The objective of the course is to make the students able to

1. Introduce the fundamental concepts, architectures, and learning rules of neural networks.
2. Provide knowledge of linear networks, multilayer perceptrons, and backpropagation learning algorithms.
3. Familiarize students with feedback neural networks such as Hopfield networks, Boltzmann machines, and recurrent neural networks.
4. Equip students with the ability to analyze and apply genetic algorithms for optimization and engineering problem-solving.
5. Develop problem-solving skills by integrating neural networks and genetic algorithms for real-world applications.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the architectures, learning rules, and activation functions of neural networks, including feedforward and feedback models.
CO2	Apply multilayer perceptrons, backpropagation algorithms, and adaptive linear networks for function approximation and engineering applications.systems.
CO3	Analyze the functioning of feedback neural networks (Hopfield, Boltzmann, RNNs) and genetic algorithms in search, optimization, and problem-solving.
CO4	Evaluate the performance of neural networks and genetic algorithms for real-world applications, considering accuracy, efficiency, and robustness.

Department of Biomedical Engineering
JIS College of Engineering

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	1	1	2	1	2	3	2
CO2	3	3	3	2	3	1	1	1	1	2	2	2	3	2
CO3	3	3	3	3	3	1	1	2	2	2	2	2	3	3
CO4	3	3	3	3	3	2	2	2	2	3	3	3	3	3
Avg.	3	2.75	2.75	2.5	2.75	1.25	1.25	1.5	1.5	2.25	2	2.25	3	2.5

Course Content:

Module- 1: Neural Networks **10L**

Definition of Neural Network, Learning rules and various activation functions, Encoding (training phase) and decoding (active phase), Single layer Perceptions, Back Propagation networks, Variation of Standard Back Propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications. Taxonomy of neural networks: feed forward and recurrent networks with supervised and unsupervised learning laws, static and dynamic processing systems, basic data structures: mapping of vector spaces, clusters, principal components.

Module-2: Linear Networks **8L**

Adaline - the adaptive linear element, Linear regression. The Wiener-Hopf equation. The Least- Mean-Square (Widrow-Hoff) learning algorithm. Method of steepest descent. Adaline as a linear adaptive filter. A sequential regression algorithm. Multi-Layer Neural Networks: Multi-Layer Perceptrons. Supervised Learning. Approximation and interpolation of functions. Back Propagation Learning law. Fast training algorithms. Applications of multilayer perceptrons: Image coding, Paint-quality inspection, Net talk.

Module-3: Feedback neural networks **3L**

Pattern storage and retrieval, Hopfield model, Boltzmann machine, Recurrent neural networks.

Module- 4: Fundamentals of Genetic Algorithm: **11L**

A brief history of evolutionary computation, biological terminology, search space encoding, reproduction elements of genetic algorithm, genetic modeling, comparison of GA and traditional search methods. Genetic technology: steady state algorithm, fitness scaling, inversion. Genetic programming: Genetic Algorithm in problem solving, Implementing a Genetic Algorithm: computer implementation, operator (reproduction, crossover and Mutation, Fitness Scaling, Coding, Discretization). Knowledge based techniques in Genetic Algorithm. Advanced operators and techniques in genetic search: Dominance, Diploidy and Abeyance. Inversion and other reordering operators, Niche and speciation.

Module-5: Applications of Genetic Algorithm **4L**

Genetic Algorithm in engineering and optimization-natural evolution –Simulated annealing and Tabu search -Genetic Algorithm in scientific models and theoretical foundations.

Text/ Reference Books:

1. Goldberg, Genetic Algorithms, Addison Wesley, 1989, ISBN 0-201-15767-5
2. Mitchell, An Introduction to Genetic Algorithms, MIT Press, 1998, ISBN 0-262-63185-7

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Biological Control System
Course Code: BME703A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

Knowledge of basic human physiology, Fundamentals of control systems and differential equations, system dynamics in engineering or biological contexts

Course Objective(s):

The objective of the course is to make the students able to

1. To understand the basic principles and mathematical tools used in control systems.
2. To compare and analyze control mechanisms in engineering and biological systems.
3. To model, simulate, and analyze feedback mechanisms in physiological control systems.
4. To apply linear and non-linear system theories to real-world biological processes.

Course Outcomes (COs):

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

COs	Statement
CO1	Describe and compare the structure and behavior of biological and engineering control systems.
CO2	Apply mathematical techniques like RH criterion and root locus for evaluating the stability of biological systems.
CO3	Analyze biological regulatory mechanisms (e.g., blood pressure, temperature) using system modeling.
CO4	Evaluate and simulate control models in complex physiological systems such as respiration, cardiovascular, and endocrine systems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	3	2	-	-	-	-	-	-	-	2	2	3
Avg.	3	3	3	2	-	-	-	-	-	-	-	2	2	2

Course Content:

Module- 1: Introduction **14L**

Technological Control System, Mathematical approaches, System stability, Differences and similarities between biological and engineering control system, Generalized System Properties, Root Locus Plots, Routh–Hurwitz (RH) Stability Criterion, Linear and Non-linear systems,

Time invariant and time varying systems of biological control processes, Linear model of respiratory mechanics, Linear model of muscle mechanics. “Systems Physiology” Versus “Systems Biology”.

Module- 2: Process regulation: 8L

Acid – base balance, Extra cellular water and electrolyte balance, Interstitial fluid volume, Blood pressure, Blood glucose, Thermal regulatory system.

Module- 3: Biological Control 14L

Cardiac rate, Respiratory rate, Mass balancing of lungs, Oxygen uptake by RBC and pulmonary capillaries, Oxygen and carbon dioxide transport in blood and tissues, Urine formation and control, skeletal muscle servo mechanism and semi-circular canal, Adaptive characteristics of the muscle stretch reflex, Block diagram representation of the muscle stretch reflex, physiological control systems: muscle stretch reflex, Model of obstructive sleep apnea–chemoreflex interaction in ventilatory control, Endocrine control system.

Text Books:

1. Ogata Katsuhika, Modern Control Engineering. 2nd Edition, Prentice Hall of India.
2. Ibrell and Guyton, Regulation and control in physiological system.

Reference Books:

1. Milsum Jhon H., Biological control system analysis, Tata McGraw-Hill.
2. Milhom T.H. Saunder. Application of control theory to physiological systems, The University of Chicago Press.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Computational Method for Biomolecules
Course Code: BME703B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Fundamentals of Biochemistry – biomolecules, amino acids, proteins, enzymes.
- Basic Molecular Biology – transcription, translation, genetic code, protein synthesis.
- Basic Physical Chemistry Concepts – thermodynamics, quantum mechanics, molecular interactions.
- Introductory Computational Techniques – basic familiarity with bioinformatics tools and simulation

Course Objective(s):

The objective of the course is to make the students able to

1. Explain biomolecular structures, their hierarchy, and functional aspects relevant to molecular modeling.
2. Apply molecular quantum mechanics principles and solvation models to analyze biomolecular interactions.
3. Analyze molecular dynamics simulation data for protein-ligand, biphasic, and solvation systems.
4. Evaluate computational modeling outcomes (homology modeling, docking, MD simulations) for biomolecular systems.

Course Outcomes (COs):

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

COs	Statement
CO1	Interpret biomolecular structures, pH-dependent protein properties, and modeling approaches like homology modeling and docking.
CO2	Apply quantum mechanics-based solvation models and solid-state approaches to predict molecular interactions in biological systems.
CO3	Analyze molecular dynamics simulation results using GROMACS for various biomolecular systems (lysozyme, protein-ligand, biphasic systems).
CO4	Evaluate the accuracy and limitations of molecular simulation methods for specific biomolecular case studies.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	1	1	2	1	2	1	2	3	2
CO2	3	3	3	2	3	1	2	2	1	2	2	2	3	2
CO3	3	3	2	3	3	1	1	2	2	2	2	2	3	3
CO4	3	3	3	3	3	2	2	3	2	3	3	2	3	3
Avg.	3	3	2.5	2.5	3	1.25	1.5	2.25	1.5	2.25	2	2	3	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Biomolecules **15L**

Biomolecular Structure and their Hierarchy, Amino acids, protein polymerization, Transcription, Translation Antibody, Protein charging at different pH range, Homology Modeling, Molecular Docking of Peptide and Protein Receptors, Microencapsulation, Cyclic voltametry Microfluidics, Similarity of Streamlines, Pathlines, Sreaklines and Timelines for a steady flow Stress tensor.

Module- 2: Applications of Molecular Quantum Mechanics **12L**

Discrete Solvation Models in Molecular Mechanics and Statistics, Continuum Solvation Models in Molecular Mechanics and Statistics, The Perspective of Quantum Mechanics, Continuum Solvation Models in Quantum Mechanics, The Mean–Field in Action, The Solid-State Approach, The Super–Cell in Action, Metal Ions and Protons compete, Water and Amino Acids Compete for the Same Metal Ion.

Module- 3: Molecular Dynamics **9L**

Tutorial from GROMACS Tutorial: Lysozyme in Water, Umbrella Sampling, Biphasic System, Protein Ligand System, Free Energy of Solvation, Virtual sites. Molecular Simulation.

Text Books

1. Chemistry of Biomolecules, 2nd Edition, S.P. Bhutani, CRC Press.
2. Biomolecules, N. Arumugam, Saras Publication.
3. Molecular Modeling and Simulation, Tamar Schlick, Springer, NY.

Reference Books

1. Biomolecular Simulations: Methods and Protocols, Luca Monticelli, Emppu Salonen, Springer, NY.
2. Innovations in Biomolecular Modeling and Simulations: Volume 2, Tamar Schlick, RSC Publishing.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Drug Delivery System
Course Code: BME703C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites knowledge of pharmaceutics, dosage form design, and biopharmaceutics; Understanding of pharmacokinetics (ADME processes); Fundamentals of polymer science and biomaterials; Basic concepts of drug delivery routes and formulation technology.

Course Objective(s):

The objective of the course is to make the students able to

5. Explain the principles, mechanisms, and influencing factors of sustained release and controlled release formulations.
6. Differentiate various novel drug delivery systems based on activation mechanisms, routes, and patient-specific needs.
7. Analyze the role of physiological barriers and formulation strategies in improving drug bioavailability.
8. Evaluate the design and performance of advanced drug delivery systems for proteins, peptides, and vaccines.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the fundamental concepts, advantages/disadvantages, and mechanisms of SR/CR formulations.
CO2	Classify and differentiate rate-controlled, gastro-retentive, buccal, and transdermal drug delivery systems.
CO3	Analyze physiological and physicochemical barriers for macromolecular drug delivery and propose suitable formulation strategies.
CO4	Evaluate novel and personalized drug delivery systems, including vaccine and bioelectronic-based approaches.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	1	1	2	2	2	2	2
CO2	3	3	2	2	2	1	1	1	2	2	2	3	2	2
CO3	3	3	3	3	3	3	2	1	2	2	3	2	2	3
CO4	3	3	3	3	3	3	3	2	2	3	3	2	2	3
Avg	3	2.75	2.25	2.25	2.25	2	1.75	1.25	1.75	2.25	2.5	2.25	2	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Sustained Release (SR) and Controlled Release (CR) formulations 10L

Introduction and basic concepts, advantages/disadvantages, factors influencing, Physicochemical and biological approaches for SR/CR formulation, Mechanism of Drug Delivery from SR/CR formulation. Polymers: introduction, definition, classification, properties and application Dosage Forms for Personalized Medicine: Introduction, Definition, Pharmacogenetics, Categories of Patients for Personalized Medicines: Customized drug delivery systems, Bioelectronic Medicines, 3D printing of pharmaceuticals, Tele-pharmacy.

Module- 2: Rate Controlled Drug Delivery Systems 6L

Principles and Fundamentals, Types, Activation; Modulated Drug Delivery Systems; Mechanically activated, pH activated, Enzyme activated, and Osmotic activated Drug Delivery Systems, Feedback regulated Drug Delivery Systems; Principles and Fundamentals.

Module- 3: Gastro-Retentive and Drug Delivery Systems 8L

Principle, concepts advantages and disadvantages, Modulation of GI transit time approaches to extend GI transit. Buccal Drug Delivery Systems: Principle of muco-adhesion, advantages and disadvantages, Mechanism of drug permeation, Methods of formulation and its evaluations.

Module- 4: Transdermal Drug Delivery Systems 4L

Structure of skin and barriers, Penetration enhancers, Transdermal Drug Delivery Systems, Formulation and evaluation.

Module- 5: Protein and Peptide Delivery 4L

Barriers for protein delivery. Formulation and Evaluation of delivery systems of proteins and other macromolecules.

Module- 6: Vaccine delivery systems 4L

Vaccines, uptake of antigens, single shot vaccines, mucosal and transdermal delivery of vaccines.

Text Books:

1. Y W. Chien, Novel Drug Delivery Systems, 2nd edition, revised and expanded, Marcel Dekker, Inc., New York, 1992.
2. Robinson, J. R., Lee V. H. L, Controlled Drug Delivery Systems, Marcel Dekker, Inc., New York, 1992.

Reference Books:

1. Encyclopedia of controlled delivery, Editor- Edith Mathiowitz, published by Wiley Interscience Publication, John Wiley and Sons, Inc, New York, Chichester/Weinheim
2. N.K. Jain, Controlled and Novel Drug Delivery, CBS Publishers and Distributors, New Delhi, First edition 1997 (reprint in 2001).
3. S.P. Vyas and R.K. Khar, Controlled Drug Delivery-concepts and advances, Vallabh Prakashan, New Delhi, First edition 2002.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Artificial Intelligence in Clinical Science
Course Code: BME704A
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Fundamental knowledge of human anatomy, physiology, and biomedical terminology.
- Basics of computer programming (Python/R/Matlab preferred).
- Understanding of probability, statistics, and linear algebra.
- Familiarity with basic machine learning concepts and healthcare workflows.

Course Objective(s):

The objective of the course is to make the students able to

1. Explain foundational concepts of human and artificial intelligence relevant to healthcare applications.
2. Differentiate AI learning paradigms and their suitability for various biomedical data types.
3. Analyze AI-driven models for medical data interpretation, clinical decision support, and personalized medicine.
4. Evaluate AI models in healthcare based on performance, interpretability, and ethical considerations.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the theoretical foundations of AI, forms of learning, and their applications in healthcare.
CO2	Classify and differentiate supervised, unsupervised, and bio-inspired AI techniques for solving healthcare-related problems.
CO3	Analyze AI-based solutions for risk stratification, medical imaging, biomarker discovery, and personalized medicine applications.
CO4	Evaluate AI models using performance metrics, interpretability criteria, and ethical-legal guidelines in medicine and healthcare.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	2	3	2	3	2
CO2	3	3	2	2	3	1	1	1	2	2	3	2	3	2
CO3	3	3	3	3	3	2	2	2	2	3	3	2	3	3
CO4	3	3	3	3	3	3	2	3	2	3	3	2	3	3
Avg	3	2.75	2.25	2.25	2.75	1.75	1.5	1.75	1.75	2.5	3	2	3	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module- 1: Foundations 20L

Introduction to Human and Artificial Intelligence: terminologies, computational models of intelligence; conceptual frameworks from cognitive and educational psychology, neuroscience, information theory, and linguistics; philosophical foundations of AI; Review of relevant mathematical and statistical concepts: logarithmic loss, cross entropy optimizing cost functions; linear and logistic regression; Forms of Learning: supervised, semi-supervised, unsupervised, active, and transfer learning; Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning: neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks; Unsupervised Learning: basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction); Knowledge Representation and Reasoning: Prepositional logic, first-order logic, ontological engineering, probabilistic reasoning; Time-series analysis: temporal models (probabilistic reasoning over time); Emerging paradigms and concepts in artificial social and emotional intelligence.

Module- 2: Applications 10L

Unique characteristics and challenges in medicine and healthcare; History and status quo of intelligent and expert systems in medicine; Risk stratification, patient outcome prediction, disease progression modeling; Clinical decision-making and intelligent systems to support evidence-based medicine; Phenotype and clinical/bio-marker discovery, Relevance to personalized medicine; Analysis of tissue morphology and other medical imaging applications.

Module- 3: Implementation and Evaluation 6L

Tools and Technologies for implementing AI methods; Model evaluation and performance metrics, cross-validation, model interpretability; Ethics of AI: bias, fairness, accountability, and transparency in machine learning; Ethical, Legal, and Social Issues of AI in medicine and healthcare.

Text/ Reference Books:

1. Stuart Russell and Peter Norvig. 2009. Artificial Intelligence: A Modern Approach (3rd ed.). Prentice Hall Press, Upper Saddle River, NJ, USA.
2. Toby Segaran. 2007. Programming Collective Intelligence (First ed.). O'Reilly.
3. Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine – a Complete Overview. Springer.
4. Sunila Gollapudi, S. 2016. Practical Machine Learning. Packt Publishing Ltd.
5. Peter Harrington. 2012. Machine Learning in Action. Manning Publications Co., Greenwich, CT, USA

Department of Biomedical Engineering
JIS College of Engineering

Course Name: IOT and Telehealth Technology
Course Code: BME704B
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Basic knowledge of electronics and embedded systems.
- Fundamentals of networking concepts (OSI, TCP/IP).
- Understanding of sensors and data acquisition.
- Basic programming skills in C/C++ or Python.

Course Objective(s):

The objective of the course is to make the students able to

1. Explain the concepts of IoT, embedded systems, networking standards, and their applications in healthcare.
2. Describe IoT hardware platforms, sensors, and communication protocols for healthcare monitoring.
3. Analyze client-server communication, embedded web server design, and IoT cloud integration.
4. Evaluate IoT-based healthcare application designs through real-world case studies.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the principles of IoT, embedded systems, and wireless communication standards in healthcare.
CO2	Classify and apply IoT hardware platforms, sensors, and APIs for medical data acquisition.
CO3	Analyze client-server communication models, embedded web servers, and IoT cloud service integration.
CO4	Evaluate IoT-based healthcare solutions such as patient monitoring and wearable devices.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	2	3	2	3	2
CO2	3	3	2	2	3	1	1	1	2	2	3	3	3	2
CO3	3	3	3	3	3	2	2	2	2	3	3	2	3	3
CO4	3	3	3	3	3	3	2	3	2	3	3	3	3	3
Avg.	3	2.75	2.25	2.25	2.75	1.75	1.5	1.75	1.75	2.5	3	2.5	3	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module-1: IOT: An Introduction **12L**

Introduction to Embedded Systems-an overview, features. Networked Embedded System types and overview, wireless communication standards-zigbee, Bluetooth and Wi-Fi. OSI and TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. IOT- understand what IOT is and discuss its application in health-care systems- Patient Monitoring and diagnostics, home healthcare and Personal care and Fitness.

Module-2: IOT Hardware Platform and Sensor Interface **8L**

Introduction to CC3100 Wi-Fi Booster Pack: overview and features. Introduction to CC3100 SDK: understand the important APIs. Getting Started with Energia Wi-Fi libraries. Sensor interface: Temperature sensor, pressure sensor, Light sensor, IR sensor.

Module- 3: Client-Server Communication Paradigm **5L**

Basic Client-Server communication model, Network Sockets, Ports, and Examples of client server communication, Energia client and server class APIs.

Module- 4: Embedded Web-Server and IOT Cloud Services **6L**

Embedded web server: Basic introduction, its importance and role in IOT, Design of a simple embedded web server: understand the HTTP and HTML basics Overview of different IOT Cloud Services.

Module- 5: Application Design and Case Study **5L**

Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration,

Case Study1: Wireless Patient Monitor system

Case Study2: Wearable Fitness and Activity Monitor

Text/ Reference Books:

1. Getting Started with Internet of Things- CunoPfister, 2011
2. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Deep Learning and Machine Learning in Health Care
Course Code: BME704C
Contact: 3:0:0
Total Contact Hours: 36
Credit: 3

Prerequisites:

- Basic knowledge of electronics and embedded systems.
- Fundamentals of networking concepts (OSI, TCP/IP).
- Understanding of sensors and data acquisition.
- Basic programming skills in C/C++ or Python.

Course Objective(s):

The objective of the course is to make the students able to

5. Explain the concepts of IoT, embedded systems, networking standards, and their applications in healthcare.
6. Describe IoT hardware platforms, sensors, and communication protocols for healthcare monitoring.
7. Analyze client-server communication, embedded web server design, and IoT cloud integration.
8. Evaluate IoT-based healthcare application designs through real-world case studies.

Course Outcomes (COs):

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

CO	Statement
CO1	Explain the principles of IoT, embedded systems, and wireless communication standards in healthcare.
CO2	Classify and apply IoT hardware platforms, sensors, and APIs for medical data acquisition.
CO3	Analyze client-server communication models, embedded web servers, and IoT cloud service integration.
CO4	Evaluate IoT-based healthcare solutions such as patient monitoring and wearable devices.

CO-PO/PSO Mapping:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	2	3	2	3	2
CO2	3	3	2	2	3	1	1	1	2	2	3	3	3	2
CO3	3	3	3	3	3	2	2	2	2	3	3	2	3	3
CO4	3	3	3	3	3	3	2	3	2	3	3	3	3	3
Avg	3	2.75	2.25	2.25	2.75	1.75	1.5	1.75	1.75	2.5	3	2.5	3	2.5

Department of Biomedical Engineering
JIS College of Engineering

Course Content:

Module 1: Introduction to Deep Learning 6L

Definition and importance of Deep Learning, Binary Classification, Logistic Regression, Logistic Regression Cost Function, Gradient Descent, Derivatives, Computation Graph.

Module- 2: Deep Learning for Healthcare 10L

Introduction, Machine learning basics, Health data, Deep Neural Networks (DNN), Embedding, Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Autoencoders, Attention Models, Graph Neural Networks, Memory network, Deep generative models.

Module- 3: Fundamentals of Machine Learning 8L

Definition, Supervised Learning, Unsupervised Learning, Reinforcement Learning, Machine Learning algorithms and Model Selection, Sparse Modeling and Estimation, Scalable Machine Learning (Online and Distributed Learning), Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Module- 4: Machine Learning for Healthcare 12L

Overview of Clinical Care, Deep Dive into Clinical Data, Risk Stratification, Survival Modelling, learning from Noisy Labels, Detecting and Mitigating Dataset Shift, Machine Learning for Pathology, Machine Learning for Mammography, Physiological Time-Series, Differential Diagnosis, Precision Medicine, Disease Progression Modelling and Subtyping

Text Books

1. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer; 1st ed. 2018 edition
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", published by MIT Press
3. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer

Reference Books:

1. Francois Chollet, "Deep Learning with Python", Manning Publications; 1st edition
2. Simon Haykin, "Neural Networks and Learning Machines", Pearson Prentice Hall, 3rd Edition
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007
4. Dr. Rajiv Chopra, Machine Learning, Khanna Publishing House, 2018

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Artificial Organs & Rehabilitation Engineering Lab
Course Code: BME791
Contact: 0:0:3
Credits: 1.5

Prerequisites:

- Basic Human Physiology (Cardiovascular, Renal, Auditory, Musculoskeletal Systems)
- Biomedical Instrumentation (sensors, transducers, signal acquisition)
- Basics of Medical Electronics and Assistive Devices
- Introductory Biomechanics and Rehabilitation Engineering

Course Objectives:

The objective of the course is to make the students able to

1. Demonstrate the principles and functioning of key artificial organ systems such as artificial kidney and pacemakers.
2. Familiarize students with the use and functionality of rehabilitation devices including prosthetics and orthotics.
3. Acquire and analyze biosignals (ECG, EMG) related to artificial organ functionality and rehabilitation monitoring.
4. Develop analytical, observational, and creative thinking skills through hands-on and innovative experiments.

Course Outcomes (COs):

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

COs	Statement
CO1	Explain the functioning of artificial organ models like dialysis and pacemaker systems.
CO2	Illustrate the use and application of assistive devices such as prosthetics, orthotics, and cochlear implants.
CO3	Analyze gait, EMG, and joint motion data for evaluating rehabilitation and muscular performance.
CO4	Design or modify a simple innovative rehabilitation or assistive device based on observed needs.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	-	-	-	2	-	-	-	-	-	-	3	2	2
CO2	2	-	-	-	2	1	-	-	-	-	-	3	2	2
CO3	2	2	-	2	3	-	-	-	-	-	-	3	2	3
CO4	3	3	3	2	3	2	2	2	2	2	2	3	3	3
Avg.	2.25	2.5	3	2	2.5	1.5	2	2	2	2	2	3	2.25	2.5

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Demonstration of Artificial Kidney (Dialysis Process) Using a Semi-Permeable Membrane Model
2. Study of Pacemaker Modes Using Simulated ECG (Software-Based or Chart)
3. Study of Cochlear Implant System (Demo/Simulation)
4. Gait Analysis Using Force Platform and Motion Sensors
5. Study of Basic Lower Limb Prosthesis (Demo Model)
6. EMG Signal Acquisition and Muscle Fatigue Analysis
7. Demonstration and Functional Study of Orthotic Devices (Ankle-Foot Orthosis, Knee Brace)
8. Measurement of Joint Angle and Range of Motion using Goniometer and Digital Sensors
9. Innovative Experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Medical Image Processing Lab
Course Code: BME792A
Contact: 0:0:3
Credits: 1.5

Prerequisite: Basic knowledge of Digital Signal Processing.

Course Objective(s):

The objective of the course is to make the students able to –

1.Understand the fundamental concepts of medical image processing.

2.Perform various image enhancement, filtering, and transformation techniques on medical images.

3.Implement image segmentation and edge detection algorithms specific to medical images.

4.Explore image compression and reconstruction methods in spatial and frequency domains.

Course Outcomes (COs):

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

COs	Statement
CO1	Convert and process medical images using basic image processing techniques like grayscale conversion, brightness, and contrast adjustment.
CO2	Perform logical operations and encryption on color planes of images.
CO3	Analyze and manipulate image histograms for enhancement purposes.
CO4	Apply spatial filtering techniques such as mean and median filtering to remove noise.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	1	2	-	-	-	-	-	-	3	2	1
CO2	2	3	3	2	2	-	-	-	-	-	-	3	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	2
CO4	3	3	3	3	3	-	-	-	1	1	1	3	3	3
Avg.	2.75	2.5	3	2	2.25	-	-	-	1	1	1	3	2.5	2

List of Experiments:

12. Convert multiple RGB Medical Images into Grey Scale Images, change the brightness-contrast and show the different planes of the images.
13. Perform the logical operation on images and also perform encryption with colour plane or logical operation concept.
14. Display histogram of a medical image and perform histogram processing operations for the image.
15. Apply Mean and Median filtering in a grayscale medical image and display the result.

16. Transform a grayscale image into frequency domain and show its magnitude and phase-angle.
17. Apply LPF and HPF in a grey scales medical Image and displays the result.
18. Compress and reconstruct a RGB and Grey scale image in spatial domain.
19. Compress and reconstruct a Grey Scale Medical Image in frequency domain.
20. Apply segmentation technique (any one) in a medical image and display the result.
21. Apply edge detection technique in a medical image and display the result.
22. Innovative experiment

Text Books/ Reference Books:

1. R.C. Gonzalez, R.E. Woods-Digital Image Processing Laboratory Manual.
2. S. Palanisamy-Medical Image Processing Laboratory Manual.

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Medical Robotics and Automation Lab
Course Code: BME792B
Contact: 0:0:3
Credits: 1.5

Prerequisite:

- Basics of electrical and electronic circuits
- Fundamentals of control systems (open/closed loop, feedback, PID)
- Basics of microcontroller and PLC programming
- Understanding of actuators, sensors, and logic gates

Course Objectives:

The objective of the course is to make the students able to

1. Implement basic open loop and closed loop control strategies using various actuators and sensors.
2. Explore and apply PID control in real-time systems using servo and electro-mechanical devices.
3. Interface and program microcontrollers and PLCs for automation and control tasks.
4. Promote innovative thinking for developing automation solutions using integrated control systems.

Course Outcomes:

After completion of this course the students will be able to

COs	Statement
CO1	Apply control system techniques to operate open loop and closed loop position control systems.
CO2	Analyze the behavior of servo mechanisms and PID control systems under different conditions.
CO3	Evaluate the performance of pneumatic, hydraulic, and electronic actuation systems.
CO4	Develop an integrated automation project using Arduino/PLC/actuators and control logic.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	-	-	-	-	-	-	3	2	2
CO2	3	3	-	2	2	-	-	-	-	-	-	3	2	3
CO3	3	3	-	2	3	-	-	1	-	-	-	3	2	3
CO4	3	2	3	2	3	1	1	1	2	2	2	3	3	3
Avg.	3	2.5	3	2	2.5	1	1	1	2	2	2	3	2.25	2.75

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Open Loop Position Control
2. Closed Loop Position Control using positional and velocity feedback.
3. Use of analog and digital servo system.
4. Use of PID Control.
5. Experiments on Pneumatic Drives and Actuators.
6. Experiments on Hydraulic Drives and Actuators.
7. Uses of Logic Gates.
8. Programming on Arduino Platform.
9. Programming on PLC for simple control operation.
10. Innovative Experiment

Department of Biomedical Engineering
JIS College of Engineering

Course Name: Neural Network and Genetic Algorithm Lab
Course Code: BME792C
Contact: 0:0:3
Credits: 1.5

Prerequisite:

- Basic programming skills in MATLAB/Python/C++.
- Understanding of fundamental mathematics (linear algebra, probability, calculus).
- Knowledge of artificial intelligence concepts and machine learning basics.
- Familiarity with optimization techniques and control systems.

Course Objectives:

The objective of the course is to make the students able to

1. Implement fundamental algorithms in fuzzy logic, neural networks, and genetic algorithms.
2. Apply soft computing techniques to real-life control and optimization problems.
3. Analyze the performance of different learning algorithms and their convergence behavior.
4. Design and evaluate hybrid intelligent systems for complex problem-solving.

Course Outcomes:

After completion of this course the students will be able to

COs	Statement
CO1	Implement fuzzy logic operations, relations, and controllers for control applications.
CO2	Apply neural network and genetic algorithm techniques to solve simple computational problems.
CO3	Analyze the performance of supervised and unsupervised learning algorithms in given datasets or applications.
CO4	Design and evaluate hybrid intelligent systems such as ANFIS and optimization frameworks for complex problems.

CO-PO/PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**2**	**2**
CO2	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**2**	**3**	**2**	**3**	**2**
CO3	**3**	**3**	**2**	**3**	**3**	**1**	**1**	**2**	**2**	**2**	**3**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Avg.	**3**	**2.5**	**2.25**	**2.5**	**3**	**1.25**	**1.25**	**1.5**	**2.25**	**2.25**	**2.75**	**2.5**	**2.5**	**2.5**

Department of Biomedical Engineering
JIS College of Engineering

List of Experiments:

1. Implementation of Fuzzy Operations
2. Implementation of Fuzzy Relations (Max-min Composition)
3. Implementation of Fuzzy Controller (Washing Machine)
4. Implementation of Simple Neural Network (McCulloh-Pitts model)
5. Implementation of Perceptron Learning Algorithm
6. Implementation of Unsupervised Learning Algorithm
7. Implementation of Simple Genetic Application
8. Study of ANFIS Architecture
9. Study of Derivative-free Optimization
10. Innovative experiment

Department of Biomedical Engineering
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4th Year 8th Semester									
Sl No.	**Broad Category**	**Category**	**Paper Code**	**Course**	**Contact Hours/ Week**				**Credit Points**
					L	**T**	**P**	**Total**	
B. PRACTICAL/ SESSIONAL									
1	ENGG	Major	BME881	Grand Viva	0	0	0	0	1
2	ENGG	Major	BME882	Internship/ Entrepreneurship*	0	0	16	16	8
Total of Theory & Practical								**16**	**9**
Total Credit in Fourth Year									**30**

For BME882: Internship/ Entrepreneurship

With Research

One industry related Project along with one MOOCs Course on Research Methodology.

Without Research

3-4 months' internship along with one elective course from NPTEL.