UPES
UNIVERSITY OF TOMORROW

SCHOOL OF
HEALTH SCIENCES
AND TECHNOLOGY

# B.Tech. Biomedical Engineering

## Four-Year Program

Program Structure | 2023-2027

UPES Bidholi Campus, P.O. Bidholi via Prem Nagar, Dehradun, Uttarakhand-248007
Tel: +91 0135 2770137 | Website: www.upes.ac.in

# UPES

**School of Health Sciences and Technology**

***B.Tech. Biomedical Engineering***

**Program Structure**

**2023-2024**


UPES Campus, “Energy Acres”

P.O Bidholi via Prem Nagar, Bidholi

Dehradun, Uttarakhand-248001

Tel : + 91-135-2776053/54

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**Contents**

## 1.0 Abbreviations

| | | |
|---|---|---|
| Cat | - | Category |
| L | - | Lecture |
| T | - | Tutorial |
| P | - | Practical |
| Cr | - | Credits |
| UC | - | University Core |
| PC | - | Program Core |
| PRJ | - | Project Work (including Seminars, Dissertation, and Internships) |
| PE | - | Program Elective (includes Specialization courses) |
| UE | - | University Elective (includes Signatory, Exploratory and Open Electives) |
| TC | - | Total Credits |

## 2.0 Vision and Mission of the University:

### Vision of UPES

To be an Institution of Global standing for developing professionally competent talent contributing to nation building.

**Mission of UPES**

- Develop industry-focused professionals with an international outlook.
- Foster effective outcome-based education system to continually improve teaching-learning and research.
- Inculcate integrative thought process among students to instill lifelong learning.
- Create global knowledge eco-system through training, research & development and consultancy.
- Practice and promote high standards of professional ethics and develop harmonious relationship with environment and society.

## 3.0 Vision and Mission of the School

**SOHST Vision**

Leadership in Health Sciences & Technology for improving Planetary, and Public Health

**SOHST Mission for people and the planet**

- Create thought leaders and change makers.
- Design appropriate, holistic, and sustainable programs
- Converge multi-disciplinary efforts to make a difference.

## 4.0 Program Educational Objectives

- This program B. Tech Biomedical Engineering is aimed at generating engineers

- Contribute to innovation in healthcare by integrating life science and engineering to develop relevant biomedical devices and algorithms.
- Contribute to India's "Make in India" mission as a biomedical engineer/scientist.
- Contribute to environment and sustainability by using biodegradable material for devices or algorithms with low carbon footprint.
- Progress into positions of increasing leadership responsibilities through good communication and technical skills.

## 5.0 Program Outcome and Program Specific Outcomes

### Program Outcome

**PO 1:** Apply knowledge of mathematics, science, and engineering principles to solve complex problems in biomedical engineering.

**PO 2:** Identify, formulate, and solve problems related to biomedical engineering by applying principles of engineering, biology, and medical sciences.

**PO 3:** Design biomedical devices, systems, and processes that meet specific needs, considering the principles of biomedical engineering, ethical and safety considerations, and societal, cultural, and environmental aspects.

**PO 4:** Plan and conduct experiments, as well as analyze and interpret data, to investigate biomedical engineering problems, using appropriate research methodologies.

**PO 5:** Utilize modern engineering tools, software, and equipment necessary for biomedical engineering practice and research.

**PO 6:** Demonstrate ethical conduct, professional responsibility, and an understanding of the societal and environmental impact of biomedical engineering solutions.

**PO 7:** Communicate effectively with technical and non-technical audiences through written and oral means, including the ability to make effective presentations and write technical reports.

**PO 8:** Function effectively as a member or leader of a multidisciplinary team, recognizing the importance of collaboration and teamwork in biomedical engineering projects.

**PO 9:** Recognize the need for lifelong learning and engage in professional development activities to stay abreast of advancements in biomedical engineering and related fields.

**PO 10:** Demonstrate the knowledge and skills required for project management and entrepreneurship, including the ability to plan, organize, and manage biomedical engineering projects.

**PO 11:** Understand the impact of biomedical engineering on society, including the ethical, social, cultural, and environmental implications of biomedical engineering solutions.

**PO 12:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Program Specific Outcomes (PSOs)**

**PSO1.** Students will be able to understand functioning of biomedical device that meets specific clinical requirements and technical specifications, as assessed through project or a similar assessment method.

**PSO2.** Students will be able to analyze and interpret physiological signals using appropriate signal processing techniques, demonstrating their proficiency in extracting relevant information from biomedical signals through quantitative assessments or examinations.

**PSO3.** Students will demonstrate an understanding of ethical considerations and regulatory requirements in biomedical engineering by successfully completing an assignment or examination that assesses their knowledge of ethical guidelines, privacy concerns, and regulations related to the design, development, and use of biomedical devices and technologies.

**PSO4.** Students will be able to design and fabricate basic biomedical devices for healthcare applications fulfilling societal needs towards public health scenarios in line with sustainable development goals (SDG 3).

## 6.0 Overview of Credit Allocation/ Credit Break up

Category-wise Credit distribution

| Category | Number of Credits | Credit Percentage (%) |
|---|---|---|
| University Core (UC) | 41 | 27 |
| Program Core (PC) | 71 | 44 |
| Program Elective (PE) | 15 | 9 |
| University Elective (UE) | 18 | 11 |
| Projects (PRJ) | 15 | 9 |
| Mandatory Non-Credit Courses | Social Internship/ Government/NGO/Start-up Internship | |
| **Total** | 160 | 100 |

## 7.0 Program Structure

**Semester I:**

| Cat | Semester I/ Course Codes | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|
| UC | CHEM1001 | Chemistry | 2 | 1 | 1 | 4 |
| UC | PHYS1002 | Physics | 2 | 1 | 1 | 4 |
| UC | BP106R MT | Mathematics (I) | 2 | 1 | 0 | 3 |
| PC | HSCC1023 | Anatomy and Physiology | 2 | 1 | 1 | 4 |
| UC | CSEG1024 | Software system foundation | 1 | 1 | 1 | 3 |
| UC | School for Life | Living Conversations (SFL) | 1 | 1 | 0 | 2 |
| | **Total** | **TOTAL** | **10** | **6** | **4** | **20** |

**Semester II:**

| Cat | Semester II | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| UC | MATH 1038 | Mathematics (II) | 1 | 1 | 0 | 2 |
| UC | | Basic Electrical and Electronics Engineering | 2 | 0 | 0 | 2 |
| UC | MEPD 1003 | Workshop Practices | 1 | 0 | 1 | 2 |
| UC | MECH 1005 | Engineering Graphics | 1 | 0 | 1 | 2 |
| UC | MECH 1006 | Engineering Thermodynamics | 2 | 1 | 0 | 3 |
| PC | HSBE2001 | Biomechanics | 2 | 0 | 0 | 2 |
| PC | HSBE1001 | Introduction to Biomedical | 1 | 1 | 1 | 3 |
| PC | | Data structure in Biomedical engineering | 1 | 0 | 1 | 2 |
| UC | School for Life | Critical Thinking and Writing (SFL) | 1 | 1 | 0 | 2 |
| MNC | HUMN 1019 | Social Internship | 0 | 0 | 0 | 0 |
| | **Total** | | **12** | **4** | **4** | **20** |

**Semester III:**

| Cat | Semester III | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|
| PC | HSMB 2018/ HSMB 2118 (Lab) | Cell Biology | 2 | 1 | 1 | 4 |
| PC | HSMB 2019/ HSBT 2104 (Lab) | Microbiology & Microbial Tech | 2 | 0 | 1 | 3 |
| PC | HSBT 1002/ HSBT 1102 (Lab)_ | Molecular Biology and Genetics | 2 | 1 | 1 | 4 |
| UE | | Exploratory Elective 1 | 2 | 1 | 0 | 3 |
| UC | School for Life | Leadership and Teamwork | 1 | 1 | 0 | 2 |
| UC | School for Life | Environmental Science | 3 | 1 | 0 | 4 |
| | **Total** | | **12** | **5** | **3** | **20** |

**Semester IV:**

| Cat | Semester IV | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|
| PC | | Bionics and Microprocessor & Lab | 1 | 0 | 1 | 2 |
| PC | | Elements of Design | 1 | 1 | 0 | 2 |
| PC | | Heat and Mass transfer | 2 | 0 | 1 | 3 |
| PC | | Biophysics | 2 | 0 | 0 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PC | | GE Module on Medical Devices[#] and Ultrasound* | 2 | 1 | 0 | 3 |
| PC | HSBT 3008/ HSBT 3108 (Lab) | Bioinformatics & Computational Biology | 2 | 0 | 1 | 3 |
| UE | | Exploratory Elective 2 | 2 | 1 | 0 | 3 |
| UC | School for Life | Working With Data | 1 | 1 | 0 | 2 |
| MNC | SIIB 2101 | Government/NGO/Startup Internship | 0 | 0 | 0 | 0 |
| | **Total** | | **13** | **4** | **3** | **20** |

**Semester V:**

| **Cat** | **Semester V** | **Subjects** | **L** | T | P | **C** |
|---|---|---|---|---|---|---|
| PC | | Biosensors and Diagnostics & Lab | 2 | 1 | 1 | 4 |
| PC | | Regenerative Technologies & Artificial organs & Lab | 1 | 0 | 1 | 2 |
| PC | | Fundamentals of Robotics & Lab | 1 | 0 | 1 | 2 |
| PC | | GE Module on X-Ray and CT* | 2 | 1 | 0 | 3 |
| PRJ | PROJ 3108 | Project I (Research Methodology/ Sci writing) | 0 | 0 | 1 | 1 |
| PE | | Program Elective - I | 2 | 1 | 0 | 3 |
| UE | | Exploratory Elective 3 | 3 | 0 | 0 | 3 |
| UC | School for Life | Design Thinking | 1 | 1 | 0 | 2 |
| | **Total** | **TOTAL** | **11** | **5** | **4** | **20** |

**Semester VI:**

| **Cat** | **Semester VI** | **Subjects** | **L** | T | P | C |
|---|---|---|---|---|---|---|
| PC | | Artificial Intelligence and Machine Learning& Lab | 2 | 1 | 1 | 4 |
| PC | | Biomaterials & Lab | 2 | 1 | 1 | 4 |
| PC | | GE Module on MRI and Leadership & Development* | 2 | 1 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| PRJ | PROJ 3109 | Project II (Research plan/ synopsis) | 0 | 0 | 1 | 1 |
| PE | | Program Elective - I | 2 | 1 | 0 | 3 |
| UE | | Exploratory Elective 4 | 2 | 1 | 0 | 3 |
| UC | School for Life | Start your Start Up (SFL) | 1 | 1 | 0 | 2 |
| MNC | SIIB 3106 | Summer Industrial Internship | 0 | 0 | 0 | 0 |
| | **Total** | | **11** | **6** | **3** | **20** |

**Semester VII:**

| Cat | Semester VII | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|
| PC | HSBE2002 | Biomedical transport | 1 | 1 | 0 | 2 |
| PC | | Data Visualization | 2 | 1 | 0 | 3 |
| PC | | Signal and Image processing | 2 | 0 | 0 | 2 |
| PRJ | | Project III (Hands On experience) | 0 | 0 | 3 | 3 |
| PE | | Program Elective - II | 2 | 1 | 0 | 3 |
| PE | | Program Elective - III | 2 | 1 | 0 | 3 |
| PE | | Exploratory Elective 5 | 2 | 1 | 0 | 3 |
| PRJ | SIIB 4107 | Summer Internship Presentation | 0 | 0 | 1 | 1 |
| | **Total** | | **11** | **5** | **4** | **20** |

**Semester VIII:**

| Cat | Semester VIII | Subjects | L | T | P | C |
|---|---|---|---|---|---|---|
| PC | HSCC 4001 | Ethics, Regulations and IPR | 2 | 1 | 0 | 3 |
| PC | HSBT 4002 | GMP and GLP | 1 | 1 | 0 | 2 |
| PE | | Program Elective - IV | 2 | 1 | 0 | 3 |
| PRJ | PROJ 4125 | Project IV (Start-up/ Industrial/ Research) | 0 | 0 | 9 | 9 |
| UE | | Exploratory Elective 6 | 3 | 0 | 0 | 3 |
| | **Total** | | **8** | **3** | **9** | **20** |

**GE Training Schedule:**

| Package | Course | Semester | Duration |
|---|---|---|---|
| Module Training days at UPES by GE professionals | Anaesthesia/ | 4 | 5 full days |
| | Ventilator/Monitor | | |
| | Ultrasound | | |
| | X-Ray | 5 | 5 full days |
| | CT | | |
| | MRI | 6 | 5 full days |
| Advance Training + Internship at GEHC Institute Bangalore | Advance modules | 7/8 | 21 days |

## 8.0 List of Electives

| | **Bioengineering** | **Biomedical Robotics** | **Bio Fabrication** |
|---|---|---|---|
| **PE-1** | Biomedical Assistive Devices | Medical Delivery Robots | Biochemistry |
| **PE-2** | Implants and Prosthetics | Rehabilitation Robots | Material Exploration |
| **PE-3** | Algorithm | Telerobots | Operational Environments for medical Devices |
| **PE-4** | Usability of Biomedical devices | Surgical Assistive Robots | |

## 9.0 Course Syllabus

**SEMESTER I**

| **CHEM 1001/CHEM 1113 (LAB)** | **Chemistry** | **L-T-P-C:2-1-1-4** |
|---|---|---|

**Course Objectives:**

The objective of Chemistry is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during their study in the industry and Engineering field. The student with the knowledge of basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will be able to understand the new developments and breakthroughs efficiently in engineering and

technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with new technologies.

**Course Outcomes:**

The students will learn to:

CO1. Analyze microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.

CO2. Rationalize bulk properties and processes using thermodynamic considerations.

CO3. Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques.

CO4. Apply the knowledge of periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.

**Syllabus:**

**Unit I: General Organic Reaction Mechanism 10 hours**

Ionic and radical reactions; heterolytic and, homolytic bond cleavage; Reactive intermediates: carbocations (cabenium and carbonium ions), carbanions, carbon radicals, carbenes –structure using orbital picture, electrophilic/nucleophilic behaviour, stability, generation and fate. Reaction kinetics: transition state theory, rate constant and free energy of activation, free energy profiles for one step and two step reactions. Nucleophilic substitution reactions: SN1, SN2, SNi mechanisms. Effect of substrate structure, nucleophiles and medium on reactivity and mechanism; neighboring group participations. Elimination Reactions: E1, E2, and E1cB mechanisms. Saytzeff and Hofmann rules. Elimination vs substitution reaction. Electrophilic and Activated Nucleophilic substitution reactions of Benzene (Nitration, sulphonation, Halogenation and Friedel Craft reactions)

**Unit II: Surface Chemistry and Catalysis 8 hours**

Adsorption: Types of adsorptions – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, uni-molecular reactions, Langmuir - applications of adsorption on pollution abatement. Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor)

**Unit III: Polymer Chemistry 9 hours**

Classification of polymers, Types of polymerization techniques (Bulk, Solution, Suspension, emulsification), Mechanism of polymerization (Cationic, Anionic, free radical and coordination), Average molecular weight, Vulcanization, conducting polymers, biodegradable polymers, Plastics used in daily life application /food technology (a few examples can be mentioned).

**Unit IV: Instrumental Methods of Analysis 9 hours**

UV Spectra: Electronic transition (σ-σ*, n-σ*, π-π* and n-π*), steric effect, solvent effect, hyperchromic effect, hypochromic effect (typical examples). IR Spectra: Modes of molecular vibrations, characteristic stretching frequencies of O-H, C-H, C=C, C=O functions. NMR Spectra: Nuclear spin, NMR active nuclei, principle of proton magnetic resonance, equivalent and nonequivalent protons. Photochemistry: Lambert's law and Beer's Law, Laws of photochemistry, Photochemical processes.

**UNIT- V: Dilute Solutions and Colligative Properties 9 hours**

Lowering of vapor pressure of solutions, Colligative properties and their applications, Ionic equilibrium: Solubility and solubility product, common ion effect, determination of solubility product by EMF method, ionic product of water, pH, pOH, hydrolysis of salt solutions: Strong acid and weak base, weak acid and strong base, weak acid and weak base, concepts of buffer.

**Reference books:**

1. University chemistry, by B. H. Mahan

2. Engineering Chemistry, by Satyaprakash & Manisha Agarwal

3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane

4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell

5. Engineering Chemistry (NPTEL Web-book) by B.L. Tembe, Kamaluddin & M.S. Krishnan

6. Physical Chemistry, by P. W. Atkins

7. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

**Practical:**

**Choice of 10-12 experiments from the following:**

1. Determination of surface tension and viscosity.

2. Thin layer chromatography.

3. Ion exchange column for removal of hardness of water.

4. Determination of chloride content of water.

5. Colligative properties using freezing point depression.

6. Determination of the rate constant of reaction.

7. Determination of cell constant and conductance of solutions.

8. Potentiometry - determination of redox potentials and emfs.

9. Synthesis of a polymer/drug.

10. Saponification/acid value of an oil.

11. Chemical analysis of salt.

12. Lattice structures and packing of spheres.

13. Models of potential energy surfaces.

14. Chemical oscillations- Iodine clock reaction.

15. Determination of the partition coefficient of a substance between two immiscible liquids.

16. Adsorption of acetic acid by charcoal.

17. Use of the capillary viscometers to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of the egg.

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 2 | | 2 | 2 | 1 | | | | | | | | |
| **CO 2** | 3 | 3 | 1 | 2 | 3 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | | 3 |
| **CO 3** | 2 | 3 | 3 | | | 1 | 3 | 1 | | 2 | | | 1 | | 3 |
| **CO 4** | 2 | 3 | 2 | | | 2 | 3 | 1 | 2 | 2 | | 1 | 2 | | 3 |
| **Average** | **3** | **3** | **2** | **1** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **1** | **1** | **0** | **2** |

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

**Mode of Exam Evaluation Process-**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**PHYS 1002 Physics** **L-T-P-C:2-1-1-4**

## Course Objectives

The objective of the course on physics is to provide students with a comprehensive understanding of the subject in the context of healthcare system. Students will learn a conceptual understanding of the fundamental principles and laws of physics, including Lasers & Fibre Optics, electromagnetisms, quantum mechanics and Quantum Computing.

## Course Outcomes

The students will learn to:

CO1. Understand the significance of lasers and their application in holography and optical fiber communication.
CO2. Illustrate the electric field for different charge geometries.
CO3. Outline the magnetic field due to different current geometries.
CO4. Utilize the fundamentals of Quantum Mechanics and analyze the behavior of particle in a box.
CO5. Apply the concepts of Nanotechnology and fundamentals of Quantum computing.

**Course Content**

**Unit I: Lasers & Fibre Optics 12 hours**

Introduction, Spontaneous and Stimulated emission of radiation, Relation b/w Einstein's A and B coefficients, Population inversion & types of pumping, Main components of a Laser, Construction & working of Ruby Laser and its applications, Construction & working of Helium-Neon laser and its applications. Holography: Elementary idea of holography and constructive and reconstructive of holography. Fundamental ideas about optical fiber, Types of fibers, Acceptance angle and cone, Numerical aperture, Propagation mechanism and communication in optical fiber, Attenuation and losses.

**Unit II: Electromagnetics 12 hours**

Coordinate systems, Del operator, Gradient, Divergence, Divergence Theorem, Stoke's Theorem, Introduction to electrostatics, calculation of electric field, potential and energy due to charge distribution by vector approach, Gauss law electric flux density. Polarization in Dielectrics, Bound charges, Dielectric Constant and strength, Continuity equation and relaxation time Boundary Conditions. Introduction, Biot-Savart's law, Ampere's Circuit Law; Applications, Magnetic flux density, Faraday's Law, Transformer and motional EMF. Displacement current, Maxwell's Equations in Final form.

**Unit III: Quantum Mechanics 12hours**

Introduction to Quantum Mechanics, photoelectric effect, Compton Effect, Pair production & Annihilation, Wave particle duality, De Broglie waves, Davisson Germer experiment, phase and group velocities and their relations, Thought experiment- Heisenberg's Gamma ray microscope, Uncertainty principle and its applications, Wave function and its interpretation, Normalization, Schrodinger time independent & dependent wave equations, Particle in a 1-D box; generalization to 3-D box.

**Unit IV: Introduction to Quantum Computing 10 hours**

Introduction to Quantum Computing **-** Introduction to Nanotechnology, applications of nanotechnology, History of Computing, Quantum Computers, Principles of Quantum Computing, Nanocomputing Technologies, Prospects and Challenges

**Reference Books:**

1. Malik H.K, Singh A.K. (2011) Engineering Physics, TMH, New Delhi. ISBN: 9780070671539

2. Beiser A. (2002) Concepts of Modern Physics, McGraw Hill Education. ISBN: 9780070495531
3. Sadiku M.N.O. (2007) Elements of Electromagnetics, Oxford University Press. ISBN: 0195300483
4. C. T. Bhunia (2010) Introduction to Quantum Computing, New Age International Publishers **ISBN** 978-8122430752
5. Griffith D.J. (2012) Introduction to Electromagnetics, PHI Learning, 4th edition, ISBN: 9780138053260.
6. Ghatak A. (2012) Optics, McGraw Hill Education. ISBN: 978-1259004346.
7. Sahni V., Goswami D. (2008) Nano Computing, McGraw Hill Education Asia Ltd., ISBN: 978007024892.

**Practicals:**

1.To determine the frequency of AC mains by using a sonometer.
**2.** To study the Hall effect and hence determine the Hall coefficient ($R_h$) and carrier density (n) of a given semiconductor material.
3. To study the induced emf as a function of velocity of the magnet passing through the coil (Faraday's Law).
4. To study the charge delivered due to electromagnetic induction.
5. To study the variation of magnetic field with distance along the axis of a current carrying circular coil and hence estimate the radius of the coil.
6. To plot the characteristics of photocurrent vs voltage at different frequency.
7. To determine the Numerical Aperture of an optical fiber and study about the bending losses.
8. To study laser beam diffraction.
9. Study of both the current - voltage characteristic and the power curve to find the maximum power point (MPP) and efficiency of a solar cell.
10. To find the Planck's constant by using LEDs.
11. Presentation related to any science concept.

**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/ Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | **End Term Examination** | |
|---|---|---|---|

| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
|---|---|---|---|---|---|---|
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Textbooks:**


1. H. Singh, Practical Physics, S. Chand & Company LTD., ISBN: 8121904692.
2. S. L. Kakani, S. Kakani, Applied Physics-Theory & Practicals, Viva Books, ISBN: 9788130924892.
3. C. L. Arora, Practical Physics, S. Chand & Company LTD., ISBN: 9788121909099, 8121909090.


**Reference Books:**


1. Gupta, Kumar, Practical Physics, Pragati Prakashan, ISBN: 9789386633569.
2. I. Prakash, R. Krishna, A. K. Jha, Practical Physics, Kitab Mahal, ISBN: 8122504167, 9788122504163
3. P. R. Sasi Kumar, Practical Physics, Prentice Hall of India Pvt Ltd, ISBN: 9788920344341


**Relationship between the Program Outcomes (POs), Program Specific Outcomes and Course Outcomes (COs)**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 | PS O3 | PS O4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO2** | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO3** | - | - | - | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO4** | - | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | - |
| **CO5** | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - | - | - |
| **Average** | - | **3** | **3** | **3** | **2** | - | - | - | - | **3** | - | - | - | - | - | - |

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | **Total** |
|---|---|---|---|---|

| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | **Mid Term Exam** | **End Term Exam** | |
|---|---|---|---|---|---|---|---|
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| **MATH1048** | **Mathematics -I** | **L-T-P-C:2-1-0-3** |
|---|---|---|

**COURSE OBJECTIVE :** The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modelling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

**COURSE OUTCOMES**:.

The students will learn to:

CO1. Understand differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.

CO2. Utilize the fallouts of Rolle's Theorem that is fundamental to the application of analysis to Engineering problems.
CO3. Apply The tool of power series and Fourier series for learning advanced Engineering Mathematics.
CO4. Deal with functions of several variables that are essential in most branches of engineering.

**COURSE CONTENTS:**

**Unit I: Calculus 12 hours**

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

**Unit II: Sequences and Series 12 hours**

Convergence of sequences and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithmic functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

**Unit III: Multivariable Calculus (Differentiation) 12 hours**

Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.

**Unit IV:Matrices 10 hours**

Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.

**TEXTBOOKS/REFERENCES:**

1. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Reena Garg, Engineering Mathematics – I, Khanna Book Publishing Co., 2018.23
3. Reena Garg & Chandrika Prasad, Advanced Engineering Mathematics, Khanna Book Publishing Co., 2018.
4. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

5. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
9. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

| Program Outcomes / Course Outcomes | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO8 | PO 9 | PO 10 | PO 11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | - |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | - |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | - |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | - |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **3** | **1** | **1** | **3** | **1** | **3** | - |

**CO-PO Mapping**

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

| HSCC1023 | Anatomy and Physiology | L-T-P-C:2-1-1-4 |
|---|---|---|

- **COURSE OBJECTIVES**

These objectives provide a framework for students to gain a comprehensive understanding of the structure and function of the human body. by achieving these objectives, students will be equipped with the knowledge and skills necessary for further study in healthcare professions, biomedical research, or related fields.

- **COURSE OUTCOMES**

The students will be able to:

**CO1-** Understand the gross morphology, structure and elements of different organs of the human body.

**CO2-** Learn the different homeostatic instruments and their awkward nature.

**CO3-** Distinguish the different tissues and organs of various frameworks of human body.

**CO4-** Apply the different trials identified with unique faculties and sensory system.

**Course Content**

**UNIT I: INTRODUCTION TO HUMAN BODY** **10 Hours**

Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology.

Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signaling pathway activation by extracellular signal molecule, Forms of intracellular signaling: a) Contact-dependent b) Paracrine c) Synaptic d) Endocrine

Classification of tissues, structure, location, and functions of epithelial, muscular and nervous and connective tissues.

**UNIT II: INTEGUMENTARY SYSTEM** **10 Hours**

Structure and functions of skin, Divisions of skeletal system, types of bone, salient features, and functions of bones of axial and appendicular skeletal system, Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction

Structural and functional classification, types of joints movements and its articulation

**UNIT III: BODY FLUIDS AND BLOOD** **10 Hours**

Body fluids, composition and functions of blood, hemopoiesis, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood, Reticulo endothelial system.

Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system

**UNIT IV: PERIPHERAL NERVOUS SYSTEM:** **08 Hours**

Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves.

Structure and functions of eye, ear, nose and tongue and their disorders.

**UNIT V: CARDIOVASCULAR SYSTEM** **07 Hours**

Heart – anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heartbeat, its regulation by autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart.

**Reference and Textbooks:**


1. Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee brothers' medical publishers, New Delhi.
2. Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson, Churchill Livingstone, New York
3. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co,Riverview,MI USA
4. Textbook of Medical Physiology- Arthur C, Guyton and John.E. Hall. Miamisburg, OH, U.S.A.
5. Principles of Anatomy and Physiology by Tortora Grabowski. Palmetto, GA, U.S.A. 31
6. Textbook of Human Histology by Inderbir Singh, Jaypee brother's medical publishers, New Delhi.
7. Textbook of Practical Physiology by C.L. Ghai, Jaypee brother's medical publishers, New Delhi.

8. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother's medical publishers, New Delhi

**Reference Books (Latest Editions)**

1. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co, Riverview, MI USA
2. Text book of Medical Physiology- Arthur C, Guyton and John. E. Hall. Miamisburg, OH, U.S.A.
3. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterjee, Academic Publishers Kolkata.

**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

Relationship between the Course Outcome (COs) and Program Outcome (POs).

**CO-PO Relationship Matrix**

Indicate the relationships by1- Slight (low) 2- Moderate (Medium) 3-Substantial (high)

| Program Outcomes / Course Outcomes | PO 1 | PO2 | PO 3 | PO 4 | PO 5 | PO6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PSO 1 | PSO 2 | PSO 3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | - |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | - |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | - |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | - |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **3** | - |

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

**Practical:**

1. Microscopic study of epithelial and connective tissue.
2. Microscopic study of muscular and nervous tissue.
3. Identification of axial bones
4. Identification of appendicular bones.
5. Introduction to hemocytometry.
6. Enumeration of white blood cell (WBC) count.
7. Enumeration of total red blood corpuscles (RBC) count.
8. Determination of bleeding time.
9. Determination of clotting time.
10. Estimation of hemoglobin content.
11. Determination of blood group.
12. Determination of erythrocyte sedimentation rate (ESR).
13. Determination of heart rate and pulse rate.
14. Recording of blood pressure.

**Recommended Books (Latest Editions)**


1. Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee Brothers medical publishers, New Delhi.
2. Anatomy and Physiology in Health and Illness by Kathleen J.W. Wilson, Churchill Livingstone, New York.
3. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co,Riverview,MI USA
4. Text book of Medical Physiology- Arthur C, Guyton and John.E. Hall. Miamisburg, OH, U.S.A.
5. Principles of Anatomy and Physiology by Tortora Grabowski. Palmetto, GA, U.S.A.
6. Textbook of Human Histology by Inderbir Singh, Jaypee brothers medical publishers, New Delhi.
7. Textbook of Practical Physiology by C.L. Ghai, Jaypee brothers medical publishers, New Delhi.
8. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother's medical publishers, New Delhi.

- **Reference Books:**


1. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co, Riverview, MI USA
2. Text book of Medical Physiology- Arthur C, Guyton and John. E. Hall. Miamisburg, OH, U.S.A.
3. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterrje, Academic Publishers Kolkata.
4. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother's medical publishers, New Delhi.


**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**
**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| CSEG1024 | Software System Foundation | L-T-P-C:1-1-1-3 |
|---|---|---|

**Course Objectives**

Familiarize students with computing and programming, focusing on high-level programming languages. Emphasis on programming skills using Python as well as data acquisition.

**Course Outcomes**

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

CO1: Describe the different components of computer system and types of software.

CO2: Express the basic concepts, the general problems and methods related to syntax and semantics of programming language.

CO3: Apply the knowledge of programming constructs to analyze the data acquire data from datasets.

**Syllabus**

**Unit I: Introduction to computer: 6 hours**

Introduction, Characteristics of computer, Evolution of Computers-Computer Generations, Classification of Computers, Basic Computer Organization, Number system. Computer Software: Types of Software, System software, Application software-Software Development Steps

**Unit II: Problem Solving and Office Automation: 6 hours**

Planning the Computer Program, Purpose, Algorithm, Flowcharts, Pseudo code, Introduction to Office Packages: MS Word, Spread Sheet, Power Point, MS Access, Outlook.

**Unit III: Programming language constructs 6 hours**

Constant, variable, keyword, data types, operators, expression, conditional statements, iterative statements, break, continue, goto, functions, array, structure, characteristic of functional and object oriented programming approach, classes, object, inheritance, polymorphism

**Unit IV: Introduction to Python** **6 hours**

Introduction, A Brief History of Python, Python Versions, Installing Python, Environment Variables, Executing Python from the Command Line, IDLE, Editing Python Files, Python Documentation, Getting Help, Dynamic Types, Python Reserved Words, Naming Conventions, Basic Syntax, Comments, String Values, String Methods, The format Method, String Operators, Numeric Data Types, Conversion Functions, Simple Output, Simple Input, The % Method, The print Function, Indenting Requirements, the if Statement, Relational and Logical Operators, Bit Wise Operators, the while Loop, break and continue, the for Loop.

**Unit V: Python specific data structure** **6 hours**

Introduction to Lists, Tuples, Sets, Dictionaries, Functions: Defining Your Own Functions, Parameters, Function Documentation, Keyword and Optional Parameters, Passing Collections to a Function.

**Unit VI: Numerical Analysis & Plotting** **6 hours**

Numpy – Overview, Setup, Datatypes, Basic Operators, Indexing, Broadcasting, Matrix Operators. Matplotlib-Overview, Setup, Basic plots, Customizing plots, Subplots, 3D plots. Data Processing with Pandas. Pandas – Overview, Setup, Data Structures, Indexing & Selecting Data, groupby Operations, Reshaping data.

**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Reference Books**


1. Pradeep K.Sinha, Priti Sinha “Foundations of Computing”, BPB Publications (2013)
2. Yashavant P. Kanetkar, “Let us C”,13th Edition,BPB Publications(2013).
3. Object-Oriented Programming with C++ | 7th Edition, by E Balagurusamy, TMH
4. Learning Python 5ed: Powerful Object-Oriented Programming Paperback – 12 July 2013 by Mark Lutz


**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| PO/CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | 2 | 2 | 1 | - | - | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - | - |
| CO3 | 1 | - | - | 2 | 1 | - | - | - | - | - | - | - | - | - | - |
| Average | 1 | 2 | 2 | 1 | 1 | | | | | | | 1 | 1 | - | - |

1. Weak Mapped 2. Moderate Mapped 3. Strong Mapped

## SEMESTER II

| MATH 1038 | Mathematics -II | L-T-P-C:1-1-0-2 |
|---|---|---|

**COURSE OBJECTIVES**

The objective of this course is to familiarize the prospective engineers with techniques in multivariate integration, ordinary and partial differential equations and complex variables. It aims to equip the students to deal with advanced level of mathematics and applications that would be essential for their disciplines.

**Course outcomes:**

The students will be able to:

CO1. Understand the mathematical tools needed in evaluating multiple integrals and their usage.

CO2. Analyze the effective mathematical tools for the solutions of differential equations that model physical processes.

CO3. Apply the tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

**Syllabus**

**Unit I:** **6 hours**

Multivariable Calculus (Integration) Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.

**Unit II:** **4 hours**

First order ordinary differential equations Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

**Unit III:** **6 hours**

Ordinary differential equations of higher orders Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.

**Unit IV:** **6 hours**

Complex Variable – Differentiation Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary

analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.

**Unit V:** **8 hours**

Complex Variable – Integration Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.

**Modes of Evaluation: Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**TEXT BOOKS/REFERENCES:**

1. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2018.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
3. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.

4. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
5. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
6. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
7. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., McGraw Hill, 2004.
9. N.P. Bali and Manish Goyal, A textbook of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
10. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | | | 1 | | 3 | | 2 | | 2 | 1 | | - |
| CO 2 | 3 | 3 | | | 2 | | 1 | | | | 2 | | 1 | - |
| CO 3 | 2 | 3 | | | 1 | | 1 | | | 3 | | 1 | 1 | - |
| Average | 2 | 3 | | | 1 | | 2 | | 1 | 2 | 2 | 1 | 1 | - |

1= Weakly Mapped, 2 = Moderately Mapped, 3 = Strongly Mapped

| ECEG 1005 | Basic Electrical and Electronics Engineering | L-T-P-C:2-0-0-2 |
|---|---|---|

**Course Objectives:**

The course objectives for Basic Electrical and Electronics Engineering aim to provide students with a fundamental understanding of electrical and electronics principles and their applications in biomedical engineering.

**Course Outcomes:**

The students will learn to:

CO 1. Employ electronic and electrical components and devices to solve the Engineering problems.

CO 2. Analyze and make simple circuits and Systems of Electrical and Electronics Engineering, Interpret the logics used in the Circuits and Systems.

CO 3. Design the electrical system with discrete components and to understand the specifications of industrial equipments.

CO4. Design the electronics system with discrete components and to understand the specifications of industrial equipments.

**Syllabus**

**UNIT-I : Diode & Applications** **5 hours**

Fundamental Characteristics of diode: Formation of P-N junction, I-V characteristics, half-wave rectifier circuits full-wave rectifier circuits Zener and Avalanche breakdown, diode applications in voltage regulation, clipper and clamper.

**UNIT II: Network Theory** **5 hours**

Resistance, inductance and capacitance, open circuit and short circuit,
electrical power and energy; Voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with DC excitation. Superposition Thevenin

and Maximum Power Transfer theorem. Switch Fuse Unit (SFU), MCB, ELCB, MCCB; Types of Wires and Cables, Earthing; Elementary calculations for energy consumption, and battery backup.

**UNIT-III: Transistor** **5 hours**

Construction and operation, (BJT) Transistor amplifying action, Amplification factors; Limits of operation. Applications of transistor, DC-Biasing: Fixed bias DC-Biasing: Emitter bias, Voltage divider bias

**UNIT IV : AC CIRCUITS** **5 hours**

Representation of sinusoidal waveforms, peak and RMS values, phasor representation.

Elementary analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RL combinations. Real power, reactive power, apparent power, power factor. Resonance Three-phase balanced circuits, voltage and current relations in star and delta connections.

**UNIT V: BOLLEAN ALGEBRA** **5 hours**

Number system and codes Minimization techniques: Boolean logic operations, Basic laws of Boolean algebra De Morgan's Theorems; Logic gates: AND, OR, NAND, NOR. Adder subtractor

**UNIT VI: TRANSFORMER AND ELECTRICAL MACHINES** **5 hours**

Construction, Working Principle and Classification; Ideal and practical transformer, losses in transformers & efficiency; Classification of motors (AC), Classification of motors (DC), characteristics & applications of DC Motors

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| Text Books | Web resources | Journals | Reference books |
|---|---|---|---|
| 1. Electronics Devices and Circuits By Boylestad & Nashelsky 10th ED : PEARSON<br>2. Principle of Electronics by V.K. Mehta & Rohit Mehta 2018, S. Chand<br>3. Basic Electrical Engineering, V.K. Mehta, 2018, S. Chand. | 1. NPTEL Lectures –will be available - 10.2.1.33 (intranet) | NA | 1. Basic Electronics By Santiram Kal, 2013: PHI<br>**2.** Digital Circuits & Logic Design By Salivahanan: Vikas Publishing House. |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | - |
| **CO 2** | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | - |
| **CO 3** | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | - |
| **CO 4** | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | - |
| **Average** | **2** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | - |
| | | | | | | | | | | | | | | | |

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| MECH 1005 | Engineering Graphics | L-T-P-C:1-0-1-2 |
|---|---|---|

**COURSE OBJECTIVES**

To construct any structure or machine correctly and methodically, one must record his idea before starting construction work. These recorded ideas become more vivid and forceful if they are shown on a paper in the form of drawing of the structure or machine. Such a drawing will be very great help to the man who looks after the construction of this structure or machine.

- **COURSE OUTCOMES**

The students will learn to:

CO1. Apply knowledge of engineering data in form of drawing

CO2. Understand different lines and their importance.

CO3. Design projects

CO4. Apply knowledge in sheet metal industry

**Syllabus**

**UNIT I- Drawing Techniques and Scales: 4 hours**

Various type of lines, principal of dimensioning, size and location as per IS code of practice (SP-46) for general Engg. Drawing. Practice of drawing, various types of lines and dimensioning exercises. Drawing exercises pertaining to symbols. Conventions and Exercise of lettering techniques. Free hand printing of letters and numerals in 3, 5, 8 and 12 mm sizes, vertical and inclined at 75 degree. Instrumental lettering in single stroke. Linear scale, Diagonal scale &Vernier scale. Projection of point, line and plane

**UNIT-II: Projections of Solids: 4 hours**

Right regular solids of revolution and polyhedrons etc. and their auxiliary views. Sectioning of Solids, Principal of sanctioning, Types of sanctioning and their practice on projection of solids, Sectioning by auxiliary planes.

**UNIT-III: Development of Surfaces:** **4 hours**

Development of surfaces of cylinders, cones, pyramid, prism etc. Exercises involving development of unique surfaces like Y-piece, hopper, tray, truncated pieces etc.

**Intersection of Surfaces:** Intersection of cylinders, cones and prisms with their axes being vertical, horizontal or inclines. Exercise on intersection of solids-cylinder and cylinder, cylinder and cone, prism and prism.

**Unit-IV: Isometric Projection:** **3 hours**

Concept of isometric views: isometric scale and exercise on isometric views.

**Practice of Orthographic projections. Simple Trusses:** Graphical Method.

**Modes of Evaluation:**
**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**
**Examination Scheme:**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Reference Book:**


1. A Text book of Engineering Drawing by P. S. Gill. S. K. Kataria and sons publications
2. A Text book of Engineering Drawing by R.K Dhawan, S. Chand & company Pvt. Ltd.
3. A Text book of Engineering Drawing by Harvindersingh, Luxmi publications


| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PSO1** | **PSO2** | **PSO3** | **PSO4** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | 1 | 2 | | | 1 | | 1 | | 2 | - | |
| **CO 2** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - | |
| **CO 3** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - | |
| **CO 4** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - | |
| **Average** | **3** | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **1** | **0** | **1** | **0** | **2** | - | |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| MEPD 1003 | Workshop practices | L-T-P-C:1-0-1-2 |
|---|---|---|

**COURSE OBJECTIVES:** The objective of this subject is to make students familiar with basic engineering practices in a workshop. This will help in equipment, handling, repair and save wastage of time.

**COURSE OUTCOMES**

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

CO1. Understand the know how casting and welding is carried out.
CO2. Understand how metal work is carried out and fitting of different parts in an equipment.
CO3. Use of carpentry in biomedical.
CO4. Apply hot working and cold working
CO5. Application of rolling and forging, drawing and extrusion.

**Syllabus**

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
2. CNC machining, Additive manufacturing.
3. Fitting operations & power tools.
4. Electrical & Electronics.
5. Carpentry.
6. Plastic moulding, glass cutting.
7. Metal casting.
8. Welding (arc welding & gas welding), brazing.

**Practical:**

Experiment 1. Casting
Experiment 2. Welding, non-traditional Machining
Experiment 3. Metal working
Experiment 4. Fitting
Experiment 5. Carpentry
Experiment 6. Additive
Experiment 7. Hot working cold working
Experiment 8. Rolling
Experiment 9. Forging, drawing, extrusion

**Mode of Exam Evaluation Process Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 1 | | | 1 | 0.5 | 3 | | 2 | | 2 | 1 | | | - |
| CO 2 | 1 | 2 | 2 | | | | 1 | | | | 2 | | 1 | | - |
| CO 3 | 2 | 3 | | 2 | 1 | 2 | 1 | | | 3 | | 1 | 1 | | - |
| CO 4 | 1 | 1 | 2 | | 2 | | 1 | | 0.5 | | 3 | | 1 | | - |
| CO 5 | | 2 | 1 | 0.5 | 1 | | 1.5 | 2.5 | | 2 | | 0.5 | | | - |
| Average | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Textbooks/References:**

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.

2. Kalpakjian S. And Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition, Pearson Education India Edition, 2002.

3. Gowri P. Hariharan and A. Suresh Babu," Manufacturing Technology – I" Pearson Education, 2008.

4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998. 5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGraw Hill House, 2017.

| MECH 1006 | Engineering Thermodynamics | L-T-P-C:2-1-0-3 |
|---|---|---|

**COURSE OBJECTIVES**

The objective of this subject is to understand fundamental concept of thermodynamic principles and their applications in engineering.

**COURSE OUTCOME**

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

CO1 Understand the basic concepts of engineering thermodynamics and the practical application of thermodynamic laws.

CO2 Illustrate the implementation of 1st law of thermodynamics for different flow processes and apply the basic concepts of heat engine, heat pump and refrigerator used in engineering field.

CO3 Use basic concepts of thermodynamics in problem solving.

CO4 Evaluate the ideal thermodynamic air standard cycles and mathematical relationships between different thermodynamic properties.

CO5 Construct the various thermodynamic models using various properties.

**Course Content**

- **UNIT- I: Basic Concepts: 12 hours**

Macroscopic and microscopic approaches, thermodynamic systems, surrounding and boundary, thermodynamic property – intensive and extensive, thermodynamic equilibrium, state, path, process and cycle, quasi-static, reversible and irreversible processes, working substance; Concept of thermodynamic: work and heat, equality of temperature, zeroth law of thermodynamic and its utility, problems; First Law of thermodynamics: energy and its forms, energy and 1st law of thermodynamics, internal energy and enthalpy, PMMFK, steady flow RBT Level energy equation, 1st law applied to non- flow process, steady flow process and transient flow process, throttling process and free expansion process, problems.

**UNIT-II Second law of thermodynamics: 12 hours**

limitations of first law, thermal reservoir, heat source and heat sink, heat engine, refrigerator and heat pump, kelvin- planck and clausius statements and their equivalence, PMMSK, Carnot cycle, Carnot heat engine and Carnot heat pump, Carnot theorem and its corollaries; Thermodynamic temperature scale; Entropy, Clausius inequality, principle of entropy increase, temperature entropy plot,

entropy change in different processes, problems; Introduction to third Law of thermodynamics. availability and irreversibility: high- and low-grade energy, availability and unavailable energy, loss of available energy due to heat transfer through a finite temperature difference, dead state of a system, availability of a non-flow or closed system, availability of a steady flow system, Helmholtz and Gibb's Functions, effectiveness and irreversibility, second law efficiencies of processes & cycles, problems.

**UNIT-III Pure Substance** **11 hours**

Pure substance and its properties, phase and phase transformation, vaporization, evaporation and boiling, saturated and superheat steam, solid – liquid – vapour equilibrium, T-V, P-V and P-T plots during steam formation, properties of dry, wet and superheated steam, property changes during steam processes, temperature – entropy (T-S) and enthalpy – entropy (H-S) diagrams, throttling and measurement of dryness fraction of steam, problems.

**UNIT-IV Ideal and Real Gases** **10 hours**

Concept of an ideal gas, basic gas laws, characteristic gas equation, Avogadro's law and universal gas constant, P-V-T surface of an ideal gas; Vander Waal's equation of state, reduced co-ordinates, compressibility factor and law of corresponding states; Mixture of gases, mass, mole and volume fraction, Gibson Dalton's law, gas constant and specific heats, entropy for a mixture of non-reactive gases, problems; Thermodynamic relations: Maxwell relations, Clapyron equation, relations for changes in enthalpy and internal energy & entropy, specific heat capacity relations, Joule Thomson coefficient & inversion curve.

## Mode of Exam Evaluation Process

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Reference Books:**

1. Jones & Dugan (1995) Engineering Thermodynamics, Prentice Hall of India.

2. Radhakrishnan E. (2006) Fundamentals of Engineering Thermodynamics, 2 nd edition, Prentice Hall of India.

3. Rao Y. V. C. (1994) Theory and Problems of Thermodynamics, Wiley Eastern Ltd.

4. Arora C. P. (2001) Thermodynamics, Tata McGraw Hill. 5. Nag P. K. (2005) Engineering Thermodynamics, Tata McGraw Hill.

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 1 | | 2 | 2 | | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 3 |
| **CO 2** | 3 | 3 | 2 | 1 | | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | | 3 | 1 | 1 | 2 | 2 | | 2 | 1 | 1 | 3 | 3 |
| **CO 4** | 2 | 1 | 1 | 1 | 1 | 2 | | | 2 | 1 | | 3 | 1 | 1 | 3 | 2 |
| **CO 5** | 2 | 2 | 2 | 1 | | 1 | | | 2 | 2 | | 3 | 1 | 1 | 3 | 2 |
| **Average** | **3** | **2** | **2** | **1** | **1** | **2** | **1** | **1** | **2** | **2** | **1** | **3** | **1** | **1** | **3** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| HSBE 1003/HSBE1013 | Data Structures in Biomedical Engineering | L-T-P-C:1-0-1-2 |
|---|---|---|

**Course Objectives**

To make students aware about the importance of data structures in representation and retrieval of data in bio medical engineering with their implementation using Python programming language.

**Course Outcomes**

On completion of this course, the students will be able to:

CO1. Understand Python syntax and semantics and apply Python flow control and functions.
CO2. Understand concepts of various data structures and their applications.
CO3. Apply appropriate data structure among various data structures available in Python.
CO4. Design solution with an understanding of data representation.

**Syllabus**

**Unit-I**: **Introduction to Python** **5 hours**

Basic Python syntax: Input/output statements, Comments, format Method, escape sequence characters, Numeric data types, Naming Conventions, Operators (Arithmetic, relational, logical, assignment, bitwise, membership, identity), type function and id function.

Control Flow: Indentation, Decision Making Statements (if, if else, elif, nested if), range function, looping structures (while loop, for loop), (break, continue & pass statements), else in loops, nested loops

Functions: Defining user defined function, Parameters, Keyword and Optional Parameters, default argument, Variable length Arguments, Scope, Recursion.

**UNIT-II**: **Collections** **4 hours**

Data Structures: Definition, Linear Data Structures, Non-Linear Data Structures Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing

**UNIT-III**: **Arrays, Stack & Queues** **3 hours**

Arrays: Overview, Types of Arrays, Operations on Arrays, Arrays vs List.

Stack: Overview of Stack, Implementation of Stack, Applications of Stack

Queues: Overview of Queue, Implementation of Queue, Applications of Queues, Priority Queues.

**UNIT-IV**: **Data Analysis and Visualization** **3 hours**

Numpy: Overview, numpy Ndarray, Datatypes, Array creation, numpy attributes, numpy operations, Numpy Functions.

Pandas: Overview, Pandas Data Structures: Series and Data Frame, Importing/Exporting Data between CSV files and Data Frames, Operations on a series, Operation on Data Frame.

**Textbook**

1. Joseph Joyner, Python Programming for Beginners: Python Programming Language Tutorial.
2. Data structures and algorithms in python by Michael T. Goodrich

**References**

1. Hands-On Data Structures and Algorithms with Python: Write complex and powerful code using the latest features of Python 3.7, 2nd Edition by Dr. Basant Agarwal, Benjamin Baka.
2. Problem Solving with Algorithms and Data Structures Using Python by Bradley N Miller and David L. Ranum.
3. Core Python Programming -Second Edition,R. Nageswara Rao, Dreamtech Press

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | | | | 1 | 2 | | | 1 | | 1 | | 2 | - |
| **CO 2** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - |
| **CO 3** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - |
| **CO 4** | 3 | | | | 1 | | | | 1 | | 1 | | 2 | - |
| **Average** | **3** | **0** | **0** | **0** | **1** | **1** | **0** | **0** | **1** | **0** | **1** | **0** | **2** | - |
| | | | | | | | | | | | | | | |

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| S.no | Lab Exercise | Contents |
|---|---|---|
| 1. | Lab. Exercise 1 | Introduction, Installing Python, Executing Python from the Command Line, IDLE, Interactive mode and Scripting mode, Getting Help, Dynamic Types, Mutable and immutable data types |
| 2. | Lab. Exercise 2 | Python Tokens (Keyword, identifier, special symbols, literals, constants, operators), Input statements, operators, |
| 3. | Lab. Exercise 3 | Conditional Statements: if, elif and nested if statements<br>Loops: for and while, nested loops |
| 4. | Lab. Exercise 4 | Functions: Function Documentation, Scope, Passing Collections to a Function, Passing Functions to a Function, map, filter, Lambda function, Inner Functions, Passing mutable and immutable datatypes in functions |
| 5. | Lab. Exercise 5 | String and Lists |
| 6. | Lab. Exercise 6 | Dictionary, Tuple |
| 7. | Lab. Exercise 7 | Array, Stack implementation and its Application |
| 8. | Lab. Exercise 8 | Queue Implementation and its Application |
| 9. | Lab. Exercise 9 | Numpy Functions (String, mathematical, statistical, sorting and searching), Numpy Special functions (reshape(), sum(), random(), zeros(), mean(), dot(), std(), empty(), arange(), numpy.linspace()) |
| 10 | Lab Exercise 10 | Pandas Data Structures: Operations on a Series (head, tail, vector operations), Data Frame operations( create, display, iteration, select column, add column, delete column), Binary operations in a Data Frame (add, sub, mul, div), Importing/Exporting Data between CSV files and Data Frames |
| 11 | Lab Exercise 11 | Matplotlib: Introduction, Matplotlib Pyplot, Plotting, markers, Line, Labels, Grid, Customizing plots, Creating Different Types of Plots (Line Graph, Bar chart, Histograms, Scatter Plot, Pie Chart), Creating Subplots |

| HSBE1001/HSBE1011 | Introduction to Biomedical Engineering | L-T-P-C:1-1-1-3 |
|---|---|---|

**Course Objectives:**

The aim of this course is to provide students with a comprehensive understanding of the field of biomedical engineering. It will develop a solid foundation to understand biomedical devices, technologies, and aware of ethical considerations in healthcare and medical technologies.

**Course Outcomes:**

The student will be able to:

CO1. Understand the overview of biomedical engineering.
CO2. Interpret the principles of various diagnostic devices and techniques in diagnostic imaging.
CO3. Identify the various techniques used in biomedical: Nucleic acid (DNA/RNA) detection technique, cell and protein engineering.
CO4. Apply the ethical practices in health care.

**Syllabus**

**Unit I: Introduction: 5 hours**

Historical Perspective-Evolution of modern healthcare system-Role of Biomedical engineers in various n domain -Professional status of biomedical engineering-General constraints in design of medical instrumentation systems.

**Unit II: Fundamentals of Medical Instrumentation (Diagnostic Imaging) 10 hours**

Anatomy and Physiology – Sources of biomedical signals- basic medical instrumentation system-General block of medical instrumentation system. X-rays, Nuclear Medical Imaging-Positron Emission Tomography-Magnetic Resonance Imaging Scanners-Diagnostic Ultrasound- Thermal imaging systems. ECG – EEG - Cardiac Pacemakers - Cardiac Defibrillators – Haemodialysis Machines-Artificial KidneyDialyzers- Ventilators-Humidifiers, Anaesthesia Machine.

**Unit III: Nucleic acid (RNA/DNA) detection technique, Cell & Protein Engineering 10 hours**

DNA/RNA structure, RNA aptamer, Selecting desired aptamer from random library (plasmid DNA), SELEX tool, PCR, Aptamer binding assay, DNA/RNA sensing, gene analysis. 2D cell culture, 3D cell culture, Role of 3D printing in biomedical engineering, organ on a chip. Protein engineering and protein expression.

**Unit IV: Ethical Practices in Health Care** **5 hours**

Medical standards and regulations – Institutional Review Boards – Good Laboratory Practices -Good Manufacturing Practices -Human factors.

Morality and Ethics-A Definition of terms, Human Experimentation-Ethical issues in feasibility studies, Ethical issues in emergency use, Ethical issues in treatment use-Codes of ethics for bio engineers.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Textbooks:**


1. Enderle, John D, Bronzino, Joseph D, Blanchard, Susan M- Introduction to Biomedical Engineering-ElsevierInc 2nd edition,2005.
2. R. S. Khandpur, Handbook of Biomedical Instrumentation, McGraw-Hill Publishing Company Limited, 2nd edition,2003.

**Reference Books:**


1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurement, Prentice Hall of India, New Delhi,2nd edition, 2002.
2. John G Webster, Medical Instrumentation: Application and Design, John Wiley and sons, New York,4th edition,2010. Daniel A Vallero, Biomedical ethics for Engineers, Elsevier publication, 1st edition, 2007
3. Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley & Sons, New York,4th edition, 2008.
4. Norbert Leitgeb "Safety of Electro-medical Devices -Risks Opportunities" Springer/Wein, 2010.


**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| PO/CO | PO1 | PO2 | PO3 | PO4 | PO 5 | PO 6 | PO7 | PO8 | PO9 | PO10 | PSO1 | PSO2 | PSO3 | PS O4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 3 | 2 | 2 | 1 | | 1 | 3 | | | | 3 | | - |
| CO2 | 3 | 3 | 2 | 2 | 2 | | 2 | 2 | | | | 1 | | - |
| CO3 | 2 | 3 | 2 | 2 | 1 | | 2 | 3 | | | | | | - |
| CO4 | 1 | 1 | 2 | 1 | 2 | | 3 | 2 | | | 1 | 2 | | - |
| Averag e | 2 | 3 | 2 | 2 | 2 | | 2 | 2 | | | 1 | 2 | | - |
| | | | | | | | | | | | | | | |

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Practical:**

1. Power isolation: isolation transformer and DC-DC converters
2. Timer circuits: ON delay and OFF delay study
3. Measurement of heart rate using F-V converter
4. ECG, EMG and EEG processing and analysis
5. Detection of QRS component from ECG signals
6. Study on Instrumentation Amplifier-Design
7. Amplify aptamer containing DNA
8. Purify aptamer (agarose, silica column)
9. Prepare RNA by IVT
10. Purify RNA and run affinity column
11. RNA to DNA by RT PCR
12. Aptamer binding assay

13. Characterization of biopotential amplifier for ECG & EMG signals

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 1 | | 2 | 2 | | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 3 |
| **CO 2** | 3 | 3 | 2 | 1 | | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | | 3 | 1 | 1 | 2 | 2 | | 2 | 1 | 1 | 3 | 3 |
| **CO 4** | 2 | 1 | 1 | 1 | 1 | 2 | | | 2 | 1 | | 3 | 1 | 1 | 3 | 2 |
| **CO 5** | 2 | 2 | 2 | 1 | | 1 | | | 2 | 2 | | 3 | 1 | 1 | 3 | 2 |
| CO6 | - | 1 | 1 | - | - | | | | | | | | 1 | 1 | 1 | |
| **Average** | **2** | **2** | **2** | **1** | **1** | **2** | **1** | **1** | **2** | **2** | **1** | **3** | **1** | **1** | **3** | **2** |

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| BP101T | Biomechanics | L-T-P-C:2-0-0-2 |
|---|---|---|

**COURSE OBJECTIVES**

This course introduces the principles of biomechanics and their application to biomedical engineering. It explores the mechanics of biological systems, emphasizing the analysis and modeling of human movement and the interaction of biological tissues.

**Course Outcome:**

By the end of the course, students should be able to:

CO1. Understand the fundamental concepts and basic principles of biomechanics.

CO2. Demonstrate engineering mechanics principles to analyze and model human movement.

CO 3. Evaluate the mechanical properties of biological tissues, bones and their response to external forces.

CO4. Applying biomechanics in physical therapy and exercise.

**Syllabus**

**Unit I: Introduction to Biomechanics** **5 hours**

Definition and scope of biomechanics, Historical overview and its relevance to biomedical engineering, Basic terminology, and units in biomechanics.

**Unit II: Kinematics of Human Movement:** **5 hours**

Position, velocity, and acceleration analysis, Joint motion analysis and degrees of freedom, Introduction to motion capture techniques, Newton's laws and their application to human motion, Forces, moments, and equilibrium, Analysis of ground reaction forces

**Unit III: Tissue Mechanics** **2 hours**

Mechanical properties of biological tissues (muscles, bones, tendons, ligaments), Stress and strain analysis, Viscoelasticity, and time-dependent behavior, Biomechanics of Soft Tissues.

**Unit IV: Biomechanics of Bone & joints**: **3 hours**

Bone structure and composition, Bone biomechanics and remodeling, Fracture mechanics and bone healing, Analysis of joint forces and torques, Biomechanics of selected joints (e.g., knee, hip, shoulder), Biomechanics of physical therapy, sports, and rehabilitation exercises.

**Essential Reading**

1. Nihat Ozkaya, Fundamentals of biomechanics: Equilibrium, Motion and deformation, 2nd Edi. Springer 1999

2. Y.C Fung, Biomechanics – Mechanical Properties of Living Tissues, 2nd Edi. Springer 1999

**Supplementary Reading**

1. Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, Taylor and Francis, 2007

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

Relationship between the Course Outcome (COs) and Program Outcome (POs)

**Co-Relationship Matrix**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | - |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | - |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | - |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | - |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | - |
| | | | | | | | | | | | | | | | |

Indicate the relationships by1- Slight (low) 2- Moderate (Medium) 3-Substantial (high)

1 = weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## SEMESTER III

| HSBT 1002/HSBT1102(LAB) | Molecular Biology and genetics | L-T-P-C:2-1-1-4 |
|---|---|---|

**COURSE OBJECTIVES**

Developing an understating of how molecular machines are constructed and regulated so that they can accurately copy, repair, and interpret genomic information in prokaryotics and eukaryotic cells.

**COURSE OUTCOMES**

By the end of the course, students should be able to

CO1. Understand the knowledge of DNA structure, organization, replication of DNA in prokaryotes and topoisomerases.

CO2. Understand the concept of transcription and post-transcriptional processing in prokaryotes.

CO3. Gain knowledge of translation, gene regulation in prokaryotes.

CO4. Apply the knowledge of recombinant DNA technology and enzymes, modules.

CO5. Apply of rDT to create new GMO, plants and animals.

**Syllabus**

**Unit I:** **10 hours**

DNA stores genetic Information: Classical experiments from Meischer to Watson (Griffith, McCarty-Avery and McCleod, Hershey and Chase), Types/ Forms of and the unusual structures they adopt (palindromes, mirror repeats, hairpins and cruciform), RNA as a genetic material (structure, monocistronic Vs Polycistronic), DNA Supercoiling (Chromosomal elements: Introns, Exons, SSRs, Satellite DNA, Transposons, Centromere and Telomeres), DNA topology-linking number, topoisomerases; Compaction of DNA: Plectonemic & Solenoidal forms, Structure of Chromosomes: Histones, Nucleosomes and their packaging into successively Higher Order Structures (30nm fibers, loops, rosettes, coil and chromatids), SMC proteins: cohesins and condensins

**Unit II:** **10 hours**

DNA Replication and its fundamentals: Semi-conservative nature, Origin and Directionality of the replication fork, Semi-discontinuous mode of replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication – Nucleases, DNA polymerases Type I to V (Discovery of DNA Pol I and Structure of DNA Pol III), Requisites of replication: Template and primers, Fidelity of DNA

replication: Polymerization rate, Processivity, and Proof-reading, Klenow fragment, helicases, topoisomerases, SSBs, ligases, primase, etc. Initiation of Replication: Origin and Origin recognizing complex in prokaryotes (DNAa, b, c proteins, and Dam methylase) Elongation: Synthesis of Leading and Lagging Strands (Okazaki fragments) Termination: Tus-Ter complex and formation of catenanes, Homology in terms of enzymes, complexes and proteins involved in Eukaryotic replication to that of Prokaryotic replication: ARS, ORC (CDC6, CDT1, MCM2-7), DNA Pol α, δ, ε, RPA and RFC

**Unit III:** **10 hours**

Transcription and Post- Transcriptional processing: Transcription: Definition, difference from replication, DNA dependent RNA Polymerase, Promoter sequences, Events of Transcription (Initiation, Elongation and Termination- rho dependent and independent), Transcription in Eukaryotes: Different classes of nuclear RNA polymerases, general Transcription factors and their assembly, concept of introns and exons, RNA splicing, Group I to IV intron splicing, spliceosome machinery, Polyadenylation and capping of mRNA transcripts

**UNIT-IV:** **5 hours**

Translation: Translational machinery, Charging of tRNA, aminoacyltRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes

**UNIT-V:** **5 hours**

Introduction to Genetics: Mendelian Genetics, Extensions of Mendelian Genetics, Sex Determination and Sex Chromosomes, Nature of heritable changes: Chromosome Mutations: Variation in Number and Arrangement, Extra-nuclear Inheritance. DNA Repair and Transposable elements.

**Unit VI:** **5 hours**

Epigenetics: Epigenetic alterations to genome: DNA methylation, Histone modification, MicroRNAs and Long Noncoding RNAs, Epigenetics in Imprinting and cancer, Dosage compensation. Emerging roles of RNA: sirNAs and rNA Interference, mirNAs and posttranscriptional Gene Expression, pirNAs and Transposons, rNA-Induced Transcriptional silencing, lncrNAs and Transcriptional repression

**Practical:**

1. PCI method of genomic DNA isolation and Quantification
2. Isolation of the plasmid from bacterial culture (alkali lysis methods)
3. Isolation of RNA and their Quantification
4. Synthesis of c-DNA using RNA template.
5. Primer design and preparation of working stocks for primers
6. PCR using gene specific primers
7. Agarose Gel electrophoresis of the PCR products
8. Protein Isolation
9. Estimation of the Protein concentration using Bradford
10. SDS-PAGE electrophoresis
11. Interpreting Pedigree Analysis (Sex linked and autosomal inheritance)
12. Chi Square analysis tests (performed on case studies)
13. Hands on experience on Drosophila genetics

**Text Books/References:**


1. Agranoff BW, Albers RW, et al., editors. Philadelphia: Lippincott-Raven; 1999.
2. Genetics Analysis and Principles., Robert J. Brooker
3. Concepts of Genetics., Klug and Cummings
4. Molecular Biology of the Cell. 4th edition. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002.
5. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000
6. Neuroscience. 2nd edition.Purves D, Augustine GJ, Fitzpatrick D, et al., editors. Sunderland (MA): Sinauer Associates; 2001.
7. Lewin's GENES XII by Jocelyn E. Krebs Elliott S. Goldstein and Stephen T. Kilpatrick.
8. The Biophysical Chemistry of Nucleic Acids and Proteins: Thomas E. Creighton; Helvetian Press; 2010.
9. Textbook on Molecular Genetics by D. N. Bharadwaj (2009); Kalyani Publisher

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 1 | | 2 | 2 | | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 3 |
| **CO 2** | 3 | 3 | 2 | 1 | | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | | 3 | 1 | 1 | 2 | 2 | | 2 | 1 | 1 | 3 | 3 |
| **CO 4** | 2 | 1 | 1 | 1 | 1 | 2 | | | 2 | 1 | | 3 | 1 | 1 | 3 | 2 |
| **CO 5** | 2 | 2 | 2 | 1 | | 1 | | | 2 | 2 | | 3 | 1 | 1 | 3 | 2 |
| **Average** | **3** | **2** | **2** | **1** | **1** | **2** | **1** | **1** | **2** | **2** | **1** | **3** | **2** | **1** | **3** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| HSMB 2018/HSMB 2118 (LAB) | Cell Biology | L-T-P-C:2-1-1-4 |
|---|---|---|

**Course objective(s):**

The purpose of this course is to provide an overview of cell structure and function at the molecular level, including the regulation of cellular processes, cell division, proliferation, cell signaling and transport of biomolecules in eukaryotic cells.

**Course Outcomes:**

On completion of this course, the students will be able to:

CO1. Understand the knowledge about different types of cell structure, function and implications of important cell organelles and other cellular components.

CO2. Understand the fundamental concepts of Cell division and regulation of Cell cycle.

CO3. In-depth understanding of Cell signaling mechanisms, transduction pathways; Types of signaling molecules and receptors, GPCR and role of second messengers, role of lipids and proteins in cell signaling and transduction pathway.

CO4. Utilize the fundamental facts about cellular processes such as intracellular transports of biomolecules, cellular growth and programmed cell death.

**Syllabus**

**Unit-I:** **10 hours**

Introduction to Cell Biology, Characteristics of Living cells, Evolution of cell, RNA world hypothesis, Origin of eukaryotic cells, Endosymbiotic hypothesis, Evolution of metabolism, Brief overview of prokaryotic cells and eukaryotic cells (animal and plant cells) and their cell organelles

.

**Unit-II:** **10 hours**

Ultra-structure and composition of Plasma membrane: Fluid mosaic model, Transport across membrane: Active and Passive transport, Facilitated transport, Cell junctions: Tight junctions, Gap junctions.

**Unit-III:** **10 hours**

Type, structure and functions of cytoskeleton, Accessory proteins of microfilament & microtubule, brief idea about molecular motors. Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Protein sorting and mechanisms of vesicular transport, Mitochondria: Structure, Semi-autonomous nature, Mitochondrial Respiratory Chain, Chemi- osmotic hypothesis, Structure and Functions of

Peroxisome, Ribosomes, Dictyosomes, Microbodies, Plastids, Chloroplast, Vacuoles; Structure of Nucleus: Nuclear envelope, nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome).

**Unit-IV:** **5 hours**

Cell cycle and its regulation, Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC, Mitosis and Meiosis: Basic process and their significance.

**Unit-V:** **10 hours**

Cell signaling transduction pathways; Types of signaling molecules and receptors, GPCR and Role of second messenger (cAMP), Role of lipids in cell signaling pathways, Cell-Cell interactions, Apoptosis and Necrosis. Protein Sorting: Organelle Biogenesis and Protein secretion, concepts of selective targeting to specific subcellular locations, concepts of membrane topology.

**Practical:**

1. Introduction to principles of sterile techniques and cell propagation
2. Identification of given plant, animal and bacterial cells and their components by microscopy
3. Grams staining for identification of bacterial cells.
4. Leishman Staining
5. Giemsa Staining
6. Separation of Peripheral Blood Mononuclear Cells from blood
7. Osmosis and Tonicity
8. Tryphan Blue Assay

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Text Books/References:**


1. Albert Bruce, Bray Dennis, Levis Julian ,Raff Martin, Roberts Keith and Watson James (2008).Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.

2. Cooper, G.M. and Hausman, R.E. (2009). The Cell: AMolecularApproach.5thEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

3. Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.

4. Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman.

5. Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.

6. Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman.

7. Pal, A. (2011). Textbook of Cell and Molecular Biology 3rd Edn, Bokks and Allied, Kolkata.

8. Plopper, G, D. Sharp, Siroski, E (2015) Lewin's Cell 3rdEdition—Johns & Bartlett Publishers.

9. Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.

10. Reed, J.C. and Green, D.R. (2011). Apoptosis: Physiology and Pathology. Cambridge Univ. Press.

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | - |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | - |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | - |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | - |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | - |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| HSMB 2019/HSMB 2104 (LAB) | Microbiology & Microbial Technology | L-T-P-C:2-1-1-4 |
|---|---|---|

**Course Objective(s):**

The course provides the students with a conceptual and experimental background in the broad discipline of microbiology. The students will be introduced to the major groups of microorganisms and their diversity in structure and functions and microbial interactions. Emphasis has been laid on bacterial growth, nutrition, control, metabolism, and genetics. To make the student aware of microbial culture selection for fermentation processes. media formulation, inoculum development and process optimization. The course also introduces the students to the scope and relevance of microbes in the field of medicine, agriculture, and industry.

**Course Outcomes:**

At the end of the course, students will be:

CO1. Aware of the conspicuous presence of microbes in the environment and their influence in our daily lives as part of the food, soil, air environment, and disease development.

CO2. Understand the immense diversity in the microbial world, their varied inter or intra-community interactions and contribution to the biotech industry.

CO3. Able to do microbial culture selection for fermentation processes, media formulation, inoculum development and process optimization.

CO4. Apply design and operation of fermenters, basic concepts for selection of a reactor, packed bed reactor, fluidized bed reactor, trickle bed reactor, bubble column reactor, scale up of bioreactor and immobilized enzyme technology.

**Syllabus**

**Unit I:** **10 hours**

Introduction to Microbiology (History and Scope- Role of Microbes in agriculture, public health, medicine and industry), Organization of Prokaryotic and Eukaryotic Cell Structure and Function. Diversity of the Microbial World- (Microbial Evolution, Taxonomy, Microbial Diversity), Viruses and their acellularity.

**Unit II:** **10 hours**

Fundamentals of fungi, algae and protist, Microbial Nutrition and Growth (Types of growth media, growth phases, culture methods), Fundamentals of microbial physiology and metabolism (Aerobic & anaerobic respiration, fermentation, Entner Duodruffs pathway, photosynthesis, nitrogen fixation). Regulation of gene expression (operon system), transformation conjugation and transduction)

**Unit III:** **10 hours**

Fundamentals of microbial ecology (Microbes from Marine, Freshwater and Terrestrial Environments), Microbial Interactions (Symbiotic, non-symbiotic)). Negative interactions : Pathogenic Microbes. Control of microbial growth – (Effect of heat, Sterilization, disinfectants, therapeutic agents, antimicrobial resistance). Application of sterilization methods in Food and Industrial Microbiology.

**Unit IV:** **10 hours**

Brief history and developments in industrial microbiology, Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates. Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations; Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

**Unit V:** **5 hours**

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase),Wine, beer. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

**Practical:**

1. Isolation of fungi from soil: Dilution plate method, Warcup method, stamping method.
2. Isolation of fungi from plant material: Epiphytic fungi, washing method, implant method, impression method; endophytic fungi.
3. Growth measurement of fungi- linear and biomass.
4. Effect of environmental (pH, temperature) and nutritional factors (carbon, nitrogen sources) on growth of fungi.
5. Isolation and identification of microscopic algae from soil and water.
6. Isolation and identification of protozoa from environmental samples.
7. Screening for antibiotic producing microbes (antibacterial, antifungal).
8. Fungal and Bacterial Fermentation
9. Anaerobic fermentation (wine)
10. Fermentation for the production of primary metabolites (Citric acid)

11. Fermentation for the production of secondary metabolites (antibiotics)
12. Solid state fermentation for production of enzymes 6. Shake flask fermentation.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

- **Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**References:**


1. Prescott's Microbiology by Willey, Sherwood and Woolverton.

2. Brock Biology of Microorganisms by Madigan, Martinko, Stahl and Clark.

3. General Microbiology by Stanier, Ingraham, Wheelis and Painter.

4. Microbiology, M. Pelczar, E. Chan, N. Kreig, 5th ed, MGH.

5. Biotechnology and Safety Assessment Thomas J.A., Fuch R.L Academic Press 3rd Edition 2002

6. Biological safety Principles and practices Fleming D.A., Hunt D. ASM Press 3rd. ed. 2000

7. Bioethics Ben Mepham Oxford University Press 2008

8. Stanbury P. F., A. Whitaker, S. J. Hall. Principles of Fermentation Technology Publisher: Butterworth-Heinemann

9. W. Crueger and A. Crueger: Biotechnology. A Textbook of Industrial Microbiology, Publisher: Sinauer Associates Gerald Reed.

10. Casida L. E. J. R: Industrial Microbiology by Publisher: New Age (1968).

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | - |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | - |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | - |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | - |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | - |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## SEMESTER IV

| Biophysics | L-T-P-C:2- |
|---|---|

**Course objective(s):**

The main objective of this course is to understand selected biological phenomena using physical principles. Students will understand how biology, chemistry and physics are interconnected in biophysical system.

**Course Outcomes:**

After studying this course, students will be able to:

CO1. Understand different intermolecular interactions, molecular excitation, energy transformation phenomena and thermodynamics basis of life.

CO2. Know the role of different weak interactions in structural organization within proteins and DNA molecules.

CO3. Gain knowledge about cell membrane and its topology, membrane transport, passive vs active transport, generation and propagation of action potential and biophysics of synapse.

CO4. Apply biophysical principles and techniques to understand denaturation and renaturation kinetics and interactions among macromolecules.

**Syllabus:**

**Unit 1: Introduction and history of biophysics: 7hrs**

Main features of quantum theory, elementary particles and their interactions, Van der waals interactions, electrostatic interactions, hydrogen bonds, ionic bond, covalent bonds, molecular excitation and energy transfer. Water as a solvent: unusual physical properties. Introduction to thermodynamics, thermodynamics probability, entropy, enthalpy, energy of activation, rate of reaction, enzyme substrate interactions and enzyme mechanism.

**Unit 2: Introduction to membrane biophysics: 8hrs**

Interfacial phenomena and membranes, surface and interfacial tensions, self-assembly of membranes, molecular structure of membranes, structure and properties of biological membranes, model membranes: liposomes, supported bilayers, lipid monolayers, transport of molecules across membranes, action potential and resting membrane potential, Electrophysiology, Patch clamp, biophysics of synapse.

**Unit 3: Forces and stereochemical factors responsible for molecular confirmation: 8hrs**

Defining confirmation of a macromolecules, complex array of biomolecular structures found in DNA and protein due to interactions, protein folding, Anfinsen's experiment, protein folding pathways, Levinthal’s paradox, intermediates and folding pathways,

energy landscape theory and folding funnel, molten globule, denaturation and renaturation kinetics, folding in-vivo by molecular chaperones.

**Unit 4: Method for investigating folding of proteins: 7hrs**

Fluorescence spectroscopy, methods for investing denaturation and renaturation kinetics: UV/Vis absorption spectroscopy, methods for macromolecular interactions: isothermal calorimetry

**Text Books:**


1. Biophysics - An Introduction by Rodney Cotterill 1st edition, 2012, ISBN:978-0471485384
2. Biophysics - An Introduction by Roland Glazer, 2nd edition, ISBN: 978-3642252112.
3. Biophysics by Vasantha Pattabhi and N. Gautham, 2nd edition, ISBN:1402002181
4. Biochemistry –by Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto 8th edition, ISBN: 978-1464126109
5. The physical Basis of Biochemistry- The foundation of Molecular Biophysics by Peter R. Bergethon, 2nd edition, ISBN 978-1-4419-6323-9.


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

Suggested readings:


6. Biophysics - An Introduction by Rodney Cotterill 1st edition, 2012, ISBN:978-0471485384
7. Biophysics - An Introduction by Roland Glazer, 2nd edition, ISBN: 978-3642252112.
8. Biophysics by Vasantha Pattabhi and N. Gautham, 2nd edition, ISBN:1402002181
9. Biochemistry –by Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto 8th edition, ISBN: 978-1464126109
10. The physical Basis of Biochemistry- The foundation of Molecular Biophysics by Peter R. Bergethon, 2nd edition, ISBN 978-1-4419-6323-9.


| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Bionics & Microprocessor | L-T-P-C:1-0-1-2 |
|---|---|

**Course Objectives**

The course objectives for Bionics & Microprocessor aim to provide students with a comprehensive understanding of bionics, microprocessors, and their applications in the field of biomedical engineering. It will provide basic knowledge and principles on design, fabrication, and control processes of bionics systems

.

**Course Outcomes**

After studying this course, students will be able to:

CO1. Understand the innovative bionic concepts by exploiting the knowledge acquired during the course.

CO2. Analyze and make simple circuits and Systems of Electrical and Electronics Engineering, Interpret the logics used in the Circuits and Systems.

CO3. Comprehend the knowledge necessary to solve typical problems by using methods of statistical signal processing.

CO4. Understand the hardware, register and memory used in the embedded systems.

CO5. Design of systems able to interface with humans; Learning base concepts of “human-centered design”.

**Syllabus**

**UNIT I: Principles of Bionics Engineering** **5 hours**

Historical evolution of bionics, related to robotics and bioengineering, Swarm robotics, biological locomotion principles, Bionic organs, Energy and powering issues in bionics and biorobotics, Fabrication technologies at different scales, Bioinspired structural design and advanced materials, Principles of morphological computation, Bionics by examples.

**UNIT II: Electronics for Bionics** **5 hours**

Analog front-end building blocks: instrumentation amplifiers, filters and ADC/DAC converters; Digital interfaces transferring digitalized sensor data to an embedded microcontroller; Design principles for energy and power efficient electronic systems for wearable applications.

**UNIT III: Introduction to microcontrollers** **3 hours**

Comparison with microprocessors Study of micro controller (MCS 51family- 8051) - Architecture, instruction set, addressing modes and programming - Comparison of various families of 8bit micro controllers. Interfacing of ADC, sensors, keyboard and DAC using microcontrollers.

**UNIT IV: Applications:** **2 hours**

Introduction to DSP processor, Applications of microcontrollers and computers in bionics engineering and biorobotics. microcontrollers in embedded biomedical applications. Human-machine interfaces for prosthetics.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Textbooks**


1. Advances in Bionic Engineering, Lu Quan Ren, Hao Wang, Zhen Dong Dai Trans Tech Publications Ltd
2. Microprocessor Architecture and Programming. Book by Ramesh Gaonkar
3. Microprocessors and interfacing, Book by Douglas Hall
4. Microprocessor 8085 And Its Interfacing Book by Sunil Mathur

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 2 | 1 | 1 | | 2 | 2 | | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 3 |
| **CO 2** | 3 | 3 | 2 | 1 | | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 1 | 3 | 2 |
| **CO 3** | 3 | 3 | 2 | 2 | | 3 | 1 | 1 | 2 | 2 | | 2 | 1 | 1 | 3 | 3 |
| **CO 4** | 2 | 1 | 1 | 1 | 1 | 2 | | | 2 | 1 | | 3 | 1 | 1 | 3 | 2 |
| **CO 5** | 2 | 2 | 2 | 1 | | 1 | | | 2 | 2 | | 3 | 1 | 1 | 3 | 2 |
| **Average** | **3** | **2** | **2** | **1** | **1** | **2** | **1** | **1** | **2** | **2** | **1** | **3** | **1** | **1** | **3** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## Practical:

1. Program for arithmetic operations in 8085 microprocessors.
2. 8085 microprocessor programs for sorting of numbers in ascending or descending order
3. Interfacing of I/O peripherals with 8085 microprocessors
4. Interfacing of ADC with 8051 microcontrollers
5. Interfacing DAC with 8051 microcontrollers
6. PWM signal generation using 555 timers.
7. Stepper motor interfacing with 8051 microcontrollers
8. Interfacing keyboard and display unit with 8051 microcontrollers.
9. Interfacing temperature sensor with 8051 microcontrollers.
10. Interfacing accelerometer sensor with 8051 microcontrollers.
11. Interfacing servo motor with 8051 microcontrollers.

| Elements of Design | L-T-P-C:1-1-0-2 |
|---|---|

**Course objective**

The elements of design are the basic components used as part of any composition. They are the objects to be arranged, the constituent parts used to create the composition itself. In most situations the elements of design build upon one another, the former element helping to create the latter. The module focuses on ways of thinking and seeing with focus on the elements like a dot, a line, color, shape, form, texture, pattern etc.

**Course Outcome**

After completing this course, you will be able to:

CO1. Develop creative conceptual ability and sensitivity to visual perception.
CO2. Understand fundamentals of visual interactions that exist between two or more elements.
CO3. Apply understanding of elements to create effective compositions.
CO4. Demonstrate an ability to present creative ideas using design language.

**Syllabus**

**Unit 1: Dot & line** **10 hours**

What is a dot? Arrangement of dots, image creation with dots, density of dots, impact of
varying densities of dots, relationship of density with clarity of pictures/images,
Line as extension of dots, straight and curved lines, various attributes of line, (width, thickness, weight, length, direction) combination of various types of lines, effect of line orientations

**Unit II: Texture and pattern** **10 hours**

What is texture? Texture and pattern in nature and man-made environment, analysis of
texture and patterns, exploration with different media

**Unit III: Shape, size & space** **10 hours**

Definition/ identification of shape, (through lines, value, color, texture etc.) Geometric and organic shapes. Linear and complex shapes. Interaction of shapes.
Basic understanding of scale and size. How sizes play a role in gaining/losing dominance over other elements in each format.
Definition of negative and positive spaces. Relationship between positive and negative spaces. Transition from space to form and vice versa.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

- **Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**PREREQUSITES AND MATERIAL**

1. Poster color, Black Ink, Scale, Markers and Geometry Box.
2. Brush(0,2, 4 ,8, ) Paper ( cartridge paper, color , and other types of paper)
3. Acrylic or water and oil-based color require to explore student in bigger surface.

**REFERENCE BOOKS**


1. Design Basics by David A. Lauer Learning.
2. Design Elements: Understanding the rules and knowing when to break them by Timothy

Samara, Rockport Publishers.

3. Design Elements, Form & Space: A Graphic Style Manual for Understanding and Design by Dennis Puhalla, Rockport Publishers.

**Co-relation Course Outcomes (COs) and Program Outcomes (POs)**

0: No Relation 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| HSBT 3008/HSBT 3108 (LAB) | Bioinformatics & Computational Biology | L-T-P-C:2-0-1-3 |
|---|---|---|

**Course objective(s):**

The objective of the course is to introduce students on most fundamental topics, such as sequence alignment and pattern finding, and explore some of the frontier areas". After completing this course, the students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data sets; they will understand how some of the commonly used bioinformatics tools work, how to use these tools effectively, and how to read and evaluate research articles in the field.

**Course Outcomes:**

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

CO1. Understand computational analyses of biological sequences, genome-wide studies and relate the results to core principles of biology.
CO2. Use computational methods to help execute a biological research plan; analyze biological problems and data using the latest machine learning and deep learning techniques.
CO3. Apply the knowledge to browse or retrieve gene, protein sequences and related information from biological databases; learn to align sequences using dot matrices, dynamic programming and heuristic approach.

**Syllabus**

**Unit-I:** **10 hours**

Introduction to bioinformatics, biological databases and their growth. How to use and search biological databases professionally? Finding out the sense of your research from millions of abstracts on PUBMED, Scopus, Web of Science and a lot more on Google Scholar, Concept of homology, pairwise sequence alignment, dot-matrix plot

**Unit-II:** **5 hours**

Scoring matrices (PAM and BLOSUM families), gap penalty, statistical significance of alignment, BLAST &FASTA. Multiple sequence alignment, Sequence Logos Dynamic programming, global (Needleman-Wunsch) and local (Smith-Waterman) alignment algorithms.

**Unit-III:** **5 hours**

Pattern finding in protein and DNA sequencing, Gibbs Sampler, Hidden Markov Models, Profiles construction and searching, phylogenetics, gene prediction.

**Unit-IV:** **5 hours**

Analysis of gene expression using microarrays or sequencing datasets, Gene Ontology, pathways, gene set enrichment analysis (GSEA), Analyze metabolomic, proteomics, and protein-protein interaction experiments, Metabolomics or Machine Learning methods for data analysis

**Unit V:** **5 hours**

New drug development, Drug pharmacokinetics & pharmacodynamics: Strategies for new drug discovery, finding a lead compound, combinatorial approaches to new drug discovery, pre-clinical and clinical trials.

**Practical:**

1. Finding patterns in genomes.
2. Implementation of motif finding algorithms.
3. Identifying various regions around genes using Genome browsers
4. Browsing genetic variation databases such as dbSNP, ClinVar.
5. Finding disease variation association using GWAS Catalog.
6. Basic machine learning using WEKA tool.
7. Accessing databases from NCBI.
8. Extracting protein and nucleotide sequences from NCBI.
9. Database Search Tools.
10. Similarity search using BLAST.
11. Pairwise sequence alignment.
12. Multiple sequence alignment.
13. Conserved domain analysis.
14. Construction of Phylogenetic trees.

**Mode of Exam Evaluation Process**

- **Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

References:


1. "Bioinformatics" by David Mount (2nd edition).
2. "Introduction to Bioinformatics Algorithms" by Neil Jones and Pavel Pevzner.
https://www.iitk.ac.in/scdmc/data/BSBE/FCH_BSE322A_Jan_2018.pdf
http://compbio.unl.edu/courses/compbiocourse.html


| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | **PSO 1** | **PSO 2** | **PSO 3** | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| CO 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 3 | 3 | 1 | 3 | 2 |
| CO 3 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 0 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Average | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Heat and Mass Transfer | L-T-P-C:2-0-1-3 |
|---|---|

**Course objective:**

To provide knowledge of Cell balances in steady/unsteady state transport processes involving momentum, energy, mass, heat transfer and its processes used in Chemical Process industries.:

**Course outcome**

The course enables the student to: -

CO1. Understand heat transfer by conduction, convection and thermal radiation for practical situations.
CO2. Analyze and calculate heat transfer in complex systems involving several heat transfer mechanisms.
CO3. Calculate mass transfer by analogy to heat transfer.

**Syllabus**

**Unit I:** **3 hours**

Conduction and Convection: Use of extended surfaces, two-dimensional steady state conduction, Thermal insulation- materials for cold and hot applications and thickness calculations, introduction to transient conduction, Biot number, use of Heisler charts. Concept and significance of boundary layer, boundary layer similarity and analogy, convection coefficients, free and forced convection, empirical correlations- internal and external flows.

**Unit II:** **3 hours**

Heat Exchangers and Evaporators: Types and selection, overall heat transfer coefficient, parallel and counter current flow, LMTD, FT correction factor, analysis and design using effectiveness-NTU method. Evaporator: Classification and use of evaporators in process industries, effect of boiling point rise and hydrostatic head on evaporator performance, liquor flow sequences, calculations for multiple effect evaporator system.

**Unit III:** **2 hours**

Diffusion: Molecular and eddy diffusivity, diffusion through stagnant gas film, equimolal and countercurrent diffusion, diffusion through solids. Interphase Mass Transfer: Theory of interphase mass transfer, overall and individual mass transfer coefficients.

**Unit IV:** **2 hours**

Distillation: Principles of distillation; Batch and Continuous distillation with reflux; Conditions of feed; Number of stages, stage efficiency. Solid– Liquid Extraction: Single and multiple-stage countercurrent extraction; Calculation of number of stages by graphical and analytical procedures. Liquid-Liquid Extraction: Triangular diagrams; Number of Stages.

**Unit V.** **5 hours**

Absorption and Adsorption: Absorption from gas mixture; Selection of solvent; Number of stages, concepts of NTU and HTU; Principles and application of adsorption. Humidification, Dehumidification and Drying: Humidification and dehumidification operation; Cooling towers; Mechanism and rate of drying, calculation for batch and continuous drying; Industrial applications. Membrane Separation: Introduction, Principles, and application.

**Practical:**

4. Determination of radiation constant of brass, iron, unpainted and painted glass.
5. Steam distillation – To calculate the efficiency of steam distillation.
6. To determine the overall heat transfer coefficient by heat exchanger.
7. Construction of drying curves (for calcium carbonate and starch).
8. Determination of moisture content and loss on drying.
9. Determination of humidity of air – i) From wet and dry bulb temperatures –use of Dew point method.
10. Description of Construction working machinery such as, fluidized bed coater, fluid energy mill, de humidifier.
11. Size analysis by sieving – To evaluate size distribution of tablet granulations – Construction of various size frequency curves including arithmetic and logarithmic probability plots.
12. Size reduction: To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.
13. Demonstration of colloid mill, planetary mixer, fluidized bed dryer, freeze dryer and other major equipment.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

Text and Reference books


1. Patankar S.V., “Numerical Heat Transfer and Fluid Flow”, Taylor and 2004 Francis.
2. Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C. and Harriott P.
   McGraw Hill International edition, Singapore
3. Principles of Unit Operations, Foust A.S. John Wiley & Sons, Singapore.

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | **PSO1** | **PSO2** | **PSO3** | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| CO 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 3 | 3 | 1 | 3 | 2 |
| CO 3 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 0 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Average | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 3 | 2 | 3 | 2 |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## SEMESTER V

| Fundamentals of Robotics | L-T-P-C:1-0-1-2 |
|---|---|

**Course Description**

The course enables an understanding of fundamentals of robotics and their design to suit healthcare purposes.

**Course Outcome**

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

CO1. Understand the different types of medical robots and their potential applications in biomedical.

CO2. Identify the basic concepts in kinematics, dynamics, and control relevant to medical robotics.

CO3. Develop the analytical and experimental skills necessary to design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.

**Syllabus**

**Unit I: Introductory topics** **3 hours**

Introduction to medical robotics (applications and paradigms) Basic kinematics concepts (forward, inverse, remote center of motion) Basic control concepts (impedance, admittance) Surgery for engineers Interventional radiology for engineers

**Unit II: Minimally Invasive Surgery (MIS)** **2 hours**

Human-machine interfaces Teleoperation Cooperative manipulation Port placement for MIS Robot design concepts Video images in MIS Augmented reality Minimally invasive surgery training

**Unit III: Image-Guided Interventions Medical imaging modalities (e.g., MRI, US, X-ray, CT)** **3 hours**

Robot compatibility with medical imagers Image segmentation and modeling Tracking devices Frames and transformations Surgical navigation Calibration Rigid and non-rigid registration Radiosurgery

**Unit IV: Current topics in medical robotics** **5 hours**

Existing clinical applications, controversies, and outcomes: - Cardiac, abdominal, and urologic procedures with teleoperated robots - Orthopaedic surgery with cooperative robots - Prostate interventions with manual “robots” - Robotic catheters for heart electrophysiology Research topics: Mobile robots in the body, Instrument-tissue interaction modeling, Autonomous robotic surgery.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

Text Books :


1. Barry Leatham – Jones, “Elements of industrial Robotics”, Pitman Publishing, 1987.
2. J. M. Selig, “Introductory Robotics”, Prentice Hall, 1992.
3. John Iovine, “Robots, Android and Animatronics”, McGraw-Hill, 2nd Edition, 2012.
4. John M. Holland, “Designing Autonomous Mobile Robots-Inside the mind of an Intelligent Machine”, Newnes Publication, 2004.
5. Robert J. Schilling, “Fundamentals of Robotics- Analysis and Control”, Pearson Education, 2006.

References:


1. MikellP.Groover, Mitchell Weiss, Roger N.Nagel Nicholas G.Odrey, “Industrial Robotics Technology, Programming and Applications”, McGraw Hill Book Company 1986.
2. Fu K.S. Gonzaleaz R.C. and Lee C.S.G., “Robotics Control Sensing, Vision and Intelligence”, McGraw Hill, International Editions, 1987.
3. Bernard Hodges and Paul Hallam, “Industrial Robotics”, British Library Cataloging in Publication 1990.
4. Deb, S.R. , “Robotics Technology and Flexible Automation”, Tata McGraw Hill, 1994.


**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | **PSO1** | **PSO2** | **PSO3** | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| CO 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 3 | 3 | 1 | 3 | 2 |
| CO 3 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 0 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Average | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Biosensors &Diagnostics & (Lab) | L-T-P-C:2-1-1-4 |
|---|---|

**Course Objectives**

The purpose of this course is to give students a thorough grasp of biosensors and how they are used in diagnostic procedures. The fundamental concepts, design concerns, fabrication processes, and analytical procedures related to biosensors will be made clear to the students.

**Course Outcomes**

The student will be able to

CO1. Understand the basic principles and classification of sensors and measurands.

CO2. Identify the different types of biosensors applied to different biomedical fields.

CO3. Apply the basics of the hardware and software requirements for the Electronic Interfaces of Sensor

CO4. Apply the sensor measurements for biological applications.

**Syllabus:**

**Unit I:** **10 hours**

Introduction to Biosensors, Definition and types of biosensors, Importance of biosensors in diagnostics, Basic components and working principles of biosensors, basic biosensors for disease diagnosis.

**Unit II:** **10 hours**

Classification and Terminology of biosensors, measurands. Hall Effect sensors and associated signal conditioning circuits, Sensors for displacement (linear and angular), velocity, acceleration, force, torque, vibration and shock measurements. Sensor measurements for conductivity and viscosity.

**Unit III:** **15 hours**

Electrochemical transducer in Biology and medicine Biochemical Transducer, Enzyme-based electrochemical biosensors, Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET). Optical sensor, fabrication and miniaturization techniques for optical technology and principle of optical measurements.

**Unit IV:** **10 hours**

Sensor-to-Frequency Conversion Data-Acquisition Systems: Hardware and Software of Data Acquisition System (DAS), Electronic Interface, Integrated Sensors, Wireless integration. Smart sensor, MEMS and Nano sensor.

**Reference books**


1. Roger, K.R. and Gerlach, C.L. 199. Update on environmental for biosensors. Env. Sci. Techno! 33 500A – 506A.
2. Bilitewski, U. Turner, A.P.F. 2000 Biosensors for environmental monitoring Harwood, Amsterdam.
3. Moses, V and Cape, R.E. 1991, Biotechnology the science and business, Harwood, Academic Publisher London


**Essential Reading**


1. Jon Cooper, Biosensors A Practical Approach, Bellwether Books
2. Manoj Kumar Ram, Venkat R, Bhethanabolta, Sensors for chemical and biological applications, CRC Press
3. D. L. Wise, Bioinstrumentation and Biosensors: Theory and Applications, CRC Press
4. J. Cooper, and T. Cass, Biosensors, Oxford University Press


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | **End Term Examination** | |
|---|---|---|---|

| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
|---|---|---|---|---|---|---|
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (Cos) and Program Outcomes (Pos)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**List of Experiments:**

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

**Regenerative Technologies and Artificial Organs L-T-P-C:1-0-1-2**

- **Course Objectives**

  The course on Regenerative Technologies and Artificial Organs aims to provide students with a comprehensive understanding of the field of regenerative medicine and the development of artificial organs**.**

- **Course Outcomes**

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

CO1: Gain information on rehabilitation engineering

CO2: Understand clinical importance and application of artificial organs.

CO 3: Analyze various types of assist devices & develop ability to choose which type of assist device is suitable for various disorders.

CO4: Design new devices based on the basic knowledge gained in different assisting devices.

**Syllabus:**

**Unit I** **2 hours**

Introduction to artificial organs, Biomaterials used in artificial organs and prostheses,

**Unit II:** **3 hours**

Introduction to organ-on-chips

**Unit III:** **2 hours**

Artificial kidney: kidney filtration, artificial waste removal methods, hemodialysis, regeneration of dialysate, membrane configuration, wearable artificial kidney machine,

**Unit IV:** **5 hours**

Artificial heart-lung machine: lungs gaseous exchange/ transport, Artificial heart valves, Liver support system, Artificial pancreas, Artificial limbs,

Audiometry: air conduction, bone conduction, masking Ophthalmoscope, Artificial cornea, Prosthetic and Orthotic devices,

**Unit V:** **3 hours**

Rehabilitation Engineering: Impairments, disabilities and handicaps, Engineering concepts in sensory and motor rehabilitation, Rehabilitation of vision, hearing and speech, Spinal rehabilitation.

**Essential Reading**


1. Gerald E Miller, Artificial Organs, Morgan & Claypool , 2006
2. Kondraske, G. V,, Rehabilitation Engineering, CRC press , 1995
3. Bronzino Joseph, Hand book of biomedical Engineering,, Springer , 2000

4. R. S.Khandpur, Biomedical Instrumentation: Technology and Application, McGraw-Hill Professional , 2004

**Modes of Evaluation:**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**List of experiments**

1. Design of organ on a chip
2. Development of organ on a chip using 3D printer
3. Demonstration of making artificial organs
4. Demonstration of making artificial organs using micro-moulding.

## SEMESTER VI

**Artificial Intelligence & Machine Learning** **L-T-P-C:2-1-1-4**

**Course Objectives**

This course will give students an overview of principles and techniques in artificial intelligence and machine learning.

**Course Outcomes**

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

CO1. Understand the application of Artificial intelligence and machine learning to solve problems.

CO2. Learn recent AI techniques for biomedical application.

CO3. Make use of Data sets in implementing the machine learning algorithms.

CO4. Implement machine learning concepts and algorithms using some programming language.

**Syllabus**

**Unit I. Introduction to Artificial Intelligence and Machine learning 10 hours**

History of Artificial Intelligence, What is AI? Emergence of AI, Cognitive Science & AI. The Origins of Machine Learning, Uses and Abuses of Machine Learning, How do Machines Learn? - Abstraction and Knowledge Representation, Generalization, Assessing the Success of Learning, Steps to Apply Machine Learning on Data, Choosing a Machine Learning Algorithm - Thinking about the Input Data, Thinking about Types of Machine Learning Algorithms, Matching Data to an Appropriate Algorithm.

**Unit II. Logical Approach to AI, Regression Models and Association Rules in ML 10 hours**

Basics of Propositional Logic: Syntax, Semantics, Tautologies and Logical Implication, Introduction to Simple Linear Regression, Simple Linear Regression Model Building, Estimation of Sum of Squared Error, Interpretation of Simple Linear Regression Coefficients, Validation of Simple Linear Regression Model, Multiple Linear Regression, Partial Correlation and Regression Model Building, Logistic Regression Model and its mathematical derivation, Market Basket Analysis, Apriori Algorithm, FP Growth Algorithm.

**Unit III. Classification Algorithms** **10 hours**

Introduction to Classification Algorithms, k-Nearest Neighbor Algorithm, Decision Trees, Naive Bayesian Classifier, Ensemble Methods: Bagging, Boosting, AdaBoost and XBoost, Random Forests, Advanced Classification Methods: Backpropagation in Multilayer Feed-Forward Neural Networks, Support Vector Machines, Classification Model Evaluation and Selection: Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value.

**Unit IV. Clustering Methods** **10 hours**

The Clustering Task and the Requirements for Cluster Analysis, Overview of Some Basic Clustering Methods, Hierarchical Methods: Agglomerate versus Divisive Hierarchical Clustering, Distance Measures, Probabilistic Hierarchical Clustering, Multiphase Hierarchical Clustering Using Clustering Feature Trees, Partitioning Methods: k-Means Clustering, k-Medoids Clustering, Density-Based Clustering: DBSCAN - Density-Based Clustering Based on Connected Regions with High Density, Measuring Clustering Goodness.

**Unit V. Case Studies (Industry/Social)**
**5 hours**

Industrial applications: ML for Cybersecurity, ML for Internet of Things, ML for Healthcare, ML for Banking and Finance, ML for Smart Cities, Application of ML to solve other social issues.

**Textbook - Introduction to Business Analytics** (IBM ICE Publication).
**Reference Material:**


1. Rich E., Artificial Intelligence, Tata McGraw Hills (2009).
2. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
3. Ryszard S. Michalski, Jaime G. Carbonell, Tom M. Mitchell, Machine Learning : An Artificial Intelligence Approach, Tioga Publishing Company, 1983.
4. “Data Mining Concepts and Techniques”, Jiawei Han and Micheline Kambe, Third Edition Elsevier Publications.


**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**
**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

- **List of experiments:**

1 Introduction to Weka Tool
2 Perform basic algorithm with inbuilt data on Weka Tool
3 Linear and Multiple Linear Regression

4 Logistics Regression Analysis
5 Decision Tree
6 Naïve Bayes
7 KNN (k-Nearest Neighbor) Algorithm
8 SVM (Support Vector Machine)
9 k-Means Clustering
10 DBSCAN (Density Based Spatial Clustering of Applications with Noise)
11 Learn to Configure Google Colab and with support of google drive
12 Implement deep Learning model on Google Colab

## A. EVALUATION & GRADING

**Mode of Exam Evaluation Process-**

- **Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

| Biomaterials & Lab | L-T-P-C:2-1-1-4 |
|---|---|

**Course Objective:**

The course objectives for Biomaterials aim to provide students with a comprehensive understanding of the properties, design, and applications of biomaterials in the field of biomedical engineering.

**Course Outcome:**

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

CO1. Understand different types of Biomaterials and its classification and apply the concept of nanotechnology towards biomaterials use.

CO2. Explore the properties of biomaterials, structure of biomaterials and Various characterization of biomaterials.

CO3. Identify significant gap required to overcome challenges and further development in metallic, polymeric materials and ceramic materials in implants.

CO4. Apply biomaterials in biomedical engineering, instruments, tissue engineering, drug delivery system.

**Syllabus**

**Unit I:** **15 hours**

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

**Unit II:** **15 hours**

Methods of synthesis of bio-nanomaterials, Properties of bio-nanomaterials, characterization of bio-nanomaterials using techniques UV-Visible, FTIR, Raman XRD, etc.

**Unit III:** **15 hours**

Application of biomaterials in biomedical engineering & nanotechnology, artificial organs, surgical tools and instruments, Biomaterials in tissue engineering and

regenerative medicine, different type of implants, testing of biomaterials/Implants, Nanomaterials in drug delivery, soft tissue engineering

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**
**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Text Books:**


1. Sujata V. Bhatt, Biomaterials, Second Edition, Narosa Publishing House, 2005.
2. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, Biomaterials: A Nano Approach, CRC Press, 2010.


**References:**


1. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003
2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, Introduction to Biomedical Engineering, Elsevier, 2005.
3. Park J.B., Biomaterials Science and Engineering, Plenum Press, 1984.

4. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,Woodhead Medical Textiles and Biomaterials for Healthcare, Publishing Limited 2006.
5. D F Williams, Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume, VCH Publishers 1992.
6. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. Implant biomaterials: A comprehensive review, World Journal of Clinical Cases, 2015.

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Practical:**

1. Synthesis of polymeric nanoparticles entrapping dye.
2. Release kinetics of the dye from the nanoparticles.
3. Synthesis of microspheres for drug delivery.
4. Characterization of polymeric nanoparticles and microspheres using SEM, Particle analyser, gravimetric analysis.
5. Encapsulation/ Beads for drug delivery.

## SEMESTER VII

| Data Visualization | L-T-P-C:2-1-0-3 |
|---|---|

### Course Objectives

The course objectives for Data visualization will provide students with a complete understanding of principles, techniques, and tools used to effectively communicate and visualize data. students will able to interpret complex datasets, identify patterns, and present insights for data analysis.

### Course Outcomes

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

CO1.Understand data visualization and its use in healthcare.

CO2. Understanding and Connecting to Data in Tableau

CO3. Exploring & Analyzing Data in Tableau for healthcare.

CO4. Evaluate and recognize and getting started with Tableau Prep Builder Understanding case studies in TabPy 1.0 for healthcare sector.

### Syllabus

**Unit I: 7 HOURS**

Data visualization in Healthcare, Significance of Data Visualization in Healthcare, Difference in Infographics and Data visualization, Designer Reader Data Trinity, Scatter plot, Bar chart, Heat map, Pie chart, Box plot, Index charts, Steam and leaf plot, Q-Q plots, Scatter plot matrix, Flow maps, Choropleth maps, How to Make a Highlight Table, Tree Maps, Bullet Graphs, Stacked Area Chart, Histogram, Box-and-Whisker Plot, Symbol Map with Mapbox Integration, Filled Maps, Dual Axis Maps, Gantt Chart, Waterfall Chart, Dual-Axis Slope Graphs, Donut Charts, Funnel Charts, Pace Charts, Pareto Chart, Control Chart, Dumbbell Charts, Jitter Plots

**Unit II:** ` **8 HOURS**

Relationships, Managing Metadata, Managing Extracts, Saving and Publishing Data Sources, Connect to Data from the Web, Data Prep with Text and Excel Files, Join Types with Union, Data Blending, Connecting to PDF, Connecting to Cubes. Create and save data connections, Create a live connection to a data source, Explain the differences between using live connections versus extracts ,Create an extract ,Save metadata properties in a . TDS. Modify data connections , Add a join ,Add a blend , Add a union , Manage data properties , Rename a data field , Assign an alias to a data value , Assign a geographic role to a data field , Change data type for a data field (number, date, string, Boolean), Change default properties for a data field (number format, aggregation, color, date format)

**Unit III:** **7 HOURS**

Create basic charts , Create a bar chart , Create a line chart , Create a scatterplot , Create a map using geographic data , Create a combined axis chart , Create a dual axis chart ,Create a stacked bar , Create a chart to show specific values (crosstab, highlight table) , Organize data and apply filters , Create a visual group , Create a group using labels , Create a set , Organize dimensions into a hierarchy. Add a filter to the view , Add a context filter, Add a date filter , Apply analytics to a worksheet , Add a manual or a computed sort , Add a reference line or trend line , Use a table calculation , Use bins and histograms , Create a calculated field (e.g. string, date, simple arithmetic) , Add a parameter. Sharing Insights , Format view for presentation , Use color , Use bolding , Use shapes , Use viz animations , Change size of marks , Select fonts , Create and modify a dashboard , Create a dashboard layout , Add interactive or explanatory elements , Add dashboard actions , Create a story using dashboards or views , Share a twbx as a PDF , Share a twbx as an image

**Unit IV** **7 HOURS**

The Input Step, The Cleaning Step, Group and Replace, The Profile Pane, The Pivot Step, The Aggregate Step, The Join Step, The Union Step, The Output Step, Tableau Prep Conductor

**Unit V** **6 HOURS**

Installation and Connecting Tableau with TabPy for Healthcare use cases, Using TabPy to run Python in Tableau (Adding Python code to a Calculated Field) for Healthcare examples, Python calculation as Calculated Field in your Tableau worksheet.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Reference Books**


1. Pro Tableau: A Step-by-Step Guide 1st ed. Edition by Seema Acharya (Author), Subhashini Chellappan (Author) ISBN-13 (pbk): 978-1-4842-2351-2 ISBN-13 (electronic): 978-1-4842-2352-9 DOI 10.1007/978-1-4842-2352-9
2. Data Visualization for Analytics (IBM ICE Publications)
3. Python Data Science Handbook, O'REILLY, Jake VanderPlas

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Signal & Image Processing | L-T-P-C:2-0-0-2 |
|---|---|

**Course Objectives**

To enhance students ability to understand techniques used in capturing and processing of biomedical signals and images. In medical profession lot of diagnosis depends upon biomedical signals and images. In depth understanding of power, artifacts, problems, and limitations of these signals and images will be attempted in this course.

**Course Outcomes**

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

CO1: Understand Signal and Image Processing Concepts

CO2: Identify Basic imaging techniques

CO3: Analyze Different types of electromagnetic signals and medical imaging.

**Course Content**

**Unit I: 9 Hours**

Enumeration and understanding of the physics of some popular biomedical signals and images. Electrocardiogram, echocardiogram, radial pulse, blood pressure, Blood oxygen saturation (SpO2), mammograms, X-ray scans etc. are few of them named here.

**Unit II: 9 Hours**

Physics and principles of signal and image formation will be discussed. Scientific principles associated with conversion of biological signals to electrical signals, analog to digital signal conversion, sampling, quantization, and digitization of signals. Processing and filtering signals to remove noise and other interference. Digital signals and digital image fundamentals. Relationship between signal samples, pixels, matrix, and tensors.

**Unit III: 9 Hours**

Different types of electromagnetic signals, visual signals, X-rays, Gamma-rays etc. Computer Tomography (CT) scans, conversion of X-ray data to images and 3D volume based on the principle of x-ray attenuation,

**Unit IV: 9 Hours**

Medical image processing techniques like filtering, transformations, data augmentations etc. Processing segmentation and classification of biomedical images.

**Text Books & Reference Books**

1. Biomedical signal and image processing 2nd edition by Kayvan Najarian and Robert Splinter. CRC press

2. Diagnostic radiology physics: a handbook for teachers and students: 4th edition by D.R. Dance, S.Christofides, A.D.A.Maidment, I.D. McLean, and K.H. Ng; International Atomic energy agency, Vienna.

3. The Physics of Medical Imaging by S. Webb, CRC Press.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | **PSO 1** | **PSO 2** | **PSO 3** | PSO 4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 2 | 3 | 3 | 1 | 2 | 2 |
| CO 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 2 | 3 | 3 | 1 | 3 | 2 |
| CO 3 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 1 | 0 | 2 | 2 | 2 | 2 | 1 | 2 | 1 |
| Average | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 0 | 2 | 2 | 3 | 3 | 2 | 3 | 2 |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| HSBE2002 | **Biomedical Transport** | **L-T-P-C:1-** |
|---|---|---|

**Course description**

Introduction to and application of the concepts of momentum, mass, and thermal energy transport in the context of problems of interest in biomedical sciences and engineering. Macroscopic and microscopic analysis of momentum, mass, and thermal energy transport problems in biomedical systems.

**Course Outcomes**

Student will be able to:

CO1. Understand the relationship between blood flow and physiological function and dysfunction in the surrounding tissues and organs.

CO2. Solve transport equations using methods from advanced mathematics.

CO3. Develop an intermediate/advanced understanding of trans-endothelial transport and oxygen delivery to tissues and organs.

CO4. Apply the kinetic models to study cell adhesion and intracellular signaling.

**Syllabus**

**Unit I. Introduction to Biomedical Transport (Fluid mechanics) 10 hours**

Fundamentals of fluid mechanics, Overview of biomedical transport phenomena, importance, and applications in healthcare, Hemodynamic and blood flow in the circulatory system.

**Unit II. Mass Transport in Biological Systems 5 hours**

Diffusion and its applications in biomedicine, Transport of solutes across biological membranes, Pharmacokinetics: drug transport and distribution in the body

**Unit III. Transport in Biochemical Reactions 5 hours**

Enzyme kinetics and reaction transport, Applications in drug metabolism and bioconversion

**Unit IV. Transport Modelling and Simulation & Case Studies and Applications.**

**10 hours**

Transport Phenomena in BioMEMS and Drug Delivery Systems. Microfluidics and lab-on-a-chip devices, Transport in drug delivery systems (nanoparticles, liposomes, etc.), Controlled release mechanisms and drug targeting, Mathematical modelling of transport phenomena, Computational methods and simulation techniques.

**REFERENCE and Textbooks**


1. Fundamentals of Biomedical Transport Processes by Gerald E. Miller, 2010, Springer
2. Transport Phenomena in Biomedical Engineering: Principles and Practices by Robert A. Peattie, Robert J. Fisher , Joseph D. Bronzino , Donald R. Peterson, 2012, CRC press.
3. Basic Transport Phenomena in Biomedical Engineering by Ronald L. Fournier, 2018, Taylor & Francis group.


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## SEMESTER VIII

| Ethics, Regulations & IPR | L-T-P-C:2-1-0-3 |
|---|---|

**Course objectives:**

The course objectives for Ethics, Regulations & IPR aim to provide students with a comprehensive understanding of ethics, regulations & IPR including their applications in healthcare. They will acquire knowledge about patents and IPR.

**Course Outcomes**

The Student will be able to:

CO1. Identify the scope of medical ethics and moral principles for the health professions

CO2. Explain the purpose of medical standards and hospital accreditation standards

CO3. Summarize the importance of hospital safety standards and medical equipment safety standards.

CO4. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects including IPR

**Syllabus:**

**Unit I: Introduction to Medical Ethics: 5 hours**

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and the Patient, The Doctor and the Profession, Professional Independence, The Doctor and Society.

**Unit II: Ethical Theories and Moral Principles: 10 hours**

Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles Non-Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine

**Unit III: Medical Standards and accreditation 10 hours**

Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA –Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics. Accreditation - JCI Accreditation & its Policies. Patient centered standards, Healthcare Organization management standards -Indian Perspective.

**Unit IV : Hospital Safety Standards and Medical Equipment Safety Standards** **10 hours**

Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Maintaining Fire Alarm Systems, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, and Inspecting Medical Equipment. General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards. Base Standard-general requirement of electrical medical devices, Collateral Standards EMC radiation protection &programmable medical device system, Particular Standards-type of medical device

**Unit V:** **10 hours**

Introduction to Intellectual Property: History, Concepts and Types, Role of Intellectual Property in Growth, Development, Trade and Commerce, Various types of Intellectual Property Rights, Protection & Maintenance of IP, IP & Patent Litigation, Claims and Specification Drafting, Patent Prosecution, IP Valuation, IP Portfolio Audit and Management, Commercialization and issues related to technology transfer. Intellectual Property Rights: Introduction and the need for intellectual property right (IPR) – Types 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 - Major International Instruments concerning Intellectual Property Rights, Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Textbooks:**


1. JohnnaFisher, “Biomedical Ethics: A Canadian Focus.” Oxford University Press Canada 2009.
2. Ben Mepham,”Bioethics-—An Introduction for the biosciences”,Oxford, 2008.
3. Domiel A Vallero, “Biomedical Ethics for Engineers”, Elsevier Pub.1st edition, 2007.
4. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
5. 2. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.


**Reference Books:**


1. Joint Commission Accreditation Standards for Hospitals, 2nd edition 2003.
2. Nils Hoppe and Jose Miola, “Medical law and Medical Ethics”, Cambridge University Press2014.
3. Robert M Veatch,” Basics of Bio Ethics”, Second Edition. Prentice- Hall,Inc, 2003
4. Physical Environment Online: A Guide to The Joint Commissions Safety Standards, HCPro, Inc.2010
5. Mohan Bansal, “Medical informatics”, Tata Mc Graw Hill Publishing Ltd, 2003
6. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.


**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| GMP & GLP | L-T-P-C:1-1-0-2 |
|---|---|

**Course Objective(s):**

The course objectives for GMP & GLP aim to provide students with a comprehensive understanding of the regulatory requirement of GMP and GLP in the field of biomedical engineering.

**Course Outcomes**:

CO1: Understand that the areas that come under GMP are: facilities and buildings, equipment, production, process control, packaging and labeling, laboratory controls, and returned/salvaged drug products., Importance of GMP and GLP for drug regulation.

CO2: Understand that the areas that come under the Good Laboratory Practices are: personnel and organizational, testing facilities, equipment, testing and controls, records, reports, and protocol for and conduct of non-clinical labs.,

**Syllabus:**

**Unit I** **10 hours**

Introduction to Good Manufacturing and Laboratory Practice, Requirement of GLP and GMP compliance for regulatory approval, Ethics in manufacturing and control, Principles of quality by design (QBD).

Introduction to the concept of Design of Experiment (DOE) Application of QBD principles in Biotech product development.

Case studies: Example of QBD and DOE in Process Development, Example of DOE in analytical development, Introduction to ICH guidelines and their usage, National and international regulatory authorities and their function, Pharmaceutical Jurisprudence and Laws related to Product design, Drug Development & Approval Process, Regulation of Clinical and Preclinical Studies, Good Manufacturing Practices, Formulation Production Management, Authorization and marketing of drugs.81 Computer simulation on process design.

**Unit II** **10 hours**

FDA classification of medical devices, CDSCO classification of medical devices

**Unit III** **10 hours**

ISO 13485 for medical devices, ISO 14971, Medical devices – Application of risk management to medical devices.

**Text Books/References:**

1. cGMP starter guide: Principles in Good Manufacturing Practices for Beginners, Emmet P. Tobin, Createspace Independent Publishing Platform, April 2016.

2. Good Manufacturing Practices for Pharmaceuticals: GMP in Practice, B Cooper, Createspace Independent Publishing Platform, July 2017.

3. Sarwar Beg and Md Saquib Hasnain, Pharmaceutical Quality by design: Principles and application, Academic press, March 2019.

4. Ron S. Kenett, Shelemyahu Zacks, Daniele Amberti, Modern Industrial Statistics: with applications in R, MINITAB and JMP, 2nd Edition, Wiley, January 2014.

5. N Politis S, Colombo P, Colombo G, M Rekkas D.Design of experiments (DoE) in pharmaceutical development, Drug Dev Ind Pharm. 2017 Jun;43(6):889-901. doi: 10.1080/03639045.2017.1291672.

6. Andrew Teasdale, David Elder, Raymond W. Nims, ICH quality guidelines- An implementation guide, Dec 2017.

7. Gajendra Singh, Gaurav Agarwal and Vipul Gupta, Drug regulatory affairs, CBS publication, 2005.

8. Marc P. Mathieu, New Drug Development: A regulatory overview, Nov 2000.

9. ICH guidelines available in the official website “https://www.ich.org”. Course Outcomes: Understand that the areas that come under the Good Laboratory Practices are: personnel and organizational, testing facilities, equipment, testing and controls, records, reports, and protocol for and conduct of non-clinical labs., Understand that the areas that come under GMP are: facilities and buildings, equipment, production, process control, packaging and labeling, laboratory controls, and returned/salvaged drug products., Importance of GMP and GLP for drug regulation.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | **Total** |
|---|---|---|---|---|

| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | **Mid Term Exam** | **End Term Exam** | |
|---|---|---|---|---|---|---|---|
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO 1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

## PROGRAM ELECTIVE

| Algorithms for Biomedical Engineers & Lab | L-T-P-C:1-1-1-3 |
|---|---|

**Course Objective:**

The course objectives for Algorithms for Biomedical Engineers aim to provide students with a fundamental understanding of basic principles and their applications in health care. They will understand the various algorithm design and analysis techniques to learn linear data structures – lists, stacks, and queues.

**Course Outcome:**

At the end of this course, the students should be able to:

CO1: Understand linear data structures and solve problems using them.

CO2: Understand the various searching and sorting algorithms

CO3: Apply trees and graphs to solve problems.

CO4: Apply Tree and Graph data structures in biomedical.

**Syllabus:**

**Unit I** **5 hours**

Introduction to Data Structures

Abstract Data Type (ADT) – Definition and Examples, Introduction to Array ADT, Linked List ADT – Insert, Delete, Search, Types of Linked List, Stack ADT – Push, Pop, Types, Applications, Implementation of Stack operations in C. Queue ADT – Enqueue, Deque, Types, Applications, Implementation of Queue operations in C.

**Unit II** **10 hours**

Introduction to Algorithms + Searching and Sorting

Introduction to Algorithms, Asymptotic analysis – Big-O and other notations, worst, average and best-case analysis. Search Algorithms - Linear Search, Binary Search. Divide and Conquer methodology. Basic Sorting Algorithms – Bubble sort, Selection sort, Insertion sort, Merge sort, Quick sort, Heap sort. Time complexity analysis of searching and sorting techniques.

**Unit III** **5 hours**

Tree Data Structures

Binary Tree ADT – Basic terms: Complete BT, Balanced, Unbalanced BT, Insert, Delete, Traversal techniques - Inorder, Postorder, Preorder, Properties, Introduction to B Tree, AVL tree. Heap Data Structures ADT – Min Heap, Max Heap.

**Unit IV** **10 hours**

Graph Data Structures

Introduction, Representation of Graph and Types, Adjacency Matrix and Adjacency List, Graph Traversal -Breadth-first traversal, Depth-first traversal. Dynamic programming Technique, Shortest Path Algorithms – Dijkstra's Algorithm, Floyd-Warshall Algorithm, Greedy Algorithm, Applications of graphs.

**Text Books:**

Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education,1997.

Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, 2nd Edition, Pearson Education, 1988.

**References:**

Aho, Hopcroft and Ullman, Data Structures and Algorithms, Pearson Education,1983.

S.Sridhar, Design and Analysis of Algorithms, First Edition, Oxford University Press. 2014

Byron Gottfried, Jitender Chhabra, Programming with C (Schaums Outlines Series), Mcgraw Hill Higher Ed., III Edition, 2010

Yashvant Kanetkar, Data Structures Through C, BPB publications, II edition, 2003

**List of Experiments:**

1. Implementation of array operations.
2. Implementation of Linked Lists: inserting, deleting, traversing, search, reversing.
3. Implementation of Queue operations – insertion, deletion, traversal, search.
4. Implementation of Stack operations - insertion, deletion, traversal, search.
5. Implementation of various Stack and Queue operations using Linked Lists.

6. Implementation of searching algorithms in C.
7. Implementation of Insertion sort.
8. Implementation of Quick sort.
9. Implementation of Merge sort.
10. Implementation of various Tree traversal algorithms.
11. Implementation of various Graph traversal algorithms.
12. Merging Problem: evaluation of expressions/operations on multiple stacks & queues.

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Biomedical Assistive Devices | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to contribute to the development, improvement, and application of biomedical assistive devices,

**Course outcome:**
The student will able to

CO1: Understand the challenges and needs of individuals with disabilities or impairments that can be addressed through biomedical assistive devices.
CO2: Demonstrate knowledge of the different types of biomedical assistive devices.
CO3: Comprehend the underlying physiological and biomechanical principles relevant to the design and operation of biomedical assistive devices.

**Syllabus:**

**Unit I: CARDIAC ASSIST DEVICES** **10 hours**

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

**Unit II: HEMODIALYSERS** **10 hours**

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

**Unit III: HEARING AIDS** **10 hours**

Common tests – audiograms, airconduction, boneconduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

**Unit IV: PROSTHETIC AND ORTHODIC DEVICES** **10 hours**

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, and sensory assist devices.

**Unit V: RECENT TRENDS** **5 hours**

Transcutaneous electrical nerve stimulator, bio-feedback.

**Text Books:**


1. Levine S.N. (ed), “Advances in Bio-medical engineering and Medical physics”, Vol. I, II, IV, inter university publications, New York, 1968 (Unit I, IV, V).
2. Kopff W.J, “Artificial Organs”, John Wiley and sons, New York, 1976. (Unit II ).
3. Albert M.Cook and Webster J.G, “Therapeutic Medical Devices”, Prentice Hall Inc., New Jersey, 1982 (Unit III).


**Modes of Evaluation:**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Implants and Prosthetics | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives:**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to contribute to the field of implants and prosthetics, enabling them to improve the lives of individuals with disabilities, injuries, or medical conditions through the development and implementation of innovative and effective solutions.

**Course Outcomes:**
The student will able to :

CO1: Learn to plan implant cases and design surgical guides
CO2: Understand how to restore the implants digitally without compromising accuracy
CO3: Analyze the phenomenon of locomotion in a sample of normal individuals and to analyze the results for use by the surgeon, the designer, and the prosthetist.
CO4: Develop design criteria for new or improved devices and as a basis for evaluating existing devices.

**Syllabus**

**Unit I: Bio-implants & Surgical Aids: 10 hours**

Blood-Biomaterial Interactions, Biomaterials-Tissue Interactions, Tissue response to Implants, Inflammation, Wound Healing, Foreign Body Response, Infection and Tumorigenesis of Biomaterials. Stent, Vascular grafts, Artificial Heart valves, Inferior Vanacava filter, Contact lenses, Intra-ocular lenses, Artificial Silicon Retina, Temporary fixation Devices, Total Hip Replacement, Total Knee Replacement, Dental filling & Restoration material, Dental implants, Suture materials, Wound dressings, Tissue Adhesives.

Unit II:**Prosthetic Feet** **10 hours**

**I**ntroduction to Prosthetics, definitions of various terminologies, Historical development in Lower Extremity Prosthetics in India and abroad. Various types of Prosthetic feet. Conventional foot. Rocker, SACH foot, modified SACH Foot. Jaipur Foot, Seattle foot, Flex foot, Quantum foot, Peg Roelite foot, Carbon copy foot, Comparatives studies of prosthetic feet. Single axis, Double axis, Multi-axial foot, other kinds of feet etc. Heel Height adjustment, Adjustable ankle, various kinds of ankle mechanisms. RCI's BPO

Unit III:**Partial Foot** **10 hours**

Various types of Partial foot prosthesis. Biomechanics of Partial foot prosthesis, Prescription Principles, Materials used for partial foot prosthesis, various cast techniques of Partial foot prosthesis, Fabrication Technique for partial foot prosthesis. **Syme's**: Various types of Symes Prosthesis, Prosthetic components, Prescription criteria, Principles. Materials used for Symes prosthesis, casting techniques. Cast modification. Fabrication Technique for Symes (P.T.B. type) prosthesis. Fabrication Technique for conventional Symes prosthesis.

Unit IV: **Trans Tibial** **10 hours**

Various types of trans-tibial prostheses including Jaipur limb & ICRC technology, Prosthetics Components – both conventional and modular. Trans-tibial Prosthetic Prescription Criteria and principles. Materials used in Trans-tibial Prosthesis. Measurement and casting techniques for Trans-tibial prosthesis. Cast modification. Fabrication techniques for trans-tibial prosthesis. Fabrication Technique for trans-tibial Conventional Prosthesis – both Open and close ended socket, Different types of socket designs – PTB, PTS, PTBSC, PTB-SCSP, Different types of suspension.

Unit V :**Gait Deviations and Analysis** **5 hours**

Person with Chopart, Symes, Trans-tibial prosthesis. Check-Out Procedures with Chopart, Symes & Trans-tibial prosthesis.

**Text Books:**

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control", Wiley Publishers, 2006. 2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012.

**Reference Books:**

1. AchimSchweikard, Floris Ernst, "Medical Robotics", Springer, 2015. 2. Jocelyne Troccaz, "Medical Robotics", Wiley-ISTE, 2012. 3. VanjaBonzovic, "Medical Robotics", I-tech Education publishing,Austria,2008. 4. Daniel Faust, "Medical Robots", Rosen Publishers, 2016. 5. Jocelyne Troccaz, "Medical Robotics", Wiley, 2013

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Biosensors for Diagnostics | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives**

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

**Course Outcomes**

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

CO1: understand the applications of various sensors and transducers available for physiological and cellular measurements
CO2: Understand fundamental transduction and biosensing principles
CO3: Understand various measurement systems includes different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters.
CO 4: Analyze various measurement devices and techniques, including the underlying biological processes that generate the quantities to be measured or controlled.

**Syllabus**

**Unit I: 15 hours**

Introduction of biosensor: Biopotential Electrodes - Electrode electrolyte interface, polarization, polarizable and nonpolarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette (metal filled glass and glass micropipette electrodes), microelectronic, properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG & EEG)

**Unit II: Chemical Biosensors 10 hours**

Blood gas and Acid-Base Physiology, Electrical and Electrochemical sensors, reference electrode, pH, pO2, pCO2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood Glucose Sensors. Transcuteneous arterial oxygen tension & carbon dioxide tension monitoring enzyme electrode.

**Unit III: Optical Sensor and Radiation Detectors** **10 hours**

Principles of optical sensors, optical fiber sensors, indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionisation chamber, Geiger counters, Scintillation detectors.

**Unit IV: Biological sensors** **10 hours**

Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immunosensors, Basic principles of MOSFET biosensors & BIOMEMS, biosensors for POC applications, AI and IoMT enabled biosensors, basic idea about Smart sensors.

**Reference Books:**


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

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Usability of biomedical devices | L-T-P-C-3-0-0-3 |
|---|---|

**Course objective:**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to contribute to the development of safe, effective, and user-friendly biomedical devices. By understanding and applying usability principles, students will be able to enhance the usability and user experience of these devices, ultimately improving patient outcomes and user satisfaction in the healthcare context.

**Course outcome:**

The student will be able to

CO1: Understand the importance of usability in biomedical devices and its impact on user satisfaction, safety, and overall device effectiveness.

CO2: Learn about the regulatory requirements and standards related to usability and human factors engineering in the development of biomedical devices

CO3: Develop skills in conducting usability evaluations and user testing of biomedical devices, including usability testing protocols, data collection techniques, and analysis methods.

**Syllabus**

**Unit I:** **10 hours**

Introduction to Usability of Biomedical Devices, Definition of usability in biomedical devices, Importance of usability in biomedical devices, Regulatory requirements for usability in biomedical devices

**Unit II:**
**10 hours**

Human Factors in Biomedical Devices, Human factors engineering and design, User interface design, Risk management and human factors

**Unit III:** **10 hours**

Usability Testing Methods for Biomedical Devices, Usability testing methods, Choosing the appropriate usability testing method, Conducting usability testing for biomedical devices

**Unit IV:** **10 hours**

Usability Evaluation Metrics for Biomedical Devices, Usability evaluation metrics, Choosing the appropriate usability evaluation metrics, Evaluating usability using metrics for biomedical devices

**Unit V:** **5 hours**

Usability in Biomedical Device Design, Usability in biomedical device design, Designing for usability in biomedical devices, Integrating usability into the design process for biomedical devices

**Text and Reference Books:**


1. Medical Device Design: Innovation From Concept to Market by Peter J. Ogrodnik
2. Usability Testing of Medical Devices by Michael E. Wiklund and Jonathan Kendler
3. Handbook of Human Factors in Medical Device Design by Matthew B. Weinger and Michael E. Wiklund
4. Medical Device Use Error: Root Cause Analysis by Michael E. Wiklund and Andrea Dwyer
5. Usability Testing Essentials: Ready, Set...Test! by Carol M. Barnum
6. The Handbook of Task Analysis for Human-Computer Interaction by Dan Diaper
7. Measuring the User Experience: Collecting, Analyzing, and Presenting Usability Metrics by Tom Tullis and Bill Albert
8. Quantifying the User Experience: Practical Statistics for User Research by Jeff Sauro
9. Design for Six Sigma for Medical Devices by Kirti A. Patel
10. Usability Engineering in der Medizintechnik: Grundlagen – Methoden – Beispiele by Jan Zieschang and Christine Pauli

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process:**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Operational environment for medical devices L-T-P-C-3-0-0-3**

**Course objective:**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to understand and navigate the operational environment of medical devices.

**Course outcome**

The student will be able to:

CO1: Understand the diverse operational environments in which medical devices are used, including hospitals, clinics, ambulatory care settings, home healthcare, and remote monitoring.

CO2: Gain knowledge of the infrastructure and support systems necessary for the proper functioning of medical devices, including power supply, network connectivity, data management, and equipment maintenance.

CO3: Apply the importance of usability and user training in the operational environment, including the development of user manuals, training materials, and ongoing support for healthcare professionals.

**Syllabus**

**Unit I: 10 hours**

Introduction to Operational Environment for Medical Devices, Definition of operational environment for medical devices, Importance of understanding operational environment, Regulatory requirements for operational environment.

**Unit II: 10 hours**

Environmental Factors Affecting Medical Devices, Temperature and humidity, Electromagnetic interference, Mechanical stress and vibration.

**Unit III: 10 hours**

Packaging and Sterilization, Packaging materials and design, Sterilization methods and their effects on device performance, Validation of packaging and sterilization processes

**Unit IV:** **10 hours**

Shipping and Storage, Shipping methods and conditions, Storage conditions and shelf life, Effects of shipping and storage on device performance

**Unit V:** **5 hours**

Post-Market Surveillance, Post-market surveillance requirements, Complaint handling and adverse event reporting, updating labelling and instructions for use based on post-market data

Text and Reference Books:


1. Medical Device Design and Regulation by Richard F. Mulley
2. ISO 14971:2019 Medical Devices — Application of Risk Management to Medical Devices
3. Environmental Factors in Electronic Product Design by Donald P. Labriola
4. Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness by Basem El-Haik and Mark J. Norris
5. Packaging for Nonthermal Processing of Food by Jung H. Han
6. Sterilization of Medical Devices by Jeremy Bagg
7. Handbook of Pharmaceutical Manufacturing Formulations: Liquid Products by Sarfaraz K. Niazi
8. The Medical Device R&D Handbook by Theodore R. Kucklick
9. Postmarket Surveillance of Medical Devices by Toby R. K. Merriman and Jonathan J. Wiik
10. Medical Device Regulation: Global Overview and Guiding Principles by Dr. William A. Hyman


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Medical Delivery Robots | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives:**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to contribute to the development and deployment of medical delivery robots in healthcare settings. By understanding the principles and considerations related to these robots, students will be able to enhance the efficiency, accuracy, and safety of healthcare delivery, ultimately improving patient care outcomes and healthcare system operations.

**Course Outcomes:**

The student will be able to

CO1.Identify the concepts of robotics, motion, joints

CO2.Summarize the principles of sensors and actuators for robots

CO3.Use the software tools for designing and analyzing the robot motion

CO4.Classify the performance to various sensors to its environment & design concepts for simple robots for surgical applications

**Syllabus:**

**Unit I : Introduction of Robotics: 5 hours**

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

**Unit II : Actuators and Grippers : 10 hours**

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.

**Unit III: Manipulators: 10 hours**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator

**Unit IV: Basic Kinematics:** **5 hours**

Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems.

**Unit V: Power Sources and Sensors :** **5 hours**

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.

**Unit VI: Robotics In Medicine** **5 hours**

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.


**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. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System Applications & Visions”, Springer 2011.
3. Barbara Webb and Thomas Consi. R, “BioRobotics: Methods & Applications”, AAAI Press/MIT Press, First Edition, 2001.
4. Constantinos Mavroidis, Antoine Ferreira, “Nanorobotics: Current approaches and Techniques”, Springer 2011.
5. Fu.K.S, Gonzalez.R.C. Lee, C.S.G, “Robotics, control, sensing, Vision and Intelligence”, Tata McGraw Hill International, First edition, 2008.

## Mode of Exam Evaluation Process

### Theory Assessment:

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

### Laboratory Assessment:

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

### Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Rehabilitation Robots | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives**:

The objective of the course is to understand the principles, design considerations, and clinical applications of rehabilitation robots. Students will be able to contribute to the development of innovative and effective solutions that improve the rehabilitation outcomes and quality of life for individuals with physical impairments or disabilities.

**Course Outcomes**:

The Student will be able to
CO1:Describe the types of medical robots and the concepts of navigation and motion replication.
CO2:Discuss about the sensors used for localization and tracking
CO3: Summarize the applications of surgical robotics
CO4: Outline the concepts in Rehabilitation of limbs and brain machine interface

**Syllabus**

**Unit I: Introduction** **10 hours**
Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.

**Unit II : Localization And Tracking** **10 hours**
Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - Hybrid systems.

**Unit III : Control Modes** **15 hours**
Motion Replication, Imaging, Rehabilitation and Prosthetics, State of art of robotics in the field of healthcare; Localization and Tracking: Position sensors requirements, Tracking, Mechanical linkages, Optical, Sound-based, Electromagnetic, Impedance-based, In-bore MRI tracking, Video matching, Fiber optic tracking systems, Hybrid systems.Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

**Unit IV: Rehabilitation** **10 hours**
Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies. Steerable Needles.Assistive robots –types of assistive robots – case studies. Design of Medical Robots, Characterization of gestures to the design of robots- Design methodologies- Technological choices - Security.

Text Books:
1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, “Robot Modeling and Control”, Wiley Publishers, 2006. 2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012. Reference Books: 1. AchimSchweikard, Floris Ernst, “Medical Robotics”, Springer, 2015. 2. Jocelyne Troccaz, “Medical Robotics”, Wiley-ISTE, 2012. 3. VanjaBonzovic, ”Medical Robotics”, I-tech Education publishing,Austria,2008. 4. Daniel Faust, “Medical Robots”, Rosen Publishers, 2016. 5. Jocelyne Troccaz, “Medical Robotics”, Wiley, 2013

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Telerobots | L-T-P-C-2-1-0-3 |
|---|---|

**Course Objectives:**

The course aims to equip students with the knowledge, skills, and critical thinking abilities necessary to contribute to the field of telerobotos. By understanding the principles, technologies, and applications of telerobots, students will be able to develop innovative solutions, address challenges, and explore new frontiers in remote robotic operations, ultimately enabling safer, more efficient, and more versatile remote control and automation capabilities.

**Course Outcomes:**

The student will be able to

CO1: Understand the concept and importance of telerobotics, which involves the remote operation of robots over a distance using communication networks.

CO2: Acquaint themselves with the different types of telerobots, such as teleoperated robots, surgical robots, and remotely operated vehicles (ROVs), and their applications in various fields, including healthcare, industry, exploration, and disaster response.

CO3: Apply the principles and techniques for controlling telerobots, including kinematic and dynamic modeling, teleoperation interfaces, telepresence, and shared autonomy.

**Syllabus:**

**Unit I:** **10 hours**

Introduction to Telerobotics, Definition of telerobotics, Historical background of telerobotics, Applications of telerobotics

**Unit II:** **10 hours**

Telerobotic System Design, Telerobotic system components, Functionalities of telerobotic system components, Design considerations for telerobotic systems

**Unit III:** **10 hours**

Telerobotic Control and Communication, Telerobotic control methods, Communication protocols for telerobotic systems, Challenges in telerobotic communication

**Unit IV:** **10 hours**

Telerobotic Applications in Healthcare, Telemedicine and telerobotics, Telesurgery and telerobotics, Telerobotics in rehabilitation

**Unit V:** **5 hours**

Ethics and Social Implications of Telerobotics, Ethical considerations in telerobotics, Social implications of telerobotics, Accessibility and telerobotics

Text and Reference Books:


1. Telerobotics, Automation, and Human Supervisory Control by Bradley D. Austin and Michael J. Barnes
2. Telerobotics, edited by Giovanna Varni and Antonio Visioli
3. Telerobotics, Automation, and Human Supervisory Control by Bradley D. Austin and Michael J. Barnes
4. Robotics and Automation Handbook, edited by Thomas R. Kurfess
5. Teleoperation and Robotics: Applications and Technology by Richard C. Dorf and James A. J. Fitzpatrick
6. Handbook of Robotics, edited by Bruno Siciliano and Oussama Khatib
7. Telemedicine Technologies: Information Technologies in Medicine and Telehealth by Bernard Fong and Ronald L. Merrell
8. Robotic Surgery: Current Applications and New Trends, edited by Vipul Patel
9. Ethics, Computing, and Genomics, edited by Herman T. Tavani and James H. Moor
10. The Ethics of Information and Communication Technologies, edited by Adriana Allen and David Wright


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Surgical assistive robots | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objectives:**

This course will provide students to contribute to the development and implementation of innovative and effective solutions that improve surgical outcomes, patient safety, and surgeon satisfaction in various surgical specialties using surgical assistive robots.

**Course Outcomes:**

The student will be able to

CO1: Understand the role and significance of surgical assistive robots in enhancing surgical procedures, improving precision, and reducing invasiveness.

CO2: Familiarize themselves with the different types of surgical assistive robots, including robot-assisted surgical systems, robotic arms, and image-guided surgical robots, and their applications in various surgical specialties.

CO3: Understand the workflow and interaction between surgeons, surgical teams, and surgical assistive robots during procedures, including considerations for training, communication, and coordination

**Syllabus:**

**Unit I:** **10 hours**

Introduction to Surgical Assistive Robots, Definition of surgical assistive robots, Historical background of surgical assistive robots, Applications of surgical assistive robots

**Unit II:** **10 hours**

Design and Development of Surgical Assistive Robots, Components of surgical assistive robots, Functionalities of surgical assistive robot components, Design considerations for surgical assistive robots

**Unit III:** **10 hours**

Surgical Assistive Robot Control and Navigation, Control methods for surgical assistive robots, Navigation techniques for surgical assistive robots, Challenges in surgical assistive robot control and navigation

**Unit IV:** **10hours**

Surgical Assistive Robot Applications in Surgery, Minimally invasive surgery and surgical assistive robots, Robot-assisted surgery and surgical assistive robots, Benefits and challenges of using surgical assistive robots in surgery

**Unit V:** **5 hours**

Ethics and Social Implications of Surgical Assistive Robots, Ethical considerations in surgical assistive robotics, Social implications of surgical assistive robots, Accessibility and surgical assistive robots

**Text and Reference Books:**


1. Surgical Robotics: Systems Applications and Visions, edited by Jacob Rosen, Blake Hannaford, and Richard M. Satava
2. Robotics and Automation Handbook, edited by Thomas R. Kurfess
3. Robotics: Control, Sensing, Vision, and Intelligence, edited by C.S.G. Lee
4. Introduction to Autonomous Robots: Mechanisms and Sensors, edited by Nikolaus Correll and Bradley Hayes
5. Medical Robotics, edited by Jong-Oh Park
6. Robotics, AI and Ethics: Critical Perspectives for the 21st Century, edited by Robert Sparrow, Julie McCann, and Kathleen Richardson
7. Robot Ethics 2.0: From Autonomous Cars to Artificial Intelligence, edited by Patrick Lin, Keith Abney, and Ryan Jenkins


**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

| Ergonomics | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objective**

Ergonomics is the study of human beings while they interact with the surroundings in general and products in specific. Ergonomics has its essence in creating products which are efficient in usability from the user point of view.

This course introduces human factors and its application in product design. It also introduces students to the basic foundation principles of human factors, to develop better products for the user. It encourages developing objective methods of evaluating ergonomic problems and the generation of more human centric design solutions.

**Course Outcomes**

The student will be able to :

CO1. Understand key concepts and components of ergonomic and its application.
CO2. Learn the principles of biomechanics and Human Physiology in context of design
CO3. Apply the basics of ergonomics, anthropometry and biomechanics in designing workstations

**Syllabus:**

**Unit I : Introduction to Ergonomics** **10 hours**

Definition of Ergonomics; Origin and history of ergonomics; Scope of ergonomics in design; Components of ergonomics

**Unit II: Biomechanics and Physiology** **10 hours**

What is biomechanics; Human body as a lever; Equilibrium, balance and stability; Centre of Gravity; Work postures; Vertebral column; Musculoskeletal Disorder- types and causes.

**Unit III: Anthropometry** **10 hours**

What is anthropometry; types of anthropometry; sources of variation in human population; anthropometric principles in design of product and workstation; concept of percentile value of anthropometric data

**Unit IV: Visual Ergonomics** **10 hours**

Human visual processes; lighting; visual demands of a task; visual comfort and safety; optical corrections

**Unit V: User need study** **5 hours**

Maslow's hierarchical theory of human needs vs Jordan's hierarchy of user needs

***Practical/Tutorial***

Student need to do a project to check their understanding of ergonomics, anthropometric principles. For example they need to redesign any existing hand held product or workstation

**Table: Correlation of POs v/s COs**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |
| | | | | | | | | | | | | | | | |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

***Reference Books:-***


1. Sanders, M. S., & McCormick, E. J. (1998). *Human factors in engineering and design* (p. 22). New York: McGraw-Hill.
2. Salvendy, G. (2012). *Handbook of human factors and ergonomics*. John Wiley & Sons.
3. Bridger, R. (2008). *Introduction to ergonomics*. Crc Press.
4. Pheasant, S., & Haslegrave, C. M. (2016). *Bodyspace: Anthropometry, ergonomics and the design of work*. CRC Press.
5. Karwowski, W., Soares, M. M., & Stanton, N. A. (Eds.). (2011). *Human factors and ergonomics in consumer product design: Uses and Applications*. CRC Press.
6. Karwowski, W. (Ed.). (2001). *International encyclopedia of ergonomics and human factors* (Vol. 3). Crc Press.
7. Bhattacharya, A., & McGlothlin, J. D. (Eds.). (1996). *Occupational ergonomics: theory and applications* (No. 27). CRC Press.
8. Anshel, J. (2002). *Visual ergonomics in the workplace*. CRC Press.
9. Dellerman, N. J., Haslegrave, C. M., & Chaffin, D. B. Working postures and movements. Tools for evaluation and engineering. 2004.
10. Tilley, A. R. (2002). *The measure of man and woman: human factors in design* (Vol. 1). John Wiley & Sons.

**Web Links:**

1. https://www.youtube.com/watch?v=LAKlmdMHpdE
2. https://www.youtube.com/watch?v=3kVnUqvRJV0
3. https://www.cdc.gov/niosh/topics/ergonomics/default.html
4. https://www.iea.cc/

**Online Videos**

1. https://www.youtube.com/watch?v=LAKlmdMHpdE
2. https://www.youtube.com/watch?v=HHcK1Zbtvyg
3. https://www.youtube.com/watch?v=vSwH8-MFkKc
4. https://www.youtube.com/watch?v=1GRvasLjPag
5. https://www.youtube.com/watch?v=WLa0bLP8-sE
6. https://www.youtube.com/watch?v=z0xLL8VWQAg

| Form Studies | L-T-P-C-3-0-0-3 |
|---|---|

**Course Objective:**
A form of an object/ product refers to its identity in a 3-dimensional space. The form also manifests itself in the tangible aspects in which we perceive an object with our different senses. The Form of a product thus becomes the crux for the Fit, Finish, Function and Value as well as becomes a primary Touchpoint for product- user interaction. This course is an introduction to forms and helps students to understand form as a building block and experiment with the block's manifestation into various possibilities.

**Course Outcomes**
The students will be able to

**CO1:** Gain knowledge about the Visual and tangible perception of Forms.
**CO2:** Understand the various nuances of Form generation.
**CO3:** Learn to work hands on generating Forms from a basic fundamental Unit and able to analyse natural and manmade forms.
**CO4:** Analyze methods of transitions and manipulations.

**Syllabus:**
- Grids- Creating 2D shapes from a grid
- Application of Elements and Principles of Design in generation of shape.
- Geometric and Organic Forms
- Cube as a basic unit, Additive and subtractive properties in form generation. Edge and Vertex treatments in a cube.
- Product – Thing, Object and Icon
- Form Development through inspiration and metaphor
- Understand a basic Form Cube/ Cylinder/ Cone etc. Form generation by addition and subtraction of massing.
- Study of forms in nature and abstraction of formal characteristics in basic forms.
- Product form and aesthetics
- Form Transitions- Basic shapes, complex shapes
- Form manipulations- Radii, Edge and Surface manipulations.
- Form its emotion and expression.
- Lifestyle Board, Mood Board, Visual Theme Board

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process**

**Theory Assessment:**

| | Continuous Assessment/Internal Assessment (50) | | | | Mid Term Exam | End Term Exam | Total |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | Continuous Assessment/Internal Assessment | | | End Term Examination | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
| **Weightage (%)** | 30 | 20 | 20 | 20 | 10 | 100 |

**Table: Correlation of POs & PSOs v/s COs**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Prerequisites and Materials**

- Students should have basic understanding of Design Elements and Principles of Design.

***Reference Books:-***


1. *Elements of Design: Rowena Reed Kostellow and the Structure of Visual Relationships* by Gail Greet Hannah, Princeton Architectural Press
2. *Principles of Form and Design* by Wucius Wong, Wiley

3. *Design and Form: The Basic Course at the Bauhaus by Johannes Itten,* Thames & Hudson Ltd
4. *Form, Function & Design* by Paul Jacques Grillo, Dover Publications
5. *Art Forms in Nature* by Ernst Haeckel, Dover Publications
6. Grillo P J - Form, Function, Design – Dover Publication
7. Lidwell W et al: Universal Principle of Design – Rockport.
8. Patric W Jordan – Designing a Pleasurable Product – Contemporary Trends Institute.
9. Coats D, Watches Tell More than Time – Product Design, Information, Quest for elegance. Mc Graw Hill.
10. Clive Grinyer – Smart Design Products That Change Our Lives – Rotovision.
11. Chartlotte & Peter Fiell – Design of The 20th Century - TASCHEN
12. Wucius Wong, Van Nostrand Reinhold Principles Of Form And Design, John Wiley & Sons, New York 1993
13. Gail Greet Hannah – Elements of Design – Rowena Reed Kostellow & The structure of visual relationship – Princeton Architectural Press. NY
14. Paul Zalanski, Mary Pat Fisher - Design Principles And Problems – Harcourt Brace College Publication.
15. Heskett - Industrial Design – Thames Hudson
16. IDSA – Design Secrets: Products - Rockport.
17. Grillo P J - Form, Function, Design – Dover Publication
18. Lidwell W et al: Universal Principle of Design – Rockport.
19. Patric W Jordan – Designing a Pleasurable Product – Contemporary Trends Institute.
20. Coats D, Watches Tell More than Time – Product Design, Information, Quest for elegance. Mc Graw Hill.
21. Clive Grinyer – Smart Design Products That Change Our Lives – Rotovision.
22. Chartlotte & Peter Fiell – Design of The 20th Century - TASCHEN
23. Alan Pipes – Drawings for 3 – Dimensional Design, Concepts, Illustrations, Presentation – Thames and Hudson.
24. Peter Stanyer and Terry Rosenberg – A Fundamental Course in Drawing.
25. Judy Martin – The Encyclopedia of Pastel Techniques - Search Press.
26. Keith West, Watson – Basic Perspective for Artists – Guptill Publications
27. Leatrice eiseman – PANTONE - Guide to Communicating with color – Grafixpress Ltd.
28. David Jury - Reviving the Rule of Typography. – Rotovision

***Online videos:***

1. https://www.youtube.com/watch?v=Nbv_-4GT3Ag
2. https://www.youtube.com/watch?v=IiPHL0L2Vh8
3. https://www.youtube.com/watch?v=EfO5gLjGu2g
4. https://www.youtube.com/watch?v=LC4vVcu-FWY
5. https://www.youtube.com/watch?v=wRdq-CU3xu8
6. https://www.youtube.com/watch?v=IiPHL0L2Vh8&t=6s
7. https://www.youtube.com/watch?v=dotqGZ3B7Bg
8. https://www.youtube.com/watch?v=-GIKHOmq5tg
9. https://www.youtube.com/watch?v=I_y8zQZOZns
10. https://www.youtube.com/watch?v=S0RKoV8hXxw
11. https://www.youtube.com/watch?v=fmDn9qP8yRo

| Material and Processes/Material Exploration | L-T-P-C-3-0-0-3 |
|---|---|

**Course objective**

Design industry is largely supported and influenced by the materials and processes used in the manufacturing of the final product. The kind of material used in a particular product changes the process used for manufacturing and vice versa.
With advances in technology and availability of various types of new materials, the design and style industry has risen to great extent. Also, the creative value of the products has taken a huge leap. It is, hence, of the utmost importance that a designer should have the basic understanding of various materials and the way they are processed to suit the product. This course will lay the foundation in the arena.

**Course outcome**

CO1: To understand of natural and manmade materials.
CO2: To understand the processes associated with plastics, glass, ceramic, natural materials and metals.
CO3: To demonstrate the understanding of material for various application.

**Syllabus:**

**Unit I: Introduction** **10 hours**

History and fundamentals, types of materials, materials used in the industry, automotive materials, properties of engineering materials, factors affecting the properties, effect of temperature, atmosphere, heat etc.

**Unit II:** **10 hours**

Thermoplastics, Thermosetting Plastics, Composites, And Elastomers:
Types, specific needs, material properties/characteristics, uses, manufacturing process, various reinforced composites, hybrid composite, adhesives, concrete, vulcanisation of rubber.

**Unit III:** **10 hours**

Process of Selection & Applications Of Plastics For Engineering & Consumer Products:
Factors affecting the selection of material, properties of plastics, types of plastics, forming, fabricating and moulding processes, deformation, applications, design limitations and potentials of plastics and their moulding processes, significance of materials and their form in structural strength of products, influence of materials and processes on product aesthetics.

**Unit IV:** **5 hours**

Types of materials:
Ceramics, Natural materials, Metals, (Properties, nature of materials, types, special applications in product)

**Unit V:** **10 hours**

Sheet Metal Grades And Working Processes

Introduction to grades, types of grades (O, D, DD, EDD), grading standards, grading requirements and uses. Blanking, piercing, lancing, forming, hemming, drawing

**Mode of Exam Evaluation Process:**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
|---|---|---|---|---|---|---|---|
| **Components** | Surprise Test/Quiz | Assignments | Group Discussion/Presentations | Project Based Learning/ Tutorials based learning | | | |
| **Weightage (%)** | 10 | 10 | 10 | 20 | 20 | 30 | 100 |

**Laboratory Assessment:**

| | **Continuous Assessment/Internal Assessment** | | | **End Term Examination** | | |
|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
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**Table: Correlation of POs & PSOs v/s COs**

| **Program Outcomes / Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped

**Reference Books:-**


1. Manufacturing Processes for Design Professionals by Rob Thompson, Thames & Hudson
2. Materials and Process Selection for Engineering Design, Second Edition by Mahmoud M. Farag, CRC Press
3. Industrial Design: Materials and Manufacturing Guide by Jim Lesko, Wiley
4. Elements of Workshop Technology by Samir Kumar Hajra Choudhary, Media Promoters & Publishers Pvt Ltd
5. Workshop Technology by W. A. J. Chapman, Routledge
6. Manufacturing Processes for Design Professionals by Rob Thompson, Thames & Hudson
7. Materials and Process Selection for Engineering Design, Second Edition by Mahmoud M. Farag, CRC Press
8. Industrial Design: Materials and Manufacturing Guide by Jim Lesko, Wiley

| HSCC1004 | Biochemistry | L-T-P-C:2-1-0-3 |
|---|---|---|

**Course objectives**: The course is aimed to give students an exposure of basic role of biomolecules and their chemical interactions inside the cell. It provides deeper insight into structures, properties and functions of major bio-molecules and metabolic pathways in the living systems.

**Course outcomes**: After the completion of course, the students will be able to :

1. Understand the structure and functions different chemical building blocks of life.
2. Identify and draw structures of various types of biomolecules (carbohydrate, lipids, proteins and nucleic acids).
3. Explain about basic concepts of enzymes and central role of enzymes in catalyzing the reactions in living system.
4. Comprehensive knowledge of primary biochemical pathways leading to synthesis and catabolism of major bio-molecules.

**Course content**

**Unit-I** **10 hours**

Monosaccharides-structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers. Disaccharides- Maltose, Lactose and Sucrose. Polysaccharides-homo and heteropolysaccharides, structural and storage polysaccharides. Anabolism and catabolism, Glycolysis - a universal pathway, reactions of glycolysis, Production of acetyl CoA, reactions of citric acid cycle. Gluconeogenesis, Glycogenesis and glycogenolysis.

**Unit-II** **10 hours**

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes- Phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols. Introduction to lipid micelles, monolayer and bilayer. β oxidation of fatty acids. Fatty acid synthesis . Synthesis of fatty acids.

**Unit-III** **15 hours**

Amino acids and peptides- classification (essential and non-essential amino acids), chemical and physical properties. Natural modification of amino acid, Non-protein amino acids, Titration curve of amino acid and its significance, Introduction to protein structure and function, alpha helix, beta pleated sheets, tertiary and quaternary structure of proteins, Different non-covalent and covalent interactions, Amino acid metabolism-Amino acid deamination and transamination. Urea cycle. Introduction to enzymes, classification of enzymes, Mechanism of action, Factors affecting enzyme activity, Michaelis-Menten equation, significance of Km, Vmax and turnover number.

**Unit-IV** **10 hours**

Nucleotides - structure and properties. Nucleic acid structure-Watson - Crick Model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. De novo synthesis of purine and pyrimidine nucleotides, Disorders of purine and pyrimidine metabolism

**Suggested reading**

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292- 3414-8.
2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.
3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer, L., W.H Freeman and Company (New York), ISBN: 13:978-1-4292-7635-1.

**Modes of Evaluation:**

**Continuous evaluation (70 %) and End Exam (30%)**

**Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Mode of Exam Evaluation Process:**

**Theory Assessment:**

| | **Continuous Assessment/Internal Assessment (50)** | | | | **Mid Term Exam** | **End Term Exam** | **Total** |
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**Laboratory Assessment:**

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|---|---|---|---|---|---|---|
| **Components** | Experimental Performance | Viva voce | Lab record | Major Experiments (Practical) | Viva voce | Total |
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**Relationship between the Course Outcomes (COs) and Program Outcomes (POs)**

| Program Outcomes / Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 2 | 2 |
| **CO 2** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 3 | 2 |
| **CO 3** | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 1 |
| **CO 4** | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 2 | 3 | 2 |
| **Average** | **3** | **1** | **2** | **2** | **1** | **1** | **1** | **1** | **2** | **1** | **1** | **3** | **1** | **2** | **2** |

1= weakly mapped, 2 = moderately mapped, 3 = strongly mapped