SCHOOL OF BIOMEDICAL ENGINEERING
INSTITUTE OF TECHNOLOGY
BANARAS HINDU UNIVERSITY

M.TECH. IN BIOMEDICAL ENGINEERING

First Semester:

Subject Code	Subject	Contact Hours/Week	Credits
BM-5101	Physiology	3	3
	Elective-I*	3	3
	Elective-II*	3	3
	Elective-III*	3	3
	Elective-IV*	3	3
BM-5301	Practical	6	4
Total of First Semester		**21**	**19**

*****Elective-I, Elective-II*, Elective-III*.& Elective-IV*
Any four of the following

BM- 5102: Biomaterials
BM- 5103: Bioinstrumentation
BM- 5104: Biomechanics-I
BM- 5105: Computer Application in Biomedical Engineering
BM- 5106: Biological System Analysis and Control
BM- 5107: Mathematical Methods in Biomedical Engineering

Second Semester:

SUBJECT CODE	SUBJECT	CONTACT HOURS/WEEK	CREDIT
	Open Elective*	3	3
	Elective-I**	3	3
	Elective-II**	3	3
	Elective-III**	3	3
	Elective-IV**	3	3
BM-5401	Practical/Project	3	2
BM-5402	Seminar	2	1
Total of Second Semester		**20**	**18**

*From other Departments/ School (Approved by the Head of the Department)

**Elective-I, Elective-II*, Elective-III*& Elective-IV*

Any four of the following

BM- 5201: Biotransport Process
BM- 5202: Electrophysiological Signal Analysis
BM- 5203: Biomechanics-II
BM- 5204: Composite Materials
BM- 5205: Biomedical Signal and Image Processing
BM- 5206: Effects of Radiation and Biomedical Applications of Radiation
BM- 5207: Bioceramics

Third Semester:

SUBJECT CODE	SUBJECT	CONTACT HOURS/WEEK	CREDIT
BM- 6301	Seminar on Dissertation	-	5
BM- 6302	Dissertation - Interim Evaluation	-	5
Total of Third Semester			**10**

Fourth Semester:

SUBJECT CODE	SUBJECT	CONTACT HOURS/WEEK	CREDIT
BM- 6401	Dissertation (Open Defence)	-	5
BM- 6402	Dissertation Evaluation	-	10
Total of Fourth Semester			**15**
GRAND TOTAL			**62**

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REVISED M. TECH. SYLLABUS

BM –5101: Physiology

Introduction to human physiology. Composition and function of blood. Structure and function of cardiovascular system, respiratory system, renal system, musculo-skeletal system, endocrine system and gastrointestinal system. The structure and function of nervous system.

BM-5102: Biomaterials

Structure of cell, tissue and organ and properties of biological materials e.g., bone, teeth and connective tissue. Soft tissue and hard tissue replacement. Facial and dermal prosthesis in human body. Biocompatibility. Interaction between materials and body and testing of implants.

Properties, compatibility characteristics and performance requirements of materials for implants. Structure property relationship of metals, polymers, ceramics and composites as biomaterial substitutes. Heart valves implants. Biomedical application of colloid.

BM-5103: Bioinstrumentation

Basic concept of biomedical instrumentation. electrodes, transducers, biosensors and their characteristics. Biopotential amplifiers. Biotelemetry. Recording of ECG, EEG, EMG, ERG, evoked potentials etc. Cardiovascular measurements. Measurement of the respiratory system. Analytical instruments in Biomedical Engineering; oximeter, spectrophotmeter, colorimeter, blood gas analyzer, blood cell counter. Therapeutic & assist devices for cardiovascular system and respiratory system. Physiotherapy devices. Electrosurgical units. Safety aspects of biomedical equipment.

BM- 5104: Biomechanics-I

Scalar and vector quantities. Different operations on vector. Forces and moments, system of forces, resultant of system of forces in 3D and 2D. Equilibrium equations. Applications with example on human body.

Work-energy equations: Applications to Biomedical system. Stress-strain diagram.

Stress concentration. Mechanical properties of human bone. Mechanical properties of cortical bone, properties of cancellous bone, viscoelasticity, elastic model of bone. Mechanical testing of soft tissues.

BM-5105: Computer Applications in Biomedical Engineering

Use of computers in physiological data acquisition and analysis. Programming, storage and display of data with reference to bioelectric potentials. Applications of Microprocessor and Microcontroller in medicine.

Digital filters; FIR and IIR type and their application to biomedical signal filtering. Data reduction techniques. Spectrum analysis.

Intelligent computing systems in medicine; Introduction to Intelligence and Artificial Intelligence. Heuristic search method, knowledge Based system, ANN architecture and learning algorithms.

Evolutionary computing and Genetic Algorithm (EC-GA)

Fuzzy Logic and its application in decision making.

Application of ANN, EC, GA, FL in Medical data analysis and diagnosis.

BM-5106: Biological System Analysis and Control

Control system: Introduction to linear control system, Mathematical Modeling, Transfer function, signal flow graph, feedback control its characteristics, advantages and state-space models. Time-domain and frequency domain analysis. Stability analysis; Routh Hurwitz criteria, Root locus plots, Bode plots, Nyquist plots and Nichols plots. Introduction to Digital control, Optimal, Adaptive and Non-linear control systems.

Physiological control systems: Introduction, mathematical modeling & control. Biological receptors, thermoregulatory system, human limb, semicircular canal, skeletal-muscle, respiratory system, pupil-control systems, neuromuscular reflex motion.

Applications of Control theory to physiological systems. Time-domain, frequency domain, stability analysis. Biological performance criteria and adaptive control systems.

Simulation implementation.

BM-5107: Mathematical Methods in Biomedical Engineering

Mathematical modeling and solution of biomedical problems namely respiratory rate, blood flow, cardiac output and impedance diffusion, ultra filtration etc.

Operational research applied to the description of physiological systems and signals processing by interfacing instrumentation, biomedical variability and probabilistic solution to medical decision making, population dynamics perturbation technique in dealing with the problems of thermodynamics. Stochastic process . Finite- Difference method .

BM-5201: Biotransport Processes

Introduction to fluid flow, heat transfer and mass transfer. Unified approach of momentum; Heat and Mass transfer; flow behaviors of Newtonian and non-Newtonian fluids; application of momentum; heat and mass transfer principles of biological system with particular emphasis on human beings; fluid mechanics of time dependent flows in

pulmonary and urinary systems; Engineering models and their utilization in describing in-vivo observations. Modeling of the body as compartment; Source and stream; heat exchange between human body and its environment; mass transfer in membrane; heamodialysis as related to artificial kidney; extra corporal oxygenerators.

BM-5202: Electrophysiological Signal Analysis

Introduction to bioelectric phenomena. Generation, transmission and interaction of signals in nervous systems. Discussion of initiation and propagation of action potential along nerve fibers. Voltage clamp experiments. Synaptic transmission and transduction process in receptors. Frequency modulation of the electrical signals. Use of mathematical models particularly electrical circuit models in describing behavior of cell membranes. Generation, propagation, characteristics and recording of ECG, EEG, EMG, EOG, ERG and evoked potentials. Neural control mechanism

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BM-5203: Biomechanics-II

Principle of continuum mechanics. Tensor treatment to explain elastic, viscoelaslicity, electric and electromechanical properties of bones, teeth and connective tissues. Wave propagation in extended and partly bound media and its application in analyzing the structural micro textural symmetry in calcified tissues. Theoretical models for bone as a hierarchical composite.

Dental forces, implant-tissue biomechanics, Crack propagation in bones, dynamic models.

Wolf's law and introduction to orthopedic biomechanics. Human body dynamics and locomotion analysis. Pressure sore biomechanics. Interaction between tissues and support surface. Mechanics of spinal distraction rods. Biomechanics of human motion and control interfaces with application to limb orthotics and prosthetics. Design of hip prosthesis. Automated driver's training programme. Sports biomechanics.

BM- 5204: Composite Materials

Types of composites and their advantages.

Reinforcement: Glass, boron, carbon, organic and ceramic fibers, their structure, properties and processing.

Matrix materials: Polymers, metal and ceramic matrices, their structure, properties and processing. Wettability and interface bonding.

Polymer matrix composites: Lamina, laminate composites. Primary and Secondary manufacturing; Lay-up, Filament winding, pultrusion, compression moulding. Machining, drilling and routing, applications.

Metal matrix composites: processing techniques and applications. Ceramic Matrix composites; processing techniques and applications.

Introduction to Nanocomposites and applications

Micromechanic: Mechanical properties, thermal properties and load transfer. Macromechanics: Elastic behavior, fracture behavior, fatigue behavior, creep behavior of composites. Tribological and electrical behavior of composites.

Degradation of composites due to various environmental conditions, corrosion resistance of composite. Designing with composites

Biological application of composites.

BM- 5205: Biomedical Signal and Image Processing

Medical imaging systems; X-ray system, C.T. Scan, Ultrasound (A, B and M scans). MRI and Positron Emission Tomography

Fundamentals of digital image processing. Storage and display operation properties of digital image. Image preprocessing by statistical and probabilistic methods.
. Image enhancement and restoration. Segmentation of images by applying Thresh hold, Edge based and Region based techniques. Image feature extraction, analysis of medical images.

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BM- 5206: Effects of Radiation and Biomedical Applications of Radiation

Basic concepts, types, sources and characteristics of electromagnetic radiations and its influence on living beings with particular emphasis on human beings. Biological effects and Biomedical applications of X- Rays, Gamma–rays, Microwaves, Ultrasound etc. Introduction to Radioisotopes and its Biomedical Applications.

Lasers, its classification, basic concept, types and their Biomedical Applications. Laser use in surgery, diagnosis and in promotion of healing. Safety
with biomedical lasers.

BM- 5207: Bioceramics

Definition and scope of bio-materials. Structure-property relationship of biological materials, structure of proteins, polysaccharides, structure-property relationship of hard tissues cell, bone, teeth and connective tissues.

Structure, properties and functional behaviour of bio-materials. Tissues response to implants (bio-compatability, wound healing process), body response to implants, blood compatability.

Classification of bio-ceramic materials for medical applications. Alumina and zirconia in surgical implants, bioactive glasses and their clinical applications, A.W. machinable and phosphate glass ceramics. Dense and porous hydroxyl apatite calcium phosphate ceramics, coatings and resorbable ceramics. Carbon as an implant. CMC and PMC composites. Characterization of bio-ceramics. Regulation of medical devices.