Master of Technology

in

BIOMEDICAL ENGINEERING

Course Structure, Scheme of Evaluation and Syllabi

(*Effective from July 2017*)

Department of Applied Mechanics

Motilal Nehru National Institute of Technology Allahabad
Allahabad, U.P. -211004, INDIA

Course Structure

I Semester (Total credit = 20)

Course code	Subject Name	L	T	P	Credits	Distribution of Marks out of 100		
						TA	Mid Sem. Exam	End Sem. Exam
AM2104	Biomechanics	4	0	0	4	20	20	60
AM2101	Applied Mathematics & Computation	4	0	0	4	20	20	60
AM21XX	**Elective-I**	4	0	0	4	20	20	60
AM21XX	**Elective-II**	4	0	0	4	20	20	60
AM21XX	**Elective-III**	4	0	0	4	20	20	60

List of Electives (Semester I):

Elective-I:		**Elective-III:**	
AM2130	Anatomy & Physiology for Biomedical Engineers	**AM2132**	Biomedical Instrumentation
AM2131	Effects of Radiation and Biomedical Application of Radiation	**AM2133**	Biomedical Signal and Image Processing
ME2118	Ergonomics	**AM2134**	Biological System Analysis and Control
Elective-II:		**AM2135**	Introduction to Biomedical Design
AM2111	Finite Element Methods		
AM2125	Non-Destructive Testing		
AM2149	Bio-fluid Dynamics		
ME2125	Computer Aided Design		

II Semester (Total credit= 20)

Course code	Subject Name	L	T	P	Credits	Distribution of Marks out of 100		
						TA	Mid Sem. Exam	End Sem. Exam
AM2253	Biomedical Engineering Laboratory	4	0	0	4	20	20	60
AM2203	Biomaterials	4	0	0	4	20	20	60
AM22XX	**Elective-IV**	4	0	0	4	20	20	60
AM22XX	**Elective-V**	4	0	0	4	20	20	60
AM22XX	**Elective-VI**	4	0	0	4	20	20	60

List of Electives (Semester II):

Elective-IV:		**Elective-VI:**	
AM2230	Advanced Biomechanics	**AM2235**	Rehabilitation Engineering and Assistive Technology
BT2234:	Bioethics, Biosafety and IPR	**AM2236**	Medical Imaging
AM2232	Electro Physiological signal Analysis	**AM2237**	Artificial Intelligence in Biomedical Engineering
Elective-V:		**AM2202**	Characterization of Materials
AM2233	Tissue Engineering		
AM2234	Electro Diagnostics, Therapy and Electrical Safety		
AM2224	MEMS and Bio-MEMS		

III Semester (Total credit= 20)

Course code	Subject Name	Credits
AM2397	Special Study/Term Project/State of the Art/Colloquium/ Industrial/ Research Training	4
AM2398	Thesis/ Project	16

IV Semester (Total credit= 20)

Course code	Subject Name	Credits
AM2498	Thesis/ Project	20

Note: The distribution of thesis evaluation marks will be as follows:

1. Supervisor(s) evaluation component: 60%.
2. Oral Board evaluation component: 40%.

Semester-I

AM2104 Biomechanics		
Designation	:	Compulsory
Pre-requisites	:	Basics of engineering mechanics, and Anatomy of human body.
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Application of Statics to Biomechanics:

Basics concepts of Force Moments and Torque Equilibrium, analysis of systems in equilibrium. Skeletal joints, Skeletal muscle. Mechanics of the elbow, shoulder, Spinal column, Hip, Knee and ankle. Basic assumptions and limitations.

Deformable body Mechanics:

Applied forces and Deformations, internal forces and moments, Stress and Strain, Basic loading configurations, Uniaxial tension test, Load- elongation diagrams, Hooke's Law, Work and Strain Energy, Properties based on Stress-strain Diagrams, Idealized model for material behavior and Mechanical properties of materials.

Multi axial Deformation and stress analysis:

Poisson's ratio, Biaxial and tri axial stresses, Failure theories, allowable stress and factor of safety, Fatigue and endurance, Torsion, Bending and combined loading.

Mechanical Properties of Bone and Soft Tissues

Mechanics of bone, Composition of bone, Mechanical properties of bone, Bone fractures and Bone Remodeling, Biomechanics of Tendon and Ligaments. Biomechanics of Skeletal Muscles. Biomechanics of Articular cartilage.

Term Paper: On recent advances based on literature survey and/or lab/industry visit

Text books and References

1. Fung Y.C., Biomechanics, Springer Verlag.
2. Winter.D.A., Biomechanics and Motor Control of Human Movement.
3. Frankel V.H.&Nordin Margareta ,Basic Biomechanics of the Skeletal System, LEA &FEBIGER.
4. Nihat Ozkaya and Margareta Nordin Fundamentals of Biomechanics, 3rd Edition. VNR, New York.

AM2101 Applied Mathematics and Computation		
Designation	:	Compulsory
Pre-requisites	:	Engineering Mathematics &Computer Programming
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Review of Elementary Engineering Mathematics: Solution of homogeneous and non-homogeneous equations; Power series; Laplace transform and its applications; Fourier series and Fourier transform

Linear Algebra: Matrices and Linear Transformations, Operational Fundamentals of Linear Algebra, Systems of Linear Equations, Gauss Elimination Family of Methods, Special Systems and Special Methods, Numerical Aspects in Linear Systems, Eigenvalues and Eigenvectors, Diagonalization and Similarity Transformations, Jacobi and Givens Rotation Methods, Tri-diagonal Matrices, QR Decomposition Method, Eigenvalue Problem of General Matrices, Singular Value Decomposition, Direct and Iterative solvers.

Ordinary Differential Equations: Introduction to ordinary differential equations, homogeneous linear equations of second order, non-homogeneous linear equations of second order, free and forced oscillation problems, problems with variable coefficients, system of equations.

Partial Differential Equations (PDEs): Existence and uniqueness of differential equations, nature of solution, Hyperbolic, Parabolic and Elliptic PDEs, nonlinear PDEs.

Nonlinear Equations: Motivation, Open and braketing method, Bisection, Fixed point, Newton's method, Secant and False position method, Rate of convergence, Merits and demerits of methods.

Numerical Integration: Motivation, Newton-Kotes method, Trapezoidal rule, Simpson's rule, Rhomberg integration, Gauss Quadrature.

Initial Value Problem: Motivation, Euler's method, Modified Euler method, Runge-Kutta methods, Adaptive integrations and multistep methods.

Boundary-value and Eigen-value Problem: Methods and Applications in Mechanics.

Text books and References

1. Numerical Methods in Engineering: M. Salvadori.
2. Applied Numerical Methods: B. Carnahan.
3. Applied Numerical Analysis: C.F. Gerald and P.O. Wheatley.
4. Numerical Mathematics & Computing: W. Cheney and D. Kincaid.
5. Applied Partial Differential Equations: Paul DuChateau and David Zachmann.
6. Partial Differential Equations for Scientists and Engineers: Stanley J. Farlow.
7. Numerical Methods for Partial Differential Equations: William F. Ames.
8. Numerical Methods for Elliptic and Parabolic Partial Differential Equations: John R Levison, Peter Knabner, Lutz Angermann.

AM2130 Anatomy & Physiology for Biomedical Engineers		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to Human Body: Human as Biological Organism, levels of the organization of human body, homeostasis, Anatomical position and terminology, Body regions and Body cavities.

Cell Structure and Function: Cells and Their Structure, Replication, Transcription and Translation, Mitosis and meiosis, Cellular Communication. Nature of cancer cells, Transport of ions through cell membrane, Resting and action potentials.

Tissues: Epithelial tissue, Connective Tissue, Muscle Tissue, Nervous Tissue.

Integumentary System: Function of the Integumentary System, Structure of the Skin, Physiology of the Skin.

Skeletal System: Structure and Function of Bone, Bone formation, Bones of the axial skeleton, Bone of the appendicular skeleton, Articulations.

Muscle Tissues mode of contraction: Microscopic and macroscopic structure of muscle, mode of muscle contraction.

Muscular System: Muscle terminology, muscle of axial and appendicular skeleton.

Nervous System: Anatomy of Central Nervous System, Peripheral and Autonomic Nervous system, Neuron, Physiology of Nerve conduction, Synapse and Synaptic Transmission. Brain, Blood brain barrier, neurotransmitter and Spinal cord. Cranial nerves, spinal nerves and Reflex arc.

Sensory Organs: Taste, smell, Structure and Function of Eye, structure and Function of ear.

Endocrine System: Hormones, Negative and Positive Feedback Endocrine gland and their secretions.

Cardiovascular System: Function and Composition of Blood, structure of Heart, blood flow thorough heart, Fetal circulation, coronary circulation, conduction system and innervation, cardiac cycle and electrocardiogram, Vessels, arteries, capillaries and veins, Principle systemic arteries and veins, Blood pressure.

Lymphatic System: Lymphatic structure, Nonspecific defense, antibody and cell mediated immunity, transfusion and rejection reactions.

Respiratory System: Respiration, Components of respiratory system, Mechanics of Breathing, Lung Volumes, Gas transport, Regulation of respiration.

Digestive System: digestive processes, Peritoneum, structure and Function of GI track.

Urinary System: Components of urinary system, Structure of nephron and its function, Urine concentration, Acid base balance.

Metabolism and temperature regulatory System, Water balance and electrolyte.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Elaine. N. Marieb, 'Essentials of Human Anatomy and Physiology', 8th edition, Pearson Education, New Delhi.
2. Richard S Snell, *Clinical Anatomy by Regions*: Lippincott Williams & Wilkins, 8th edition.
3. Charles E. Tobin, Basic human Anatomy.
4. Guyton and Hall, "Textbook of Medical Physiology", Elsevier.
5. William F. Ganong, 'Review of Medical Physiology', 22nd edition, McGraw Hill, New Delhi.

AM2131 Effects of Radiation and Biomedical Application of Radiation		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Basic concept, types, source and characteristics of Electromagnetic radiations and its influence human health. Biological Effects and biomedical application of X-Rays, Gamma Rays, Microwave, Ultrasound etc. Introduction to Radio isotopes and its Biomedical Applications.

Laser, its Classification, Basic concept, types and their biomedical applications, Laser use in surgery, diagnosis and in promotion of healing, Safety with Biomedical Laser.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. A Sorenson and Phelps, Physics of Nuclear Medicine, W.B. Saunders Co.
2. J. R. Cameron and J.G. Skofronick, Medical Physics.
3. Christenson, Physics of Diagnostic Radiology, John Wiley.

ME2118 Ergonomics		
Designation	:	Elective
Pre-requisites	:	Solid mechanics, Linear Algebra, Differential Equations, etc.
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to Ergonomics; Elements of Anthropometry; Physiology, Anatomy; Biomechanics. Kinesiology; Workspace Design, Seating Design; Cumulative Trauma Disorders (CTDs); Manual. Material Handling; Hand Tool Design; Human Information Processing; Cognitive ergonomics; Manmachine system interface, Displays and Controls, Principles of graphic user interface design; Compatibility environmental factors; Human errors, product safety, product liability.

The Elemental Resource Model for Human Performance, Measurement of Neuromuscular Performance Capacities, Measurement of Sensory-Motor Control Performance Capacities: Tracking Tasks, Measurement of Information-Processing Subsystem Performance Capacities, High-Level Task Analysis: Cognitive Components, Task Analysis and Decomposition: Physical Components, Human–Computer Interaction Design, Applications of Human Performance Measurements to Clinical Trials to Determine Therapy Effectiveness and Safety, Applications of Quantitative Assessment of Human Performance in Occupational Medicine, Human Performance Engineering Design and Analysis Tools, Human Performance Engineering: Challenges and Prospects for the Future.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. J. D. Branzino, Handbook of Biomedical Engineering: Fundamentals of Biomedical Engineering, CRC Press.
2. Shrawan Kumar, Biomechanics in Ergonomics, CRC Press.

AM2111 Finite Element Methods		
Designation	:	Elective
Pre-requisites	:	Linear Algebra with Matrix Operations, Differential Equations, Mechanics of Materials, Theory of Elasticity.
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks. Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction: Course objectives, History of FEM, Application Areas, Concept of Discretization and Interpolation, Different Steps in Finite Element Analysis, Demonstration through FE Analysis of Axially Loaded Bar.

Variational Methods & Energy Principles: Brief Introduction to Variational Calculus, Energy Principles – Principle of Virtual Work and Complementary Virtual Work, Principle of Minimum Potential Energy and Complementary Potential Energy, Mixed Principles.

Detailed FE Formulation for Solid Mechanics: Finite element discretization – Piecewise Interpolation & Shape Functions, C0 and C1 Interpolation, Conventional 1D, 2D & 3D Elements, Special Elements, Sub Parametric, Super Parametric &Isoparametric elements. FE Formulation Using Variational Methods & Energy Principles. Coordinate transformation & Jacobian, Numerical Integration & Calculation of Element Matrices.

Classical Finite Element Methods: Ritz Method, Method of Weighted Residuals, Galerkin method, Strong & Weak formulation. One & Two dimensional structural & non-structural boundary value problems involving scalar and vector valued dependent variables.

Dynamic Problems and Other Topics (in brief): Dynamic Equations from Hamilton's Principle, Mass (Consistent & Diagonal) and Damping Matrices, Free Vibration Analysis – Eigen value problem, Time-History analysis in Forced Vibration – Direct (Explicit & Implicit) Integration Methods.
Nonlinear & Stability problems, Error & Error estimation, Conforming &Non conforming Elements, Patch test.

Application through Computer Programming& Commercial Software:

- Input for Geometric & Material Configuration, Loading and Boundary Conditions.
- Automatic Mesh Generation, Nodal Coordinate and Nodal Connectivity.
- Calculation of Element Matrices (Stiffness & Mass Matrices, Load Vector).
- Assembly of Element Matrices to Global Matrices, Imposing Boundary Conditions.
- Solution (Gauss Elimination & other methods), Post Processing.

Text books and References

1. Energy and Finite Element Methods in Structural Mechanics: I. H. Shames and C. L. Dym.
2. Concepts and Applications of Finite Element Analysis: R. D. Cook, D. S. Malkus and M. E. Plesha.
3. The Finite Element Method Vol. I-II: O.C. Zienkiwiczand R.L. Taylor.
4. Finite Element Procedures: K. J. Bathe.
5. An Introduction to Finite Element Methods: J.N. Reddy.
6. Finite Element Methods in Engineering: S.S. Rao.

AM2125 Non-Destructive Testing		
Designation	:	Elective
Pre-requisites	:	Basic Material Science and Engineering
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Overview of NDT: NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT, Visual inspection Unaided and aided.

Surface NDE methods: Liquid Penetrant Testing – Principles, Types and properties of liquid penetrants, Developers, Advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, Inspection materials Magnetisation methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Thermography and eddy current testing (ET): Thermography- Principles, Contact and non contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing- generation of eddy currents, properties of eddy currents, eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation.

Ultrasonic testing (UT) and acoustic emission (AE): Ultrasonic Testing-Principle, Transducers, Transmission and pulse-echo method, Straight beam and angle beam, Instrumentation, Data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique, AE parameters, Applications

Radiography (RT): Principle, Interaction of X-Ray with matter, Imaging, film and film less techniques, Types and use of filters and screens, Geometric factors, Inverse square law, Characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

[1] Practical Non-Destructive Testing: Baldev Raj, T.Jayakumar, M.Thavasimuthu

[2] Non-Destructive Testing Techniques: Ravi Prakash

[3] ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.

[4] Introduction to Non-destructive testing: a training guide: Paul E Mix

[5] Handbook of Nondestructive evaluation: Charles J. Hellier

[6] ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

AM2149 Bio-fluid Dynamics		
Designation	:	Elective
Pre-requisites	:	Engineering Fluid Mechanics, Elementary Biology
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to Fluid Mechanics: Fluid properties, basic laws governing conservation of mass momentum and energy; Laminar flow, Couette flow and Hagen-Poiseuille equation, turbulent flow.

Bio-fluid Dynamics: Blood system network and physiology, blood rheology, Vessel structure and mechanical properties Lymphatic system; Body fluids and their motions; Flow of Newtonian and non-Newtonian fluids in rigid tubes, flexible tubes and collapsible tubes.

Cardio-vascular system: Heart and pumping process, Blood flow in body, Flow dynamical study of circulatory system, heart and blood vessels, anatomy and physiological considerations; Components and functions of arterial and venous systems: Blood flow through arteries and veins; Kinetic energy, flow, pressure-flow relations in vascular beds; Cardiac cycle; Cardiac valve dysfunctions; Blood pressure, regulation and controlling factors; Coronary circulation, heart failure.

Human Respiratory system: Physiology, Weibel's lung model, realistic lung model, studies of flow behavior in upper and lower human respiratory system during different breathing conditions, studies of wall shear stress and its implications, Dispersion and deposition of aerosols/inhaled particles in respiratory system, critical airways, tumorous airways.

Text books and References

1. "Bio-fluid Mechanics", J.N. Mazumdar, World Scientific, 1992.
2. "Biomechanics: Motion", Flow, Stress, and Growth", Y.C. Fung, Springer-Verlag, 1990.
3. "Cardiovascular Physiology", R.M. Berne, M.N. Levy, 8th Edition, Mosby, 2001.
4. "Bio-fluid Dynamics", C. Klienstreuer, Taylor & Francis.

ME2125 Computer Aided Design		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks. Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction: Historical Development, Explicit and Implicit Equations, Intrinsic Equations, Parametric Equations, Coordinate Systems.

Curves: Fundamental of Curve Design, Parametric Space of a Curve, Reparametrization, Space Curves: Spline Curves, Bezier Curves, B-Spline Curve,Rational Polynomials, Rational curves, NURBS.

Surfaces: Fundamental of Surface Design, Parametric Space of a Surface, Reparametrization of a Surface patch, Sixteen point form, Four Curve Form, Plane, Cylindrical and Ruled Surfaces, Surfaces of Revolutions, Bezier Surface, B-Spline Surface.

Solids: Fundamental of Solid Design, Parametric Space of a Solids; Continuity and composite Solids, Surface and Curves in a Solid.

Solid Modeling: Topology and Geometry, Settheory, Euler Operators, Regularized Boolean Operators, Construction Criteria, Graph Based Models, Instances and Parameterized Shapes, Cell-decomposition and Spatial Occupancy Enumeration, Sweep representation, CGS, BRep, Wireframe Analytical properties, Relational properties and Intersection. Applications in Biomedical Engineering Design.

Laboratory:- Students will be introduced to basic design elements in making 2D sketches, leading up to more complex features with 3D parts and assemblies. Students will also gain practical experience in engineering design and 3D printing fabrication using the Pro/ENGINEER and other available Softwares.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Posinasetti Nageswara Rao CAD/CAM: Principles and Applications, Tata McGraw-Hill Education.
2. Groover, CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education India.

AM2132 Biomedical Instrumentation		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Basic concepts of Medical Instrumentation: Generalized medical Instrumentation System, Medical Measurement constraints, Classification of Biomedical Instruments, Generalized static and dynamic characteristics, Design criteria, Commercial Medical Instrumentation Development process, Regulation of Medical Devices.

Theory, Analysis and design of biomedical transducers: optical, photo-electric, electrochemical, electrical, mechanical, electromechanical and thermoelectric, Applications to biomedical systems, Transducer characteristics sensors for physical measurands, sensors for measurement of chemicals. Medical measurands sensor characteristics and design for measurement of medical parameters like ECG, arterial blood pressure heart sounds, bio-potential amplifiers, Various types of electrodes used in ECG, EEG and EMG, Measurement of EEG, EMG and their diagnostic applications in Medicine, Flow and pressure measuring instruments in biomedical engineering, Development of non-invasive diagnostic instruments for tissue abnormalities, Medical Ultrasonography, Latest biomedical Instruments, Electro surgical unit, Pulse Oximeter, Defibrillators, Foetal ECG.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Khandpur R.S., Hand book of Biomedical instrumentation,TMH.
2. Tompkins, Biomedical Digital Signal Processing.
3. Cormwell L. et al., Bio medical Instrumentation & Measurements, PHI.
4. Carr & Brown, Introduction to Biomedical Equipment, PHI.
5. Webster JG, *Medical Instrumentation: Application and Design,* 4th ed., John Wiley & Sons: New York.

AM2133 Biomedical Signal and Image Processing		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Biosignals and their Characteristics –Origin of Biomedical Signals, Classification of Biosignals, Stochastic Signals, Signal Sampling and conditioning, DFT properties-Frequency Domain Analysis of Signals, FFT Algorithms, Digital Filter Design.

Time Domain Modeling- AR modeling, Spectral Estimation, Data Compression Techniques- Wavelet Transformation, Vector Quantization, Linear and Non Linear prediction of Bio signals, Waveform detection and Pattern Recognition.

Digital Image representation, Elements of digital Image Processing System. Image Transforms- Discrete Fourier Transform and properties, Separable Image Transforms, Image Enhancement, Image Restoration, Image segmentation, Image Reconstructions from projections, Data compression-DPCM, Vector quantization, JPEG, MPEG, Wavelet Transforms, Brief description of CT,MRI, Ultrasound, PET and SPECT images.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Cohen, Biomedical Signal Processing, Vol 1&2, CRC Press.
2. Tompkins W.J., Biomedical Digital signal Processing, Prentice Hall.
3. Jain A.K., Digital Image Processing, PHI.
4. Hicho Z. et. al., Fundamentals of Medical Imaging, John Wiley.

AM2134 Biological System Analysis and Control		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to linear control system, mathematical modeling, transfer functions, signal flow graphs, feedback control and its characteristics, Time domain and frequency domain analysis, stability analysis, Routh Hurwitz criteria, root locus plot, Bode plot, Nyquist Plot and Nichols plot, introduction to digital control, optimal, adaptive and Non-linear control.

Introduction mathematical modeling and control. Biological receptors, thermoregulatory systems, Human limbs, semicircular canal, musculoskeletal system, Respiratory system, pupil control system, neuromuscular reflex motion.

Application of control theory to physiological systems, Time domain and frequency domain analysis, stability analysis, Biological performance criteria and adaptive control, Simulation and implementation.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Michael C. K. Khoo, Physiological Control Systems: Analysis, Simulation, and Estimation (IEEE Press Series on Biomedical Engineering).
2. John H. Milsum, Biological control systems analysis, McGraw-Hill.

AM2135 Introduction to Biomedical Design		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Principles of Implant Design, Clinical Problems Requiring Implants for Solution, Principles of Implant Design / Design Parameters: Permanent versus Absorbable Devices, the Missing Organ and its Replacement, Criteria for Materials Selection, Tissue Engineering: Scaffolds, Cells and Regulators, Case Study of Organ Regeneration, Design Parameters, Design Specifications: Biomaterials ,Biocompatibility: Local and Systemic Effects, Design Specifications: Tissue Bonding and Modulus Matching, Degradation of Devices: Natural and Synthetic Polymers, Biocompatibility: Scar Formation and Contraction, Degradation of Devices: Corrosion and Wear, Regulation of medical Devices, Scaffolds for Cartilage Repair, Implants for Bone, Implants for Plastic Surgery, Cardiovascular Prostheses: Heart Valves and Blood Vessels, Devices for Nerve Regeneration, Musculoskeletal Soft Tissues: Meniscus, Intervertebral Disk, Dental and Ear Implants, Other Devices: Spinal Cord, Heart Lung.

Design and application of electromechanical biomedical devices, Concept of prototype development and testing of medical instrument. Techniques for designing electronic circuits as part of complete sensor systems, basic electronics circuits, principles of accuracy, op amp circuits, analog signal conditioning, power supplies, microprocessors, wireless communications, sensors, and sensor interface circuits, practical printed circuit board (PCB) design including component selection, PCB layout, assembly.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. E. J. Mccormick, Human factors in Engineering and Design, TMH.
2. O. P. Astrand and R. Kaare, Textbook of Work Physiology, McGraw Hill.
3. Yannas, I. V. *Tissue and Organ Regeneration in Adults*. New York, NY: Springer-Verlag, 2001.
4. Ayyana M. Chakravartula, Lisa A. Pruitt Mechanics of Biomaterials: Fundamental Principles for Implant Design (Cambridge Texts in Biomedical Engineering).
5. Webster J. G., *Medical Instrumentation: Application and Design,* 4th ed., John Wiley & Sons: New York.
6. J. D. Branzino, Handbook of Biomedical Engineering: Fundamentals of Biomedical Engineering, CRC Press.

Semester-II

AM2253 Biomedical Engineering Laboratory		
Designation	:	Compulsory
Pre-requisites	:	Biomechanics, Biomaterials and Biomedical Instrumentation.
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

1. To perform the tensile test on biomedical implant using universal testing machine. To draw stress strain curve and to find out the followings: (1) Yield stress, (2) Ultimate Stress, (3) Breaking Stress, (4) Percentage Elongation, (5) Percent Reduction in Area, and (6) the Modulus of Elasticity.
2. To determine the impact strength of biomaterial using (a) Charpy test (b) Izod test for biomedical implants.
3. To determine the value of modulus of elasticity of an implant by measurement of slope and deflection of a beam using beam-bending apparatus. Draw load-deflection diagram.
4. To perform torsion test on the given biomedical implant. To draw toque –twist curve and to find out the following. To determine the hardness of the given material by (1) Brinell Method (2) Rockwell Method.
5. Measurement of Blood Pressure using different methods.
6. Recording and analysis of electrocardiogram.
7. Recording and analysis of electroencephalogram.
8. Recording and analysis of electromyogram.
9. Preparation of composite using Hand layup method.
10. 3-point bending test of composite.
11. Project-1.
12. Project-2.
13. Project-3.
14. Project-4.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

Lab Manuals.

AM2203 Biomaterials		
Designation	:	Compulsory
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Classes of biomaterials, Bulk Properties of Materials, Surface properties and surface characterization of materials, Properties of biomaterials: Physical, thermal, electrical and optical properties of bio-materials. Biocompatibility, Bio-functionality, Mechanical and Biological Testing of Biomaterials.

Metallic Implant Materials: Stainless steels, Co-based alloys, Ti and Ti-based alloys and Other metals. Corrosion of metallic implants.

Ceramic Implant Materials: Aluminum oxides, Calcium Phosphate, Glass Ceramics and Carbons. Medical applications of Ceramic Materials.

Polymeric implant: Polymerization, Polymeric implant materials, Degradable Polymers used for Biomedical Applications. Silicone used for Biomaterials, Hydrogels, Smart Polymers as biomaterials, Polymers used for drug delivery and Tissue Engineering Applications. Natural polymers found in human body, Composites as Biomaterials.

Cardiovascular Biomaterials, Orthopedic Biomaterials, Ophthalmological Biomaterials, Biomaterials for soft tissue applications and hard tissue application. Biomaterials used for artificial skin, artificial hair implantation etc.

Novel Biomaterials and Uses in Engineering and Tissue Engineering.

Recent advances in the field of Biomaterials.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons Biomaterials Science, Second Edition: Wiley Science.
2. Jef A., Helsen H., Jürgen Breme, Metals as Biomaterials Wiley.
3. Kinam Park and Randall J. Mrsny Controlled Drug Delivery Designing Technology for the future American chemical society Publication.
4. Park .J.B. & Lakes R.S, Biomaterials: An Introduction, Plenum Press, New York.
5. Silver F .H, Biomaterials, Medical Devices &Tissue Engineering: An Integrated approach, Chapman & Hall.

AM2230 Advanced Biomechanics		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Applications of Principles of Biomechanics in Two and three dimensional kinematics.

Kinematics: Body segment parameters: Method of measuring and estimating body segment parameters, two dimensional and three dimensional computational methods.

Two dimensional inverse dynamics: Planar motion analysis, numerical formulations, Human joint kinetics.

Three dimensional Kinetics: Data required for Three dimensional analysis, anthropometry and three dimensional kinetics calculations.

Electromyographic Kinesiology: Physiology of the EMG Signals, Acquisition, interpretation and Analysis of EMG Signals. Applications of EMG Techniques in Biomechanics related problems.

Computer simulation of Human Movement: Mathematical formulations, free body diagrams, Lagrange's equation of motion, numerical solution techniques, control theory, advantages and limitation of computer models.

Elastic Behavior of Biological Materials: Strain and stress relationship, Plastic deformation, Biological material properties based on strain and stress diagram.

Viscoelastic Behavior of Soft Tissues:

Viscoelasticity, Analogies based on Spring and dashpots, Empirical models of Viscoelasticity, Time-dependent material response, Bio viscoelastic solids, Structure of Skeletal Muscle, Sliding element theory of muscle action, Hill's Equation for skeletal muscle, Modified Hill equation, Hypothesis of Cross Bridge Theory . Other recent muscle models.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Nihat Ozkaya and Margareta Nordin Fundamentals of Biomechanics:, 3rd Edition. VNR, New York.
2. David A. Winter Biomechanics and motor control of Human Movements:, 3rd Edition, John Wiley & Sons, Inc.
3. D. Gordon, E. Robertson, Graham E. Caldwell, Joseph Hamill Research Methods in Biomechanics:. Human Kinetics.
4. Mark L. Latash Neurophysiological Basis of Movement:, Human Kinetics.
5. Fung, Y.C.: Biomechanics: Mechanical Properties of Living Tissues, Springer, 1993.

BT2234: Bioethics, Biosafety and IPR		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Different ethical issues related to biotechnology, Importance and application of bioethics. International guidelines on bio-safety and bioethics and current legal issues.

Different standard practices (GLP, GMP, GCP, etc.). Social and international challenges for modern medicine, GM food, stem cell therapy.

Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, trade secrets, Geographical Indications. Precautions while patenting disclosure/non-disclosure. Patent infringement- meaning, scope, litigation, case studies.

Applications, international guidelines, and importance of biosafety, biosafety guidelines of biotechnology laboratories, important factors and safety guidelines to start-up of a biotechnology based company.

Role of different organizational level in bio-business set-up. Transition of an idea from biotechnology based R&D to business units, fund generation and resource creation for bio business startup.

Different bio-product based industries, their history, products and establishments. Different national and international organizations their functioning.

Text books and References

1. Eric Grace Biotechnology unzipped: Promises and realities.Wash. DC: Joseph Henry Press. 1997.
2. Arthur Kornberg. Sausalito, CA The golden helix: University Science Books. 1995.
3. Richard Oliver The coming biotech age: The business of biomaterials. NY: McGraw Hill. 2000.
4. Ruth Ellen Bulger et al., The ethical dimensions of the biological sciences. NY: Cambridge University Press. 1993.
5. David F. Betsch, Principles of Biotechnology.

AM2232 Electro Physiological Signal Analysis		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to bioelectric phenomenon, generation, transmission and interaction of signals in nervous systems. Discussion of initiation and propagation of action potential along the nerve fibers. Voltage clamp experiments, synaptic transmission and transduction process and receptors. Frequency modulation of the electrical signals. Use of mathematical models particularly electrical circuits models and describing behavior of cell membrane. Neural control mechanism, genesis and characteristics of EEG, ECG, EMG and Evoked potentials.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Cynthia Furse, Douglas A. Christensen, Carl H. Durney Basic Introduction to Bioelectromagnetics, Second Edition, CRC Press.
2. J. Malvino & R. Plonsey Bioelectromagnatism.
3. Webster J G, *Medical Instrumentation: Application and Design*, 4th ed., John Wiley & Sons: New York.

AM2233 Tissue Engineering		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to Tissue Engineering, Fundamentals of Stem Cell Tissue Engineering, Growth Factors and Morphogens: Signals for Tissue Engineering, Extracellular Matrix: Structure, Function, and Applications to Tissue Engineering, Mechanical Forces on Cells, Cell Adhesion, Cell Migration, Inflammatory and Immune Responses to Tissue Engineered Devices, Polymeric Scaffolds for Tissue Engineering Applications, Calcium Phosphate Ceramics for Bone Tissue Engineering, Biomimetic Materials, Nanocomposite Scaffolds for Tissue Engineering, Roles of Thermodynamic State and Molecular Mobility in Bio-preservation, Drug Delivery Gene Therapy, Tissue Engineering Bioreactors, Animal Models for Evaluation of Tissue-Engineered Orthopedic Implants, Bioengineering of Human Skin Substitutes, Gene Therapy and Tissue Engineering Based on Muscle-Derived Stem Cells: Potential for Musculoskeletal Tissue Regeneration and Repair, Tissue Engineering application in Bone, cartilage, Vascular graft, Heart valves, Tissue Engineering, Stem Cells and Cloning for the Regeneration of Urologic Organs, The Bioengineering of Dental Tissues and recent advances.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Patrick, Mikos and McIntire. Frontiers in Tissue Engineering, Pergamon Press.
2. Lanza, Labnger and Vacanti. Principles of Tissue Engineering, Academic Press.
3. Morgan and Yarmush, Tissue Engineering Methods and Protocols, Humana Press.

AM2234 Electro Diagnostics, Therapy and Electrical Safety		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Bio-potential Electrodes: Electrode- electrolyte interface, Polarizable and Non- Polarizable electrodes, Electrode behavior and circuit models, Body surface recording electrodes, internal electrodes, electrode array, microelectrodes and electrode for electric stimulation of Tissue. Practical considerations for optimum performance.

Diagnostic Equipment's: Recording of ECG, Different Lead Systems, Vector cardiography, Diagnostic Applications of ECG, Recording of EEG, different montage for EEG recording, Application of EEG for diagnosis of epilepsy, Surface EMG and its diagnostic applications.

Therapeutic Equipment: Cardiac Pacemakers, different types of pacemakers, pacing system analyzer, recent developments in implantable cardiac pacemaker. Cardiac defibrillators, Surgical Diathermy, Electro Surgical units and safety. Diagnostic application of LASERs, High frequency heat therapy, Short wave diathermy, microwave diathermy, Pain relief through electrical stimulation, Bladder Stimulator and cerebral stimulators. Hemodialysis, Ventilators, Anesthesia machines, Automatic Drug delivery Systems.

Electrical Safety: Physiological effect of electricity, Microshock and Macroshock Hazards, Electrical safety codes and standards, Basic approaches to protection against shock, grounding, Electrical safety analyzers, testing the electrical systems and electric appliances.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Khandpur R. S., Hand book of Biomedical instrumentation, TMH.
2. Carr & Brown, Introduction to Biomedical Equipment, PHI.
3. Webester J. G., Medical Instrumentation, 3rd Edition, John Wiley.

AM2223 MEMS & Bio-MEMS		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction: MEMS, microsystem, sensor, actuator, history, market, applications, etc.

Review of Essential Mechanical, Electrical Concepts: Mechanical: stress, strain, beam, cantilever, plates, bending, thermal stress, torsion of beam, fracture, vibration etc, Electrical: Conductor, insulator, semiconductor.

Scaling Laws in Miniaturization: Scaling in geometry, force, electricity, fluid, heat transfer, etc.

Material for MEMS: Review of crystal structure, miller indices, material for MEMS, substrate, device, packaging, silicon, silicon compound, gallium arsenide, piezoelectric martial, quartz, polymer, biomaterials and biocompatibility issues etc.

Micro Total Analysis System (μTAS): Fluid control components, μ-TAS: sample handling, μ-TAS: separation components, μ-TAS: detection, cell handling and characterization systems, systems for biotechnology and PCR, polynucleotide arrays and genetic screening.

Sensing and Actuation: Electrostatic sensing and actuation, thermal sensing and actuation, piezoelectric and piezoresistive sensing and actuation, magnetic sensing and actuation, miniature biosensors, biosensors arrays and implantable devices, neural interfaces, microsurgical tools, micro needles, and drug delivery, Microsystems for tissue engineering, tissue scaffolds, optical biosensors, etc.

Fabrication of MEMS: Bulk micromachining, surface micromachining, lithography, LIGA, SLIGA, etc.

MEMS Packaging: MEMS metrology, Overview of packaging of microelectronics, packaging design, technique, material, etc.

MEMS Design and Software: Design methodologies for MEMS, study of following softwares based on availability: Ansys multiphysics, COMSOL multiphysics, MatLab, Intellisuite, AutoCAD, SolidWorks, Spice, Ledit, etc.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Foundations of MEMS, Chang Liu, Pearson Education International.
2. MEMS and MICROSYSTEM Design and Manufacture, Tai-Ran Hsu, Tata Mcgraw-Hill Publishing Company Ltd., New Delhi.
3. Microsystem Design, S. D. Senturia, Kluwer Academic Publishers.
4. Fundamentals of Microfabrication, Marc Madou, CRC Press, NY.
5. Microsystem Technology in Chemistry and Life Sciences, A. Manz and H. Becker, Eds. Springer-Verlag, New York.

Fundamentals of Micro Fabrication, the Science of Miniaturization, M. Madou, Nanogen Corporation, USA, CRC Press.

AM2235 Rehabilitation Engineering and Assistive Technology		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to Rehabilitation:

Definition, Concept of Rehabilitation, Concept of disability, Socio-vocational Rehabilitation, Medical, Psychological and social issues influencing the rehabilitation, Rehabilitation team, Therapeutic exercises and treatment techniques used in rehabilitation process, Socio-legal aspect of rehabilitation.

Orthotics & Prosthetics in Rehabilitation:

Concept of orthotics and prosthetics, material and fabrication for orthotics and prosthetics, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Advance and automated prosthetics and orthosis, externally powered and Controlled orthotics & prosthetics,-FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand. Engineering concepts in motor rehabilitation, applications. Computer Aided Engineering in Customized Component Design for orthotics and prosthetics.

Computer Application in Rehabilitation Engineering:

Interface in compensation for visual perception, Improvement of orientation and Mobility.

Engineering concepts in sensory rehabilitation Engineering; Sensory augmentation and substitution:

Visual system, Classification of Visual Impairments, Prevention and cure of visual impairments, Visual Augmentation, Tactile vision substitution, auditory substitution and augmentation, tactile auditory substitution, Assistive devices for the visual impaired, Hearing aids, cochlear implantation. Materials used for wheel chairs, Type of Wheel Chairs, design of wheel Chair, Tricycle, Walkers, Crutches.

Rehabilitation Aids for Mentally Impaired:

Walking Aids, Seating Aids and Postural Aids.

Applied Rehabilitative conditions:

Rehabilitation of people with spinal cord injury, stroke, cerebral palsy, traumatic brain injury, Hemiplegic, Spasticity, Myopathy, Cerebral injury and limb amputation. Rehabilitation engineering for the restoration of variety of human activities for disabilities that include sensory, motor of cognitive losses.

Artificial organs: Kidney, heart, pancreas, liver, etc.

Burn injury Rehabilitation

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. Smith, Raymond V. & John H. Leslie, "Rehabilitation Engineering". CRC Press.
2. Mann, William C. and Joseph P. Pane, "Assistive Technology for Persons with Disabilities" The American Occupation Therapy Association Inc.
3. Webster, John G. et al, "Electronic Devices for Rehabilitation" John Wiley & Sons.
4. Cooper Rory A, Ohnabe Hisaichi, Hobson Douglas A. "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering)", CRC Press.
5. Cooper Rory A, Rehabilitation Engineering Applied to Mobility and Manipulation (Series in Medical Physics and Biomedical Engineering), CRC Press.

AM2236 Medical Imaging		
Designation	:	Elective
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Introduction to medical imaging and different medical Imaging modalities. Review of Signals and system, Fourier transform, Transfer functions, Hankel transform, Sampling theorem.

Image Quality: Contrast, Modulation transfer function, resolution, Noise, Signal to noise ratio, accuracy, etc.

Radiography: Atomic structure (review), Ionization, forms of Ionizing radiation and their properties, Radiation dosimetry.

Projection Radiography: X-Ray production, X-ray interaction with biological matters, Instrumentation for medical X-ray system, Filters, contrast agents, X- Films and intensifiers, Image formation, Noise and artifacts.

X-Ray Computed Tomography: CT Instrumentation, Different generations of CT Scanner, Imaging principle, Image formation, Redon transform, Back Projection Theorem, Helical CT Reconstruction, Cone Beam CT, Image quality in CT.

Application of Projection radiography: Mammography, Fluoroscopy, Angiography, etc.

Nuclear Medical Imaging: Radio Active Decay, Modes of decay, Radio traces, Instrumentation for planer scintigraphy, Image Formation and Image quality. Instrumentation for PET and SPECT, Image Quality in PET and SPECT.

Ultrasound Imaging: Physics of Ultrasound, interaction of ultrasound with biological matter, Ultrasound beam patterns and focusing. Instrumentation for ultrasound imaging system, ultrasound transducer and probes, pulse echo imaging, A Mode, B Mode and M Mode imaging. Doppler ultrasound imaging.

Magnetic Resonance Imaging:

Instrumentation for MRI System, Concept of MRI Imaging, Magnetization, RF excitation, relaxation, Pulse echo sequences and contrast mechanism. MRI data acquisition, Image Reconstruction and Image quality.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. William R. Hendee, E. Russell Ritenour, Medical Imaging Physics.
2. Jerry L. Prince, Jonathan M., Medical Imaging Signals And Systems. Pearson Education.
3. Andrew G. Webb, Introduction to Biomedical Imaging, IEEE Press.

AM2237 Artificial Intelligence in Biomedical Engineering		
Designation	:	Elective
Pre-requisites	:	Basic knowledge of Computers, Linear algebra, etc.
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Basics of Artificial Neural Networks: Introduction, Pattern and data, methods for pattern recognition tasks, Artificial neural networks: Terminology, Models of neurons, Topology. Activation and synaptic dynamics: Activation dynamic models, synaptic dynamic models, learning methods. Functional units of ANN for pattern recognition tasks: Pattern recognition problems, basic functional units, Feed forward neural networks: Analysis of pattern association networks, analysis of pattern classification networks, Feedback neural networks: Analysis of linear associative, FF Networks. Competitive learning neural networks: Components of competitive learning network, analysis of pattern clustering network, Biomedical applications of ANN: Modeling and diagnosing the cardiovascular system, Pattern recognizing of pathology images, ultrasound and magnetic resonance medical images textures analysis using ANN.

Term Paper: On recent advances based on literature survey and/or lab/industry visit.

Text books and References

1. D. L. Hudson and M. E. Cohen, "Neural Networks and Artificial Intelligence for Biomedical Engineering", Prentice Hall.
2. Vojislav Kecman, "Learning and soft computing", Pearson Education (Asia) Pte. Ltd.
3. S. Haykin, "Neural networks: A Comprehensive Foundation"' Pearson Education (Asia) Pte. Ltd/Prentice Hall of India.
4. M. T. Hagan, H. B. Demuth and M. Beale, "Neural Network.

AM2202 Characterization of Materials		
Designation	:	
Pre-requisites	:	
Credit and Contact hours	:	4(L) - 0(T) – 0(P) – 4(Cr)
Assessment Methods	:	**Theory Examination: (Scheme)** End Semester Exam: 60 marks Mid Semester Exam: 20 marks
		Internal Assessment: (Scheme) 20 marks (5 marks for attendance + 15 marks for assignment submission Surprise Tests, Quizzes, Assignments and Tutorials, etc.).

Syllabus

Crystallography: Overviews in bonding, Bravais lattices, Miller indices, imperfections in crystals, crystal structures of common metal, ceramics, polymers. symmetries in crystals, point groups, space groups, reciprocal lattice, morphology

X-ray Diffraction Techniques: Production of X-rays, its properties and hazards, photon scattering, X-ray diffraction and Bragg's law, intensities calculations, Laue techniques, Debye-Scherrer techniques. modern diffractometers, diffractometer measurements, determination of crystal structure of powder sample, small angle scattering, line broadening, particle size, crystallite size, residual stress measurement, plane indexing, precise parameter measurement, phase identification, phase quantification, phase diagram determination, stereographic projection, pole figure, preferred orientation (texture analysis) and chemical analysis, profile fitting and Rietveld analysis.

Optical Microscopy: Principles and operations of microscopy, resolution, magnification, numerical aperture, depth of field, viewing area, contrast, geometry of optical microscopes, application of microscopy in metallurgical studies (qualitative and quantitative), morphology and symmetry, grain boundaries and dislocations, phase contrast microscopy, polarized light microscopy, hot-stage microscopy, sample preparation.

Electron Microscopy: Electron sources, electron diffraction, principles and operation of scanning electron microscope. Construction of electron microscopes, specimen handling and preparation, secondary electron image, backscattered electron image, image processing, analysis of electron micro-graphs and fractography studies, transmission electron microscopy (TEM).

Scanning Probe Microscopy: Principles and operation of scanning probe microscopes, scanning tunneling microscope, atomic force microscope, magnetic force microscopy, topography studies, nano-indentation and its probing.

Thermal Analysis: Thermo gravimetric analysis, differential thermal analysis, differential scanning calorimetery, thermo-mechanical analysis and their applications.

Solid State and Surface Spectroscopies: Electron Energy Loss Spectroscopy (EELS), Reflection Absorption Infra-red Spectroscopy (RAIRS), Transmission IR, Raman, Photoelectron Spectroscopy (PES), Auger Electron Spectroscopy (AES), X-ray Fluorescence (XRF), Nuclear Magnetic Resonance (NMR), Extended X-ray Absorption Fine Structure (EXAFS).

Term Paper: On recent advances based on literature survey and/or lab/industry visit

Text books and References

1. Crystals and Crystal structures, R.J.D. Tilley, John Wiley and Sons, 2006
2. Elements of X-ray Diffraction, Cullity B. D., Addison-Wesley Publishing Co.
3. Electron Microscopy and Analysis, P.J. Goodhew, F.J. Humphreys, Taylor & francis, Second edition.
4. Solid state chemistry and its Applications, Antony R. West, Wiley Student Edition.
5. Fundamentals of Molecular spectroscopy, Colin N. Banwell and Elaine M. McCash, Tat McGraw-Hill Publishing Co. Ltd., Fourth edition.

Materials Characterization :Introduction to Microscopic and Spectroscopic, Yang Leng, John Wiley&Sons.