*Scheme of Instruction, Evaluation*

*And*

*Syllabi of*

*With effect from Academic Year 2023-24*

# B.E. Biomedical Engineering

## III & IV Semesters


**DEPARTMENT OF BIOMEDICAL ENGINEERING**

**UNIVERSITY COLLEGE OF ENGINEERING**

**(Autonomous)**

**Esd.1917** **Hyderabad – 500 007, TS, INDIA** **Estd. 1929**

With effect from the academic year 2023-2024

# SCHEME OF INSTRUCTION

**B.E. (Biomedical Engineering)**

**III - SEMESTER**

*With effect from the Academic year 2023-2024*

| Sl.No | Course Code | Course Name | Contact hours per week | | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|
| | | | L | P | CIE | SEE | |
| **THEORY** | | | | | | | |
| 1. | BS 301 MT | Engineering Mathematics-II | 3 | - | 40 | 60 | 3 |
| 2. | ES 301 BM | Electronic Circuits | 3 | - | 40 | 60 | 3 |
| 3. | HS 301 BM | Hospital Administration and Management | 3 | - | 40 | 60 | 3 |
| 4. | PC 301 BM | Anatomy | 3 | - | 40 | 60 | 3 |
| 5. | PC 302 BM | Physiology | 3 | - | 40 | 60 | 3 |
| 6. | PC 303 BM | Biochemistry | 3 | - | 40 | 60 | 3 |
| **PRACTICALS** | | | | | | | |
| 7. | ES 351 BM | Electronic Circuits Lab | - | 2 | 25 | 50 | 1 |
| 8. | PC 351 BM | Anatomy Lab | - | 2 | 25 | 50 | 1 |
| 9. | PC 352 BM | Physiology Lab | - | 2 | 25 | 50 | 1 |
| 10. | PC 353 BM | Biochemistry Lab | - | 2 | 25 | 50 | 1 |
| | | **TOTAL** | **18** | **08** | **340** | **560** | **22** |

L : Lectures

T : Tutorials

P : Practical

CIE : Continuous Internal Evaluation

SEE : Semester End Examination

With effect from the academic year 2023-2024

**BS 301MT**

# ENGINEERING MATHEMATICS – II

(Common to all branches)

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of University Examination | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To study matrix algebra and its use in solving system of linear equations and in solving eigen value problems
2. To provide an overview of ordinary differential equations
3. To study special functions like Legendre and Bessel functions
4. To introduce the concept of functions of complex variable and their properties

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

1. Solve system of linear equations and eigen value problems
2. Solve certain first order and higher order differential equations
3. Determine the analyticity of complex functions and expand functions as Taylor and Laurent series
4. Evaluate complex and real integrals using residue theorem

## UNIT-I

**Matrices :**Elementary row and column operations, Rank of a matrix, Echelon form, System of linear equations, Linearly dependence and independence of vectors, Linear transformation, Orthogonal transformation, eigen values, Eigenvectors, Properties of eigen values, Cayley-Hamilton theorem, Quadratic forms, Diagonalization of Matrices, Reduction of quadratic form to canonical form by orthogonal transformation , Nature of quadratic forms.

## UNIT-II

**First Order Ordinary Differential Equations :**Exact first order differential equations , Integrating factors, Linear first order equations , Bernoulli's, Riccati's and Clairaut's differential equations ,Orthogonal trajectories of a given family of curves.

## UNIT-III

**Differential Equations of Higher Orders :**Linear independence and dependence, Solutions of second and higher order linear homogeneous equations with constants coefficients, Method of reduction of order for the linear homogeneous second order differential equations with variable coefficients , Solutions of non-homogeneous linear differential equations, Method of variation of parameters, solution of Euler-Cauchy equation, Simultaneous linear differential equations, Power Series solution, Legendre Polynomial of first kind, Bessel's function of first kind and their properties

## UNIT-IV

**Functions of a Complex Variable**: Limits and continuity of a function, differentiability and analyticity, Elementary Analytic functions, Necessary and Sufficient conditions for a function to be analytic, Cauchy-Riemann equations in polar form, harmonic functions, complex integration, Cauchy's integral theorem, extension of Cauchy's integral theorem for multiply connected regions, Cauchy's integral formula, Cauchy's inequality, Cauchy's formula for derivatives, Liouville's theorem, Maximum Modulus principle (without proof)and its applications.

## UNIT-V

**Residue Calculus:** Power series, Taylor's series, Laurent's series, zeros and singularities, residues, residue theorem, evaluation of real integrals using residue theorem, Argument principle, Rouche's Theorem and their applications, conformal mapping Bilinear transformations. (**All Theorems without Proof).**

***Suggested Readings:***


1. R.K. Jain & S.R.K. lyengar, *Advanced Engineering Mathematics*, Narosa Publications, 4th Edition,2014.
2. Erwin Kreyszig, *Advanced Engineering Mathematics*, John Wiley , 9th Edition, ,2012.
3. Dr. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publications, 43rd Edition,2014.
4. Dr. M.D. Raisinghania, *Ordinary and Partial differential equations*, S.CHAND, 17th Edition 2014.
5. James Brown, R.V Churchill, *Complex Variables and applications*, Mc Graw Hill 9th Edition 2013.
6. B.V. Ramana, *Higher Engineering Mathematics*, 23rd reprint, 2015.
7. S.L Ross, *Differential Equations* 3rd Edition, Wiley India.
8. G.F. Simmons and S.G. Krantz, *Differential Equations*, Tata Mc Graw Hill, 2007.
9. N. Bali, M.Goyal, A text book of *Engineering Mathematics*, Laxmi publications,2010
10. H.K. Dass, Er. Rajnish Varma, *Higher Engineering Mathematics*, S Chand Technical Third Edition.

With effect from the academic year 2023-2024

**ES 301 BM**

## ELECTRONIC CIRCUITS

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. The course facilitates the students to study the principle and operation of Op-Amps.
2. Exposure towards the applications of the Op-Amps.
3. To know about the linear wave shaping circuits.
4. The students also learn about Voltage regulators and SMPS.

**Course Outcomes**:

1. Understand and design the concept of Oscillators.
2. Illustrate Operational amplifiers and their internal devices, including BJT and MOSFET transistors.
3. Examine different applications of OP-AMPs with design examples.
4. Design linear wave shaping circuits and higher order filters.
5. Outline the basic concept of Power supply and SMPS.

**UNIT-I**

**Sinusoidal Oscillators:** Condition for oscillations – LC Oscillators – Hartley, Colpitts, Frequency and amplitude stability of oscillators – Crystal Oscillators – RC Oscillators – RC phase shift and Wien bridge oscillators.

**UNIT-II**

**Operational Amplifiers :** Concept of Direct Coupled Amplifiers. Differential Amplifier- Calculation of Common Mode Rejection Ratio, Differential Amplifier supplied with a constant current source, Normalized Transfer Characteristics of a differential Amplifier. Ideal Characteristics of an operational Amplifier, and Parameters of an Op-Amp.

**UNIT-III**

**Applications of Operational Amplifier:** Inverting and Non-inverting Amplifiers, Summing, scaling and Averaging amplifiers, Integrators, Differentiators, Logarithmic Amplifiers, Bio-signal Amplifiers, Actuator drivers, Rail-to-Rail op-amps, Voltage to Current and Current to Voltage Converters, Precision Rectifiers, Peak Detectors. Comparators, Schmitt trigger, Multivibrators, Waveform generators (triangular and saw tooth), 555 Timers.

**UNIT-IV**

**Linear wave shaping circuits & Filters:** Clipping circuits for single level and two level, Clamping circuit and applications Butterworth Filters: Active low pass Filter, High pass filter, Band pass filter, Band elimination filter & Notch filter. Higher order Filters and their Comparison. Design of second, fourth and sixth order filters using op-amps. Switched Capacitance Filters.

**UNIT-V**

**Voltage Regulators & SMPS** Linear power supply (voltage regulators); Basic Transistorized regulators, Three pin regulators, switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode.

Working principle of SMPS, Block Diagram of SMPS, Design criteria for SMPS, comparison of linear & switching power supply. Batteries, Types.

**Suggested Reading:**

1. Ramakanth A Gayakwad, *Op-Amps and Linear ICs*, 4th Edition, PHI, EE Edition, 2013.
2. R.F Coughlin and F.F Driscoll, *Op-Amps and Linear Integrated Circuits*, PHI, EE Edition, 4th Edition.2001.
3. JB Gupta, Electronic Devices and Circuits, S.K Kataria & sons, 5th Edition, 2012.

**HS 301 BM**

## HOSPITAL ADMINISTRATION AND MANAGEMENT

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of University Examination | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**COURSE OBJECTIVES:**

1. To be familiar with the administration of all the departments in the hospitals.
2. To understand the Hospital Planning and Information management.
3. To learn the Equipment Maintenance Management

**COURSE OUTCOMES:** Upon completion of the course, the student will be able to

1. Familiarize with knowledge and skills necessary to competently manage a health care facility.
2. Know the roles and responsibilities of various departments present in the hospital.
3. Comprehend different services, Computer management in various departments in the hospital
4. Realize electrical supply and utilization of various equipments present in the hospital
5. Recognize the skills required for maintaining the Biomedical equipment and department.

**UNIT – I**

Hospital Administration: Challenges of the hospital, Roles and functions of hospital administration, Role and evolution of hospitals, Types and Classification of Hospitals - Teaching-cum-Research Hospitals, General Hospital, Specialist Hospitals, P.H.C. Ethical and Legal aspects of hospital administration.

**UNIT – II**

Hospital Management: Approaches to management, Principles of Management, Managerial activities of a hospital, Materials management. Hospital Planning – Principles, location, site selection, hospital planning team. Budgeting, equipping a hospital. Computers and Information Management in Hospitals: Admission/Discharge Records. Patient Billing. In-patient and OPD Registration, Pharmacy Management. Purchase and Inventory Control. Risk Management.

**UNIT – III**

Hospital Services: Clinical Services – Outpatient, Emergency, Inpatient, Intensive care unit, Operation Theater and Nursing. Diagnostic and Therapeutic Services – Laboratory, Radiology, Pharmacy and Transfusion. Support and Utility Services – Medical Records department, CSSD, Dietary, housekeeping and Public relations in hospitals. Ambulance, Fire Fighting and Safety services. Hospital Infection and Control. BME Services in Hospitals.

**UNIT – IV**

Electrical factors in Hospital Design: Layout and Centralization of Technical Services, Electrical Power Supply: Reliability, Three Phase Systems. Voltage stabilization. Proper location of Air Conditioners, Elevators, Transformers, other electrical machinery and Electrical Shielding techniques to prevent 50Hz power supply interference on sensitive Electro Medical / Diagnostic / Monitoring / Therapeutic Equipment. Standby power supply arrangements. Centralization: Commonality of technical services and centralization for optimum utility of equipment and staff. Efficient operation and cost effectiveness.

**UNIT – V**

Medical Equipment Maintenance Management: Procurement Procedures, Proper Selection, Safety, Spares, Evaluation, Testing and Installation. Purchase and Contract Procedures. Training of medical staff on technical capabilities and proper use of Biomedical equipment. Biomedical Equipment Maintenance: Procedures & Policy, Mandatory Requirements. Maintenance Procedures- AMC, CMC. Servicing Procedures: Servicing Schedules.

Fault Diagnosis. Repairs and Modifications. Maintenance of Log Books. Implementation of Electrical Safety Codes and Standards, Stores Management. Functional Organization of a BME/Clinical Engineering Department, NABL-NABH documentation.

**Suggested Reading:**


1. Goel S.L., and Kumar R., *Hospital Administration and Management* Vol. 1,2,3, Deep and Deep, New Delhi.
2. G.D. Kunders, *Hospitals Planning, Design and Management*, Tata McGraw-Hill, 2003.
3. DC Joshi., and Mamatha Joshi., *Hospital Administration @2009, Jaypee Brothers Medical Publishers*, New Delhi.
4. BM Sakharkar, *Principles of Hospital Administration & Planning*, @ 2009. *Jaypee Brothers Medical Publishers*, New Delhi.

**PC 301 BM**

## ANATOMY

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:** The course is taught with the objective of enabling the student to

1. Understand the Anatomical terms, planes, positions of the body and study structure, classification, location and action of muscles, bones and joints with examples.
2. Study the structure and classification of nervous system, parts and coverings of brain and spinal cord.
3. Study the location and structure of lungs, heart and major blood vessels of the body and understand the general plan of circulatory system.
4. Describe the location and structure of various parts of Gastrointestinal tract, its associated glands, urinary and reproductive systems.
5. Study the location structure function and secretions of major endocrine glands of the body.

**Course Outcomes:** On completion of this course student will be able to

1. Define the anatomical terms, planes, positions and classify muscles, bones and joints of the body.
2. Understand the parts of nervous system and assess the functionality of the brain.
3. Understand the organs of the thoracic cavity and major blood vessels of the body and describe their structural and functional correlation.
4. Understand the parts of digestive, excretory and reproductive systems and understand their structural and functional correlation.
5. Appreciate the significance of the structure and secretions of endocrine glands.

**UNIT-I**

**Musculo-Skeletal System:** Anatomical Positions. Planes of Body. Anatomical terms. Skeletal system. Bones: Types with examples. Joints: Types with examples. Structure and Classification of synovial joint with examples. Muscular system. Types and locations. Structure of a skeletal muscle. Important muscle of limbs-location. Actions.

**UNIT-II**

**Nervous System:** Classification into Central Nervous System (CNS), Peripheral Nervous System (PNS), Autonomic Nervous System (ANS).

**Brain &Spinal Cord:** Meninges covering with emphasis on subarchnoid space. Spinal cord. Subdivisions of brain. Base of brain with cranial nerve attachments. Brain stem, Cerebellum, Cerebrum, Diencephalon, Ventricular System, Peripheral Nervous System, Autonomic Nervous System, Special Senses.

**UNIT-III**

**Circulatory System:** Heart. General plan of Circulatory System-Arterial System, Venous System, Lymphatic System. Important Blood Vessels of different parts of body.

**Respiratory system:** Various parts of Respiratory System-Trachea, Bronchial tree, Lungs.

**UNIT-IV**

**Digestive System:** Parts of Digestive System. Important parts of Gastro Intestinal Tract (GIT) and associated glands.

**Urinary system:** Parts of Urinary System. Kidneys, Urater, Urinary Bladder and Urethra. Male Reproductive System. Female Reproductive System.

**UNIT-V**

**Endocrine Glands:** Location, Descriptions and functions-Thyroid, Pituitary, Pancreas, Supra renal, Parathyroid-Important relations, Secretions.

**Suggested Readings:**

1.Gibson J, *Modern Physiology & Anatomy for Nurses*, Blackwell Scientific Publishers, 1981
2.Charles E.Tobin, *Basic Human Anatomy*, McGraw Hill, 1980.

**PC 302 BM**

## PHYSIOLOGY

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. This course is designed such that the student is exposed to various mechanisms involved in the normal functioning of human body underlining the basic working principles of different biological processes with Engineering tools.
2. It deals with the overall functional orientation of a living organism which has undergone a variably rapid change all through its process of evolution.
3. Casting a systematic array of different systems such as respiratory, circulatory, neuro-muscular mechanisms, stimuli propagation etc, emphasizing on the clinical importance of the same.

**Course Outcomes:**

1. understand various mechanisms involved in the normal functioning of human body
2. Able to evaluate CVS by BP and heart rate
3. able to perceive the importance of Respiratory System and identifying the need for ventilators
4. understanding the renal system and formulating the principles of homeostasis
5. understand the cognitive functions of brain

**UNIT-I**

**General Physiology:** Evolutionary aspects of biological systems, homeostasis, Organelles, Integration of Organelles, Cells, Membrane Physiology, Transport across cell membrane, genesis of membrane potentials, Nernest equation, Resting membrane potential, Goldmann-Hodgkin-Katz equation, Cable properties(Local signaling), Analog Potentials(Digital mode), Differential equations of action potentials, Voltage-Clamp and Patch-clamp methods, Signal Processing-Synapse, signal Transduction, Signal Integration(Input-sensory),Centers of Integration-Spinal Cord, Brain Stem, Cerebral Cortex, Motor System(Output)-Organization-Cortical, Sub cortical and spinal, Reflex process, NMJ, Smooth muscle, Cardiac Muscle, Skeletal muscle, Excitation-Contraction coupling, Sarcomere-Contractile Unit, Motor Unit, Frequency and Intensity related summation(temporal and Multi motor unit Summation), EMG.

**UNIT-II**

**Cardiovascular System:** Conducting system of the Heart, ECG, Blood as Non-Newtonian fluid, Dynamics of peripheral circulation, Resistance and Impedance, Streamline and Turbulent flow, Raynold's Number, Poisulle equation, Bernoulli equation, B.P., Control systems- Neurohumoral regulation, applied aspects.

**UNIT-III**

**Respiratory System:** Biophysics of Transport Across Respiratory Membrane, Perfusion and Diffusion limited process, Ventilation, Alveolar, Shunt and Dead space equations, Ventilation-perfusion inequalities, Physiological and anatomical shunts and dead spaces, Biophysics of transport of gasses in the blood, hemoglobin-oxygen association and dissociation curve, Haldane and Bohr effect, Applied aspects, Ventilators, Oxygen Therapy.

**UNIT-IV**

**Renal System:** Regulation of volume and composition of Body fluids, Clearance equations, Biophysics of Filtration, Acid-Base Balance, regulation of Body Temperature-Physical and Physiological process, applied aspects, Dialysis. Hormonal regulation of Body functions, Overview of Reproductive Physiology, Endocrine System.

**UNIT-V**

**Nervous System:** Higher functions of Brain (Perception, Rule of special senses, Learning and memory), Cybernetics of living systems, Neuro-Endocrine Control System, Servo mechanism, Motor skills, Neural Network related to the cognitive functions of the brain, near field (EEG) and Far Field Potentials(Evoked Potentials).

**Suggested Readings:**

1. Mount Castle, Textbook of Medical Physiology.
2. Best and Taylor, Physiological basis of Medical Practice.
3. Boron F, Medical Physical
4. John.Herbert Green, An Introduction to physiology, Oxford University Press, 1976
5. Gillain pocock, Christopher D.Richards, Human Physiology, The Basis of Medicine, Oxford University Press, 2004

**PC 303 BM**

## BIOCHEMISTRY

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To study the basic chemical reactions occurring inside the cell which are responsible for the physiological activity of the body are studied under this disciplinary course. This also includes the clinical study of the kinetics of normal and diseased cell through different techniques of analysis like the analysis of blood, urine, cerebra spinal fluid etc.
2. This study also enlightens the students with the basic course of reactions occurring with the DNA and RNA which determine the characteristic features of the human.

**Course Outcomes:**

1. Understand basic chemical reactions occurring inside the cell which are responsible for the physiological activity of the body
2. Understand the nature and properties of enzymes and identify their Diagnostic and therapeutic uses
3. To determine the characteristic features and reactions occurring with the DNA and RNA
4. Analyse the chemical composition of blood and urine in order to identify any non functionality
5. Demonstrate various instrumentation techniques involved in biochemical analysis

**UNIT-I**

Biochemistry of living cell. Sub-cellular fractionation using the Differential Centrifugation method. Functions of each organelle. Redox potential. Oxidative phosphorylation. Transport of substances across biological membranes.

**UNIT-II**

Broad chemical nature of enzymes-Isolation and study of the properties of enzymes. Study of enzyme kinetics by spectrophotometry. Diagnostic and Therapeutic uses of enzymes.

**UNIT-III**

Protein synthesis. Transcription and Translation. Replication, Polymerase Chain Reaction (PCR) Techniques, Recombinant DNA Technology.

Immunological Techniques or Immunoassay-Radio Immuno Assay (RIA), Enzyme-Linked Immunosorbent Assay (ELISA), Chemiluminiscence.

**UNIT-IV**

Chemical composition of blood-Separation of serum proteins and lipoproteins by electrophoresis and ultracentrifugation. Acid-Base balance and biochemical measurements of acid-base and electrolyte status of the patients. Urine Analysis.

**UNIT-V**

General methods of biochemical analysis carried out in the estimation of blood constituents, such as glucose etc. Principles and different methods of chromatography-fluorometry, flame photometry, Applications of isotopes in biochemistry.

**Suggested Readings:**

1. Martin D.W., Mayes P.A. & Rodwell V.W., *Harper's Review of Biochemistry*, Lange Medical publications, Meruzen Asia,1980.
2. Lalit srivastava M., Nibhriti Das & Subrata Sinha, *Essentials of Practical biochemistry*, CBS Publishers, 1st Edition, 2002

**ES 351 BM**

## ELECTRONIC CIRCUITS LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. The course facilitates the students to design the Oscillators.
2. To study the operation of Op-Amps.
3. Exposure towards the applications of the Op-Amps.
4. To know about the linear wave shaping circuits.
5. The students also learn about Voltage regulators and SMPS.

**Course Outcomes**:

1. Build LC and RC Oscillators.
2. Illustrate different applications of Operational amplifiers.
3. Design the 3-Op-Amp Instrumentation amplifier.
4. Construct linear wave shaping circuits and higher order filters.
5. Demonstrate the Current sources.

**List of Experiments:**

1. RC Coupled Amplifiers (Frequency response of BJT & FET)
2. Oscillators:
   a) Wein Bridge Oscillator
   b) RC Phase Shift Oscillator
   c) Hartley Oscillator
   d) Colpitts Oscillator
3. Op-Amps based Filters
   a) Active Low Pass Filters
   b) Active High Pass Filters
   c) Band Pass Filters
   d) Notch Filters
4. Wave Shaping Circuits using operational amplifiers:
   a) Differentiator
   b) Integrator
   c) Clipper
   d) Clamper
5. Differential amplifier
6. Instrumentation amplifier (INA112 & 3op-amp)
7. 555 Timer Applications:
   a) Astable Multivibrator
   b) Monostable Multivibrator
   c) Bistable Multivibrator
8. Current Sources
   a) Precision DC Current sources
   b) Voltage to Current Converters (AC & DC)
   c) High Frequency Current sources.

**PC 351 BM**

## ANATOMY LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:** The course is taught with the objective of enabling the student to

1. Understand the gross structure and location of organs in the dissected human body
2. Study the radiological anatomy
3. Describe the parts of the nervous system and study the lobes and functional areas of the brain.
4. Study the muscles, bones, joints, vessels and nerves of the body and their functioning.
5. Study the microscopic structure of primary tissues of the body.

**Course Outcomes**: On completion of this course student will be able to

1. Identify the location and structure of various organs of the body.
2. Understand the human tissue structures and their appearance in x-rays.
3. Identify the structure under the microscope
4. Identify the different parts and lobes of the brain
5. Identify the bones, joints, muscles, vessels and nerves of the body.

### List of Demonstrations:

1. Demonstration of Anatomical planes, positions and surface landmarks of the body.
2. Demonstration of upper limb bones.
3. Demonstration of upper limb specimens.
4. Demonstration of lower limb bones.
5. Demonstration of lower limb specimens.
6. Demonstration of trachea. lungs, heart, major blood vessels of thorax.
7. Demonstration of abdominal and pelvic bones and viscera - digestive, reproductive and excretory organs.
8. Demonstration of Brain.
9. Demonstration of major endocrine glands.
10. Microscopic structure of primary tissues of the body.

**PC 352 BM**

## PHYSIOLOGY LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. This course deals with the overall functioning of a living organism which has undergone a variably rapid change all through its process of evolution.
2. Casting a systematic array of different systems such as respiratory, circulatory, neuro-muscular mechanisms, stimuli propagation etc, emphasizing on the clinical importance of the same.

**Course Outcomes:**

1. Able to record BP.
2. To evaluate visual, auditory systems in human being.
3. Able to record various biopotentials.
4. Able to record and evaluate respiratory system.
5. To understand the muscular activity.

**List of Experiments:**

1. Recording of B.P. by different methods.
2. Effect of exercise on BP
3. Effect of posture on BP
4. Vital capacity by Spiro meter
5. Effect of posture on Vital capacity
6. Calculation of Vital Index
7. Tests of Hearing
8. Tests of Vision
    a. Visual Acuity & errors of Refraction
    b. Colour Vision
9. Recording of ECG
10. Examination of Sensory system
11. Examination of Motor System
12. Study of Rate of Conduction of Nerve impulse.

**PC 353 BM**

## BIOCHEMISTRY LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. To includes the clinical study of the kinetics of normal and diseased cell through different techniques of analysis like the analysis of blood, urine, cerebro spinal fluid etc.
2. To understand various working principles of different instruments.

**Course Outcomes:**

1. Understand the importance of electrophoresis and chromatograph in medical studies.
2. Able to use various instruments like colorimetry, pH meter, spectrophotometer etc.
3. To estimate glucose.
4. To understand the basic principle of operation of various instruments.

**List of Experiments:**

1. Study of Plasma protein electrophoresis.
2. Study of Chromatography of amino acids.
3. Study of Colorimetry.
4. Study of Spectrophotometry.
5. Study of pH meter, Urinometer, Glucometer, ABG analyzer, Semi-auto analyzer, Fully Auto-analyzer.
6. Study of Flame photometry-Analysis of Na and K in an unknown sample.
7. Quantitative estimation of glucose.

# SCHEME OF INSTRUCTION

**B.E. (Biomedical Engineering)**

**IV - SEMESTER**

*With effect from the Academic year 2023-2024*

| Sl. No | Course Code | Course Name | Contact hours per week | | Scheme of Examination | | Credits |
|---|---|---|---|---|---|---|---|
| | | | L | P | CIE | SEE | |
| **THEORY** | | | | | | | |
| 1. | ES 401 BM | Digital Electronics | 3 | - | 40 | 60 | 3 |
| 2. | ES 402 BM | Signals and Systems for Biomedical Engineers | 3 | - | 40 | 60 | 3 |
| 3. | PC 401 BM | Biomedical Instrumentation | 3 | - | 40 | 60 | 3 |
| 4. | PC 402 BM | Transducer and Biosensor Engineering | 3 | - | 40 | 60 | 3 |
| 5. | PC 403 BM | Biomaterials | 3 | - | 40 | 60 | 3 |
| 6. | ***Professional Elective – I*** | | 3 | - | 40 | 60 | 3 |
| | PE 401 BM | Fiber Optics & Lasers in Medicine | | | | | |
| | PE 402 BM | Bioinformatics | | | | | |
| | PE 403 BM | Biostatistics | | | | | |
| **PRACTICALS** | | | | | | | |
| 7. | ES 451 BM | Digital Electronics Lab | - | 2 | 25 | 50 | 1 |
| 8. | PC 451 BM | Biomedical Instrumentation Lab | - | 2 | 25 | 50 | 1 |
| 9. | PC 452 BM | Virtual Instrumentation & Simulation Lab | - | 2 | 25 | 50 | 1 |
| 10. | PC 453 BM | Biomaterials Processing & Characterisation Lab | - | 2 | 25 | 50 | 1 |
| | | **TOTAL** | **18** | **08** | **340** | **560** | **22** |

L : Lectures

T : Tutorials

P : Practical

CIE : Continuous Internal Evaluation

SEE : Semester End Examination

**ES 401 BM**

# DIGITAL ELECTRONICS

| | |
|---|---|
| Instruction: | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits: | 3 |

**Course Objectives:**

1. This course facilitates the students to study the properties for Boolean algebra and simplification of Boolean equations using K-maps.
2. The digital circuits' classification is studied and the main elements of this classification are studied. Application of these circuits to build a basic computer is discussed.
3. The students also learn about different types of memories.
4. The course also discuss about the basic applications of digital electronics like digital clock, frequency counter.

**Course Outcomes:**

1. Understand various codes and simplify Boolean equations using K-maps
2. Design basic data processing circuits
3. Applications of flip-flops
4. To build a basic memory and state diagrams for any sequential circuit
5. Build ADCs and DACs

**UNIT-I**

Codes: BCD, ASCII code, Excess-3 code, Gray code. Error detecting and error correcting codes. Combinational Logic Design: Boolean laws & theorems. Karnaugh Map-simplification of Boolean expressions- Sum of Products (SOP) form, Product of Sums (POS) form.

Logic Gates, Implementation of Logic Functions using gates, Realization of Boolean Expressions using universal gates.

**UNIT-II**

Arithmetic Circuits: Half adder, Full adder, Half subtractor, Full subtractor, Parallel binary adder, parallel binary Subtractor. Code-converter

Data processing circuits: Multiplexers, De-Multiplexers, Encoders-Priority Encoder, Decoders.

Digital Circuit Testing tools: Logic pulser, Logic probe, Current Tracer.

**UNIT-III**

Sequential circuits: Flip-flops-RS, T, D, JK and JK Master slave. Realizations of one flip flop using other flip flops.

Registers: Serial-in parallel-out, Serial-in Serial-out, parallel-in-serial-out parallel-in-parallel-out.

Counters: Asynchronous and synchronous counters, decade counters, ring counters.

Design of synchronous counters using excitation tables, Synchronous Up/Down counters.

**UNIT-IV**

Organization of ROM and RAM, Programmable Logic Devices – Programmable Logic Array (PLA) – Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) – Implementation of combinational logic circuits using ROM, PLA, PAL, Implementation of state diagrams for sequential circuit.

Applications: Digital Clock, Frequency counter, Time measurement, Displays.

**UNIT-V**

Introduction to DAC, ADC: Sampling, Quantization, quantization noise, aliasing and reconstruction filtering, Specifications, DAC Conversion, Binary weighted Resistor DAC, R-2R Ladder DAC, Inverted (or) Current mode DAC, Sample and hold circuits

ADC conversion, Types of ADCs: Direct Conversion ADC/Flash type ADC, Successive approximation ADC, Integrating ADCs, Sigma-Delta ADCs, Analog Multiplexers.

**Suggested Reading:**

1. M. Morris Mano, "Digital Design", 4th Edition, Prentice Hall of India Pvt. Ltd., 2008 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003.
2. Donald P. Leach & Albert Paul Malvino, *Digital Principles and electronic,* 5th Ed., Tata Mc. Graw Hill Publishing Co. Ltd., New Delhi, 2003
3. R. P. Jain, *Modern Digital Electronics,* 3rd Ed., Tata Mc Graw Hill Publishing Co. Ltd., New Delhi, 2003

**ES 402 BM**

## SIGNALS AND SYSTEMS FOR BIOMEDICAL ENGINEERS

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To Identify and use the following elementary signals: exponentials, sinusoids, complex exponentials, exponentially damped sinusoids step functions, impulses, sifting and time scaling properties of impulses.
2. To evaluate the time domain signal corresponding to DTFS, FS, DTFT, and FT representations using the defining equations.
3. To determine whether an input/output description for a system has the following properties: stability, memory, memory less, causality, invertibility (simple cases), time invariance, and linearity.
4. To evaluate the convolution sum and integral given an input and the impulse response.

**Course Outcomes:** Students will be able to:

1. To understand and classify the Signals and Systems
2. to analyze the frequency components of signals by Fourier analysis
3. to evaluate the convolution integral and apply it for the system analysis
4. to apply the DFT and DTFT for discrete signals
5. to construct DIT FFT and DIF FFT algorithms for discrete signals for the frequency domain analysis

**UNIT-I**

**Introduction** Signal and system, classification of signals, Energy and power signals, Periodic and Aperiodic signals, Even and odd signals, Impulse function, Unit step function, Ramp function, Rectangular function, constant function, Signum function, Right hand sided exponential function, and left hand sided exponential function, operations on signals, Types of systems, linear and Non-linear systems, Time variant and time invariant systems, Causal and non-causal systems, Invertible and non-invertible systems, stable and unstable systems.

**UNIT-II**

**Fourier Series and Fourier transform** Analogy between vector and signal, Signal representation by discrete set of orthogonal, functions, Exponential and trigonometric Fourier series, convergence, Dirichelet's conditions, the discrete spectrum, limitations of Fourier series. The direct and inverse Fourier transform, continuous spectrum, Existence and properties of Fourier transform, Parseval's theorem, Fourier transform of periodic functions, Limitations of Fourier transform.

**UNIT-III**

**LTI systems** Convolution integral, Properties of convolution, convolution as summation, graphical method of convolution, Applications of convolution. Correlation, Auto correlation , Cross correlation, applications of correlation, Sampling of continuous time signal, sampling theorem and problems, Nyquist rate, Aliasing effect, Reconstruction methods of signals.

**UNIT-IV**

**DFT & DTFT** The Discrete Fourier Transform: Properties of Discrete Fourier Transform. Linear convolution using Discrete Fourier Transform,

Discrete Time Fourier Transform: Z transform, Properties of the region of convergence for the Z-Transform, Inverse Z Transform, Z transform properties.

**UNIT-V**

**FFT** Fast Fourier transform: Twiddle factor, properties of twiddle factor, decimation-in-time and decimation-in frequency. FFT algorithms for radix-2 case, in place computation, bit-reversal. Inverse FFT, Power Spectral Density estimation of signals and its applications.

**Suggested Reading:**

1. Alan V. Oppenheim and Willsky. Allan. S, *Signals and systems*, 2nd edition, PHI-2009.
2. Luis F Chaparro, *Signals and systems using MAT LAB*, Academic press, 2011.
3. Alan V. Oppenheim and Ronald W Schafer, *Digital Signal Processing*, PHI-2008.
4. A. Anand Kumar, *Signals and Systems*, 2nd edition, PHI Learning- 2012.
5. P. Ramesh Babu, *Digital Signal Processing*, Scitech publications private Ltd-2007.
6. Lathi B.P., Signals, *Systems. and communication*, BSP-2006.

**PC 401 BM**

# BIOMEDICAL INSTRUMENTATION

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To introduce the students to the basic concepts of biomedical instrumentation.
2. To familiarize the students with the instruments used to record biopotentials
3. To introduce the students to different medical instruments and their applications

**Course Outcomes:** Students will be able to:

1. Understand the components of medical instruments
2. Comprehend the instruments for recording/measuring ECG and other cardiovascular parameters
3. Explain EEG and EMG recording systems
4. Understand the function of general medical instruments
5. Compare the working principles of analytical instruments

## UNIT-I

Block diagram of a medical instrumentation system, Challenges faced with physiological measurements. Medical instrument specifications. Biopotential electrodes: Electrode-Electrolyte Interface, Half cell potential, Offset Voltage. External, Internal and Microelectrodes. Equivalent circuit and applications of biopotential electrodes. Basic requirements for the display and recording of Biopotential signals. Classification of recorders, PMMC writing systems. General features of ink-jet, thermo-sensitive and optical recorders. Array recorders. Medical Oscilloscopes, Multibeam and Non-fade display systems, LCD, OLED.

## UNIT-II

Electrocardiography: Block diagram and preamplifier circuit, Single channel and multi-channel ECG systems. Holter monitors-ECG and NIBP, Stress test systems. Blood Pressure measurement: Components and working principle of sphygmomanometer. Direct and indirect methods of Blood Pressure measurements. Electromagnetic and Ultrasonic techniques of Blood flow measurement. Phonocardiography- Origin of Heart Sounds, types of microphones for heart sound measurement. Contact and non-contact type of measurement.

## UNIT-III

Electroencephalography: EEG-Block diagram and preamplifier circuit, electrodes and their placement. Lead configuration and general EEG graphs. Evoked potentials and their measurement. Filters for EEG rhythm analysis. Electromyography: Introduction to EMG signals. EMG-Block diagram and circuits. Electrodes and their placement. Nerve conduction velocity, determination using EMG, Stimulators for EMG recording.

## UNIT-IV

Working principle and types of Nebulizer, Suction apparatus. Fluid warmer, Fumigation, Oxygen concentrator. Blood Cell Counters-Microscopic and Automatic methods. Coulter Counter, Portable Coulter counters-Handheld and Point-of-Care testing. Automatic differential counting of cells. Oximeters-Ear, pulse, skin-reflectance and intra vascular types.

## UNIT-V

Methods of chemical analysis. Absorption Photometry, emission photometry, Flurometry, Colorimeter, spectrophotometer, Flame photometer, Mass spectrophotometer, Electrophoresis, chromatography, blood gas analyzer, Electrolyte Analyzer, Semi and fully automated analyzers, ELISA reader and ELISA washer.

**Suggested Readings:**

1. Webster J.G., *Medical Instrumentation Application and Design*. Houghton Mifflin, 2009.
2. Carr and Brown, *Introduction to Biomedical equipment technology*, 2011.
3. Khandpur R.S. *Hand Book of Biomedical Instrumentation*, Tata McGrawHill,2003.
4. Khandpur R.S. *Hand Book of Analytical Instrumentation*, Tata McGrawHill,2010.
5. John Enderle, Susan M. Blanchard, and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition, 2005.

With effect from the academic year 2023-2024

**PC 402 BM**

## TRANSDUCER AND BIOSENSOR ENGINEERING

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. This course facilitates the students to understand the basic characteristics of transducer.
2. They learn the classification of transducers such as temperature, pressure, displacement and piezoelectric transducers.
3. Signal conditioning and processing, controllers, display, recording; direct digital control, programmable logic controllers, and PC based instrumentation.

**Course Outcomes:** Students will be able to:

1. Understand the concept of primary and secondary sensors and extending the principle used to measure various physiological parameters
2. to construct signal conditioning circuit for various transducers
3. to identify the precautionary measures while using capacitive transducers
4. to predict electrolyte concentration or gas Estimation in blood or serum
5. to extend these principles to MEMS based transducers and understand fabrication techniques

**UNIT-I**

**Measurements and Transducers:** SI units, systematic and random errors in measurements, expression of uncertainty – accuracy and precision index, propagation of errors; PMMC, MI and dynamometer type instruments, bridges for measurement of R, L and C, Q-meter.

Block diagram of an instrument, Principles of transduction, Sensor Classification; static and dynamic characteristics of measurement systems. Primary sensors, Bimetals, Bellows, Bourdon tube, Capsule, Diaphragm, Medical applications.

**UNIT-II**

**Resistive sensors:** Potentiometers, Strain gauges, RTDs, Thermistors, LDR. Signal conditioning. Wheatstone bridge, balance and deflection measurements. Instrumentation amplifier. Interference types and reduction. Shield grounding. Isolation amplifiers, Medical applications.

**UNIT-III**

**Capacitive and inductive transducers**: Reaction variation and electromagnetic sensors. Capacitive sensors, inductive sensors, LVDT, electromagnetic sensors. Signal conditioning, AC bridges, AC amplifiers, electrostatic shields, carrier amplifiers, phase-sensitive detectors, Medical applications.

**UNIT-IV**

**Self-generating sensors**: Thermoelectric sensors, thermocouples, piezoelectric sensors, photovoltaic sensors. Signal conditioning. chopper and low-drift amplifiers, Noise in op-amps. Digital sensors. Telemetry and data acquisition, Medical applications.

**UNIT-V**

**Chemical transducers:** Electrochemical transducers, Fiber optic chemical transducer. Chemical Transducers of Acoustic and Thermal Properties. Biosensors – Enzyme-based bio-sensors, Immuno Sensors, microbial sensors.

Other sensors: Accelerometer transducers, Gyroscopes, pH sensors, measurement of Conductivity, viscosity, flow meters, Humidity, signal conditioning and Applications, System on Chip/ Organ on Chip and applications like Theraunostics.

**Suggested Reading:**

1. Ramon Pallas-Areny and John G. Webster, *Sensors and signal conditioning*, John Wiley and Sons, 2001.
2. Tatsuo Togawa, Toshiyo Tamura & P. Ake Oberg, *Biomedical Transducers and Instruments*, CRC Press, Boca Raton, 1997.
3. Richard S.C. Cobbold, *Transducers for Biomedical Measurements: Principles and Applications*. John Wiley and Sons Inc., 1974
4. Electronic measurements and instrumentation by A K Sawhany

**PC 403 BM**

## BIOMATERIALS

| | |
|---|---|
| Instruction: | 3 Periods per week |
| Duration of SEE: | 3 Hours |
| SEE: | 60 Marks |
| CIE: | 40 Marks |
| Credits: | 3 |

**Course Objectives:**

1. To understand the need and properties of the biomaterials.
2. To understand the properties, biocompatibility issues and applications of various classes of biomaterials.
3. To understand the biomaterials-tissue interactions.

**Course Outcomes:** The students will be able to:

1. List the properties and Engineering requirements of biomaterials
2. Compare the properties and applications of various types of biomaterials
3. Assess the tissue and blood compatibility of biomaterials
4. To choose proper biomaterial for soft tissue replacements
5. Describe the application of materials in hard tissues replacement and their fixation

### UNIT – I

Properties of Biomaterials: Biomaterial–definition and need, Types of Biomaterials, Requirements of an ideal biomaterial, Biocompatibility.

Characterization of materials – Mechanical, chemical, thermal, electrical, optical and other properties. Scanning Electron Microscope, Transmission Electron Microscopy, Fourier transform Infrared Spectroscopy, Atomic Force Microscopy.

### UNIT – II

Materials used as biomaterials and their properties: Properties of metallic biomaterials – stainless steels, Co-based alloys, Ti and Ti–based alloys, Ni-Ti alloys.

Properties of Ceramic biomaterials - Aluminum Oxides, Calcium Phosphate, Glass ceramics and Carbons.

Properties of Polymeric biomaterials – Polyamides, Polyethylene, Polypropylene, Polyacrylates, Polyvinyl Chloride. Properties of composite biomaterials and biological/natural materials.

### UNIT – III

Tissue response to biomaterials and testing of biomaterials: Inflammation, wound–healing and foreign body response, systemic toxicity and hypersensitivity, Blood compatibility, Carcinogenicity, implant–associated infection. In-Vitro and In-Vivo assessment of tissue compatibility and testing of blood–material interaction. Degradation of metals, polymers and ceramics in general and in the biological environment.

### UNIT – IV

Soft tissue replacements: Sutures, Surgical tapes and Staples, Tissue Adhesives, Percutaneous Devices, Artificial Skin, Maxillofacial implant, Ear and Eye Implants, Fluid Transfer Implants, Vascular Implants, Heart Valve Implants, Heart and Lung Assist Devices, Dialysis Membrane, Drug delivery systems. Burn Dressings, Skin substitutes, Artificial Cartilage.

### UNIT – V

Hard tissue replacements: Wires, Pins, Screws, Fracture Plates-Cortical and Cancellous Bone Plates. Intra-medullary devices, spinal fixation devices. Lower extremity Implants, Upper Extremity Implants, Endosseous Tooth Implants–Subperiosteal and staple /Transosteal implants, Interface of orthopedic implants. Bone-cement fixation, Porous in growth (Biological) fixation, Direct bonding between bone and implant, Interference and passive fixation.

**Suggested Reading:**


1. Joon B. Park and Roderic S. Lakes, *Biomaterials – An introduction* Plenum Press, 2nd Edition,1992.
2. Buddy D. Ratner, Allan S. Hoffman, Frederick, J. Schoen and Jack E. Lemons, *Biomaterials Science – An Introduction to materials in Medicine*, Academic Press, 1996.
3. John Enderle, Susan Blanchard and Joseph Bronzino, I*ntroduction to Biomedical Engineering*, 2nd Edition, Elsevier Academic Press, 2009.
4. Roger Narayan, *Biomedical Materials*, Springer, 2009.
5. NPTEL Video lecture: *Introduction to Biomaterials.*

With effect from the academic year 2023-2024

**PE 401 BM**

**FIBER OPTICS & LASERS IN MEDICINE**
**(PROFESSIONAL ELECTIVE 1)**

| | |
|---|---|
| Instruction | 3 Periods per week |
| Duration of University Examination | 3 Hours |
| SEE | 60 Marks |
| CIE | 40 Marks |
| Credits | 3 |

**Course Objectives:**

1. To offer clear understanding of tissue characteristics when it is exposed to optical energy.
2. To know about various optical sources and applications of lasers.
3. To expose the students to the Laser fundamentals and fiber optics.

**Course Outcomes:** Successfully the student will be able to:

1. Use optical sources for Medical LASER instrumentation and measurement.
2. Analyze the optical properties of tissues and light interactions with tissues
3. Understand basic concepts of optical fibers and their properties
4. Applications of Fiber Optics used in medical imaging systems
5. To provide adequate knowledge about Medical applications of Lasers

**UNIT-I**

INTRODUCTION: Historical background .Medical Lasers: Introduction, Laser physics- fundamentals, principles, advances. Medical Laser system-fundamentals, principles. Laser safety-fundamentals.

APPLICATION OF LASERS IN DIAGNOSIS &THERAPY: Introduction, Laser assisted diagnosis and therapy fundamentals.

**UNIT-II**

LASER-TISSUE INTERACTION: Laser interaction with tissue-principles; laser assisted diagnostic –principles, application of lasers in diagnosis and imaging-advances, laser surgery and therapy –principles-photo thermal & photomechanical mechanism, thermal interaction between laser and tissue-advances.

**UNIT-III**

SINGLE OPTICAL FIBER: Introduction, historical background, optical fiber fundamentals. Light transmission in optical fibers-principles, optical properties of optical fibers-advances, fabrication of optical fibers- principles , optical fibers for UV, visible, IR light-principles, power transmission through optical fibers-principles.

**UNIT-IV**

OPTICAL FIBER BUNDLES: Introduction, non ordered fiber optic bundles for light guides-fundamental & principles, ordered fiber optic bundles for imaging devices-fundamentals & principles, fiberscope and endoscopes-fundamentals fiber optic imaging systems-advances. ENDOSCOPY: Introduction endoscopic imaging systems-fundamental, principles, advances, endoscopic diagnostic –advances endoscopic therapy –fundamentals.

**UNIT-V**

CLINICAL APPLICATIONS OF FIBER OPTIC LASER SYSTEMS: Introduction, fiber optic laser system in cardiovascular disease, gastroenterology. Gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, and flow diagram for laser angioplasty& photodynamic therapy.

**Suggested Reading:**


1. Laser and optical fibers in Medicine by Abraham Katzir, Academics Press,1998.
2. Therapeutic Lasers-Theory and Practice by G. David Baxter, Churchill Livingstone Publications.
3. Medical Lasers and their safe use DAVID H Shiney .Stephen and L Trokel, Springer, Springer. verlag publications.
4. Elements of fiber optics S.L. Wymer, Regents PHI
5. Biomedical Electronics and Instrumentation S. K. Venkata Ram Galgotia publications.

With effect from the academic year 2023-2024

**PE 402 BM**

# BIOINFORMATICS
## (PROFESSIONAL ELECTIVE I)

| | |
|---|---|
| Instruction: | 3 Periods per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE: | 40 Marks |
| Credits: | 3 |

**Course Objectives:**

1. To give students an introduction to the basic techniques of bioinformatics.
2. Emphasis will be given to the application of bioinformatics and biological databases to problem solving in real research problems.

**Course Outcomes:** Upon completion of the course, the students will be able to:

1. Describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge
2. Explain the major steps in pair-wise and multiple sequence alignment, explain the principle for, and execute pair-wise sequence alignment by dynamic programming.
3. Predict the secondary and tertiary structures of protein sequences.

**UNIT I**

Prediction of protein molecular function and structure: Primary sequence of a protein and its analysis, Secondary, Tertiary and quaternary structures and their prediction methods, Fold recognition methods, Homology/comparative modeling of proteins, Energy calculations, local and global minimization, Energy Minimizations: Conjugate, steepest and Powell , Molecular dynamics and simulation studies.

**UNIT II**

Algorithms: Algorithms and complexity, Biological algorithms, computer algorithms, The change problem, Correct, incorrect algorithms, Recursive algorithms, Iterative, recursive algorithms, Fast and slow algorithms, Big-O notation, Algorithm designing techniques- Exhaustive search, Branch-and-bound algorithms, Dynamic programming, Divide-and-conquer algorithms, Randomized algorithms, Gibbs sampling.

**UNIT III**

Computer algorithms for prediction of protein structures. DNA Sequence Comparison, Algorithms for alignment of sequences and structures of proteins and protein families, PAM, BLOSUM, Bayesian modeling and networks, Probabilistic models or Hidden Markov models, Needleman Wunch and Smith Waterman algorithms, Global sequence alignment, Scoring alignments, Local sequence alignment, Alignment with gap penalties. Multiple alignment, Gene prediction-Statistical and Similarity-based approaches. Spliced alignment.

**UNIT IV**

Genetic algorithms: Genetic algorithms for the prediction of multiple sequence alignment, Gene expression analysis, Hierarchical clustering, K-Means clustering, clustering and corrupted cliques. Evolutionary trees-Distance-based tree reconstruction, Reconstructing trees from additive matrices, Evolutionary trees and hierarchical clustering. Character-based tree reconstruction- Small parsimony problem, large parsimony problem.

**UNIT V**

Neural Networks: Biological neurons and neural networks. Networks of artificial neurons. Learning in single layer and multi-layer perceptrons. Back-propagation. Radial basis function networks: Algorithms and applications. Committee machines. Self-organizing maps: algorithms and applications. Learning vector Quantization. Machine Learning, Statistical learning, Decision trees. Inductive logic programming,

Computation learning, Unsupervised learning, temporal difference learning, Delayed reinforcement learning, Explanation based learning. Case studies on few research papers.

**Suggested Reading:**

1. Bioinformatics – Sequence and Genome Analysis. David W. Mount.
2. Beale and T.J. Jackson, Introduction to Neural Networks, IOP Publishing Company, 1990.
3. Baeck, D.B. Fogel and Z. Michalewicz ,Genetic Algorithms, IOS Press, 1997.

**PE 403 BM**

# BIOSTATISTICS
## (PROFESSIONAL ELECTIVE I)

| | |
|---|---|
| Instruction: | 3 Periods per week |
| Duration of SEE | 3 Hours |
| SEE | 60 Marks |
| CIE: | 40 Marks |
| Credits: | 3 |

**Course Objectives**:

1. To introduce basic statistical methods like curve fitting, correlation and regression.
2. To provide the knowledge of probability distributions like normal, Poisson and tests of significance.

**Course Outcomes**: Upon completion of the course, the students will be able to:

1. Apply various probability distributions to solve practical problems, to estimate unknown parameters of populations and apply the tests of hypotheses.
2. Perform regression analysis and to compute and interpret the coefficient of correlation

**UNIT- I**

Concepts of Biostatistics. Basic statistical measures, measures of central tendency, measures of dispersion, variance, standard deviation, properties of probability, probability distribution, sampling distribution.

**UNIT- II**

Estimation and hypothesis testing. Confidence intervals for data, t distribution, determination of sample size for estimating means and proportions. Hypothesis testing for a single population mean/proportion difference between two population means/proportions, sample size to control type I and type II errors.

**UNIT- III**

Analysis of variance. The completely randomized design, random sized complete block design, repeated measures design.

**UNIT- IV**

Regression and correlation. Simple linear regression model, regression equation, the correlation model, multiple linear regression model, multiple regression equation, multiple correlation model, additional techniques of regression analysis.

**UNIT- V**

Chi-square distribution, tests of good fit, independence, homogeneity, non-parametric statistical procedures, regression analysis. Introduction of Open source software and its applications.

**Suggested Reading:**

1. Stanton A. Glantz, *Primer of biostatistics,* Mc Graw Hill , 2nd Ed.
2. Wayne S. Daniel, *Biostatistics: A foundation for analysis in the health sciences*, John Wiley & Sons, 6th Ed. 2012.

**ES 451 BM**

## DIGITAL ELECTRONICS LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| Duration of SEE: | 2 Hours |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. Analyze and design dc and switching circuits.
2. Analyze and design combinational logic circuits.
3. Analyze and design sequential circuits.

**Course Outcomes:** the students will be able to:

1. Demonstrate the truth table of various expressions and combinational circuits using logic gates.
2. Design, test and evaluate various combinational circuits such as adders, subtractors, multiplexers and de-multiplexers.
3. Construct flips-flops, counters and shift registers.
4. Simulate BCD 7-Segment Display.
5. Design and implement multivibrators using IC 555.

### I. List of Experiments:

1. Clippers and Clampers - Series and Parallel
2. Astable, Monostable and Bistable Multivibrators
3. Logic Gates-AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR
4. Half Adder, Full Adder, Half Subtractor, Full Subtractor
5. Flip Flops-RS, JK, D, T, JK-Master Slave
6. A/D and D/A converters
7. Multiplexers and Demultiplexers
8. Shift register-Series/Parallel-in to Series/Parallel-out
9. CMOS-TTL and TTL-CMOS interfacing
10. BCD-7 segment Display, DPM
11. PLL and Voltage Controlled Oscillator
12. Counters-Decade, Binary, Divide-by-N

### II. Mini Project and Design exercises:

Mini project is to be executed batch-wise. Design exercises are to be carried out individually.

With effect from the academic year 2023-2024

**PC 451 BM**

## BIOMEDICAL INSTRUMENTATION LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| Duration of SEE: | 2 Hours |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. To introduce the students to the basic concepts of biomedical instrumentation.
2. To familiarize the students with the instruments used to record biopotentials
3. To introduce the students to different medical instruments and their applications

**Course Outcomes:** Students will be able to:

1. Learn the operation and characteristics of transducers through experiments.
2. See and identify the components of medical instruments
3. Operate and maintain the ECG and other equipment
4. Handle EEG and EMG recording systems
5. Understand the function of general medical instruments

### 1. Operation of Various transducers

A. Linear Variable Differential Transducer (LVDT)
B. Strain Gauge
C. Potentiometric Transducer as a displacement Transducer
D. Light Dependent Resistor (LDR) as a displacement Transducer
E. Peizo electric Transducer as a pressure transducer
F. Temperature Transducers
    a) Resistive temperature detector (RTD)
    b) Thermister
    c) Thermocouple
G. Capacitive Transducer
    a) Linear Displacement Transducer
    b) Angular Displacement Transducer
H. Indirect Measurement of Blood Pressure
    a) Oscillometry method
    b) Auscultatory method
    c) Palpatory method

### 2. Operation of various medical Instruments

a) pH Meter
b) Conductivity meter
c) Colorimeter
d) Nebulizer
e) Suction apparatus
f) Needle destroyer
g) Pulse Oximeter

### 3. Design experiments with various sensors

With effect from the academic year 2023-2024

**PC 452 BM**

## VIRTUAL INSTRUMENTATION AND SIMULATION LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| Duration of SEE: | 2 Hours |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. To introduce the students to the basic concepts of Matlab and Labview.
2. To familiarize the students with the implementation of filters
3. To introduce the students to different medical instruments and their implementation in lab view and mat lab.

**Course Outcomes:** Students will be able to:

1. Learn the operation and characteristics of filters through experiments.
2. Analysis the signals of medical instruments
3. Design the filters and analyze transforms
4. Design medical instruments using Lab view
5. Extraction and Analysis of EEG, EMG & ECG Signals

### Virtual Instrumentation Lab using MATLAB

1. Implementation in MATLAB
    a) Generation of basic signals
    b) Linear and circular convolution
    c) Realization of FIR and IIR filters
    d) Finding DFT, IDFT, STFT, WT of given sequence
    e) Plotting the power spectral density
2. Computation of convolution and correlation sequences
3. Noise reduction techniques
4. Design of IIR and FIR Filters
5. PSD Estimation

### Instrumentation Lab using LABVIEW

1. Introduction to LABVIEW and Data Acquisition
2. Simulation of Biosignals
3. Design of a Biosignal Logger.
4. Design of an Analog ECG Signal Generator
5. Acquisition of Biopotentials using Biosignals
6. Time domain and Frequency Domain Measurement of Real Time biosignals
7. Spectrum analysis of ECG and PCG signal
8. Design of Heart Rate Analyzer
9. Extraction of Brain Waves from EEG
10. Design of a Demand Pacemaker
11. GPIB Communication
12. Instrumentation of an amplifier to acquire an ECG Signal
13. Signal Processing of an ECG signal and measuring the Heart Rate
14. Implementation of Digital Filter to remove noise in biosignals
15. Spectrum analysis of Noisy and pure biosignal
16. Acquire, Analysis and Present an EEG using Virtual Instrumentation
17. Extraction and Analysis of Brainwaves from an EEG Signal
18. Biofeedback system on EMG
19. Acquisition of PCG signal.

With effect from the academic year 2023-2024

**PC 453 BM**

## BIOMATERIALS PROCESSING AND CHARACTERIZATION LAB

| | |
|---|---|
| Instruction | 2 Periods per week |
| Duration of SEE: | 2 Hours |
| SEE: | 50 Marks |
| CIE: | 25 Marks |
| Credits | 1 |

**Course Objectives:**

1. To introduce the fundamental concepts and properties of biomaterials.
2. To familiarize the students with the fabrication methods of scaffolds.
3. Hands on laboratory experience in the processing and characterization of biomaterials

**Course Outcomes:**

1. Students will gain practical knowledge on various materials and their properties.
2. Students will develop the skills to design and conduct experiments and interpret the data.
3 Acquire the skills to analyze the data using software programmes.
4. Students can able to understand the invitro testing of the biomaterial scaffolds.
5. Students gain hands-on experience on materials for their potential use in biological applications.

**List of Experiments:**

1. Introduction to biomaterials and classification of materials.
2. Preparation of various buffer solutions and pH testing using pH meter.
3. Fabrication and characterization of polymer and ceramic-based scaffolds.
4. Identification and characterization of metallic Biomaterials
5. Analysis of scaffold characterization using Origin software.
6. Porosity analysis using image J software.
7. Study of mechanical properties of biomaterials such as tensile strength, compression, strength and hardness.
8. Analysis of histology slides using compound microscopy.
9. Degradation study of developed biomaterials.
10. Swelling study of the fabricated scaffolds.
11. Design and development of scaffolds using 3D printer.