Tissue Engineering

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM107101BM

[Prerequisite -Nil]

Course Objectives

1. To Make Students Understand The Basic Utility And Potential Of Tissue Engineering Principles.
2. To Create Problem Solving Ability Among Students For Developing Strategies To Build Tissue Engineering Solutions.
3. To Encourage Students For Fabricating Tissue Engineering Products.
4. To Prepare Students For Advance Level Courses In Bionems.

Course Content

Unit 1 Fundamental Of Tissue Engineering

Fundamentals Of Stem Cell Tissue Engineering; Growth Factors; Extracellular Matrix: Structure, Function And Tissue Engineering Application; Mechanical Forces On Cells; Cell Adhesion; Cell Migration.

Unit 2 Tissue Engineering Enabling Technologies

Polymer Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds Tissue Engineering; Bioreactors; Regulatory Issues In Tissue Engineering.

Unit 3 Tissue Engineering Application I

Bioengineering Of Human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Temporomandibular Tissue Engineering; Smooth Muscle Tissue Engineering; Esophagus Tissue Engineering.

Unit 4 Tissue Engineering Application II

Vascular Graft Tissue Engineering Cardiac Tissue Engineering; Heart Valve Tissue Engineering; Urologic Organ Tissue Engineering; Hepatic Tissue Engineering; Renal Tissue Engineering; Dental Tissue Engineering; Tracheal Tissue Engineering.

Course Materials

Text Books:

1. Clemens van Blitterswijk (2008), Tissue Engineering, Academic Press.

Reference Books:

1. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.). (2020). Principles of tissue engineering. Academic press.

2. Palsson, B., Hubbell, J. A., Plonsey, R., & Bronzino, J. D. (2003). Principles and applications in engineering series. Tissue Engineering, CRC Press, Boca Raton, FL.

Biophotonics

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-1-0, (4)	Core	BM107102BM

[Prerequisite -Nil]

Course Objectives

1To differentiate the various working principles of optical imaging systems
2. To outline the various applications of biosensors in medicine
3. To analyse the working principle of flow cytometer
4. To describe the importance of photodynamic therapy in treatment of diseases
5. To explain about Bionanophotonics and other advance topics

Course Content

Unit 1 Introduction

Biophotonics – A new frontier; Fundamentals of Light and Matter – Nature of Light, Quantized States of Matter, Intermolecular Effects, Three Dimensional Structures and Stereoisomers; Basics of Biology; Fundamentals of Light-Matter Interactions

Unit 2 Bioimaging

Principles of Lasers, Current Laser Technology and Nonlinear Optics – Quantitative Description of Light: Radiometry, Time-Resolved Studies, Laser Safety; Photobiology – Photo processes in Biopolymers, In Vivo Photo execution, In Vivo Spectroscopy, Optical Biopsy, Single-Molecule Detection; Principles and Techniques of Bioimaging – Transmission and other Microscopy, Optical Coherence Tomography, Spectral and Time Resolved Imaging and other related Imaging; Applications

Unit-3 Biosensors, Flow Cytometry and Photodynamic Therapy

Introduction to Biosensors, Principles of Biosensing, Different Biosensors; Microarray Technology for Genomics and Proteomics – DNA, Protein, Cell, Tissue Microarray Technology; Basics of Flow Cytometry, Commercial Flow Cytometry; Basic Principles of Photodynamic Therapy, Photosensitisers, Current Research and Future Directions

Unit-4 Emerging Areas and Case Study

Bionanophotonics and Array Technologies, Optical Diagnostics and Targeted Therapy, Laser Scissors, Super Resolution Microscopy Techniques(STED, STORM, PALM), Ultrasound-mediated Biophotonics Imaging, A Case Study on Deep Learning for Biophotonics, A Case Study on Biophotonics to Occupy Crucial Role in Clinical Assessment of Cancers.

Course Materials

Text Books:

1. Prasad, P. N. (2004). Introduction to Biophotonics. Germany: Wiley
2. 2. Biophotonics for Medical Applications. (2015). Netherlands: Elsevier Science

Reference Books:

1. Prasad, P. N. (2004). Nanophotonics. Germany: Wiley
2. Keiser, G. (2018). Biophotonics: Concepts to Applications. Singapore: Springer Singapore

Rehabilitation Engineering

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM107201BM

[Prerequisite -Nil]

Course Objectives

To Make Students Understand The Basic Concepts Of Tools And Devices Associated To Rehabilitation Technology .
2. To Create Problem Solving Ability Among Students For Framing Rehabilitation Solution For Disabilities.
3. To Encourage Students For Designing Smart Rehabilitation Products.
4. To Prepare Students For Entrepreneurship In Rehabilitation Services And Products.

Course Content

Unit 1 Visual Rehabilitation

Visual Aids: Low Vision Aids, Braille, Tactile Vision, Auditory Vision, Stimulation Of Visual Cortex,; Mobility Aids For Blinds: Canes, Laser Cane, Ultrasonic Guides, Electronic Travel Aids, Aids For Type Writting.

Unit-2 Hearing Rehabilitation

Hearing Aids: Hearing And Audiology, Conventional Hearing Aids, Auditory Prostheses; Aids For Deaf: Aids For Finger Spelling, Lipreading Aids, Aids To Daily Life, Aids To Speech.

Unit-3 Tactile And Motor Rehabilitation

Aids For Tactile Impaired: Sensory Substitution To Increase Hand Function, Systems Designed To Reduce Tissue Trauma; Interfacing The Motor Impaired: Characteristics Of Motor Impairments, Basic Selection, Transducer For Motor Impaired, Microcomputer Based Aids.

Unit-4 Mobility And Upper Limb Rehabilitation

Mobility Aids: Feeders, Page Turner, Robotic Aids, Powered Wheelchair Controller, Modified Driving Aids; Upper Extremity Prosthetic Devices: Body Controlled Prostheses, Myoelectric Control, Boston Arm, Otto Bock Myoelectric Prosthetics Center System, Utah Arm, SVEN Hand Prosthesis, Man-machine interface.

Course Materials

Text Books:

1. Bronzino, Joseph (2000); Handbook of biomedical engineering. 2nd edition ,CRC Press.

Reference Books:

1. Horia- Nocholai Teodorecu, L.C.Jain (2000), intelligent systems and technologies in rehabilitation
engineering; CRC.
2. Robinson C.J (1995) Rehabilitation engineering. CRC press.
3. Etienne Grandjean, Harold Oldroyd (1988), Fitting the task to the man, Taylor & Francis.

Medical Image Processing

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM107202BM

[Prerequisite -Nil]

Course Objectives

1. To learn the basics of digital image processing techniques.
2. To have an understanding on the application of digital image processing techniques on medical image processing.
3. The students should be able to implement and apply image processing techniques for image quality improvement
and analysis of medical images.

Course Content

Unit 1 Fundamentals of Digital Image Processing

Components of an image processing system, Digital image representation, Digital images, Image sampling and quantization, Applications of image processing in the medical field, Medical image enhancement (Spatial and frequency domain).

Unit-2 Medical Image Segmentation

Segmentation based on dissimilarities (point, line and edges), region-based segmentation (thresholding, region growing, splitting and merging, active contours, clustering, Applications in medical image segmentation, performance evaluation of segmentation algorithms.

Unit-3 Medical Image Compression

Coding Redundancy, Spatial and Temporal Redundancy, Irrelevant Information, Measuring Image Information, Shannon's First Theorem, Fidelity Criteria, Image Compression Models, The Encoding or Compression Process, The Decoding or Decompression Process, Image Formats, Containers, and Compression Standards, lossy and lossless image compression techniques.

Unit-4 Feature Extraction and Classification of Medical Images

Boundary preprocessing and features, region-based features, texture analysis, principal components, pattern classification and performance evaluation.

Course Materials

Text Books:

1. Woods, R. E., Gonzalez, R. C. (2018). Digital Image Processing. United Kingdom: Pearson.
2. Jain, A. K. (1989). Fundamentals of Digital Image Processing. India: Prentice Hall

Reference Books:

1. Jayaraman, S., Veerakumar T., Esakkirajan, S. (2017) Digital Image Processing, McGraw Hill Education.
2. Rangayyan, R. M. (2004). Biomedical image analysis. CRC press.
3. IEEE Transactions on Medical Imaging (ISSN:0278-0062), Journal IEEE.

Biochemistry

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM107203BM

[Prerequisite -Nil]

Course Objectives

1. The student will learn basic understanding of concept of Biochemistry regarding biomolecules – carbohydrates,
proteins, lipids, nucleic acids, enzymes, Macromolecule metabolism and their medical application.

Course Content

Unit 1 Introduction

Structure, Function and Physiological Importance of Biomolecules, Enzyme Classification, Mechanism of Action and Kinetics

Unit-2 Metabolism of Major Classes of Biological Macromolecules

Bioenergetics & the general Metabolism of Carbohydrates, Lipids, Nucleic Acid and Amino Acids.

Unit-3 Major Tests

Brief Biochemistry of Hormones, Vitamins and Minerals: Requirements and Function, Liver Function Test, Renal Function Test, Thyroid Function Test, Cardiac Function Test, Pancreatic Function Test.

Unit-4 Water and Electrolyte Balance and Imbalance

Water and Electrolyte Balance and Imbalance - Water Intake and Loss, Regulatory Mechanisms, Blood Osmolarity and Osmolality, Extra Cellular and Intracellular Cations and Anions, Electrolyte Balance, Acid Base Balance – Blood Buffers, Mechanism of Action Acidosis and Alkalosis, Compensatory Mechanisms, Assessment of Acid Base Status.

Course Materials

Text Books:

1. Botham, K. M., Weil, P. A., Bender, D., Rodwell, V. W., Kennelly, P. J. (2018). Harper's Illustrated Biochemistry Thirty-First Edition. United States: McGraw-Hill Education.
2. Lehninger, A. L., Nelson, D. L., Cox, M. M. (2008). Lehninger principles of biochemistry. United Kingdom: W. H.
Freeman.

Reference Books:

1. Voet, J. G., Voet, D. (2011). Biochemistry. United Kingdom: Wiley.
2. Baynes, J. W., Dominiczak, M. H. (2018). Medical Biochemistry. Netherlands: Elsevier Health Sciences.
3. Ashby, P., Walker, S. A., Rae, P., Beckett, G. J., Walker, S. W. (2013). Clinical Biochemistry. United Kingdom: Wiley.

Basic Clinical Science

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Program Elective	BM107204BM

[Prerequisite -Nil]

Course Objectives

1. To understand physiology and pathology of the cardiac system.
2. To understand the normal and abnormal ECG along with their interpretation.
3. To study about orthopedics and fracture management.
4. To know about joints and their diseases.

Course Content

Unit 1 Cardiac System

Heart structure and function. Cardiac cycle. Various valves and their functions. IABP. Cardiovascular measurements. Heart lung machine. Applications. Clinical significance. CVP and SWAN Catheters.

Unit-2 Electrocardiogram and Interpretation

Electrocardiography: Sources of ECG potentials. Dipole theory. Conduction system. Normal and abnormal ECGs. Diagnostic applications. Interpretation of ECG. Cardiac pacing. Diagnostic indications. Criteria for selection. Therapeutic indications. Complications. Pacemaker. Temporary pacing. Permanent pacing.

Unit-3 Orthopedics and Fracture Bioengineering

Orthopedics & Fracture Bioengineering aspects of fracture management. Structure of bone: gross, microscopic biochemical. Fracture-types mechanism of injury. Normal healing of fractures. Pieze electricity and electrical stimulation for bone healing. Treatment of fractures-general principles –closed methods. External fixation and internal fixation. Biomechanics of internal fixation and description of external fixators. Bioengineering principles of internal fixation. Intra medullary nails. Plates, screws. The concepts of load hearing and load sharing and shielding by implants

Unit-4 Joints and Disease

Joints bioengineering aspects of joint diseases. Structure of joints – fibrous, cartilaginous, synovial. Lubrication of joints and the function of articular cartilage. Degeneration of cartilage degenerative arthritis and rheumatoid arthritis. Joint replacement, hip, knee, shoulder, small joints.

Course Materials

Text Books:

1. Rushmer, R. F. (1967). Cardiovascular Dynamics. United Kingdom: W.B. Saunders.
2. Frankel, V. H., Nordin, M. (2012). Basic Biomechanics of the Musculoskeletal System. United Kingdom: Lippincott Williams & Wilkins.

Reference Books:

1. Maheshwari, J., Mhaskar, V. A. (2019). Essential Orthopaedics: (including Clinical Methods). India: Jaypee Brothers,Medical Publishers Pvt. Limited.
2. Hall, J. E. (2020). Guyton and Hall Textbook of Medical Physiology. United States: Elsevier.
3. Grant, A. W., Grant, A., Waugh, A. (2006). Ross and Wilson Anatomy and Physiology in Health and Illness. United Kingdom: Churchill Livingstone.

Lab-On-Chip Devices

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM107301BM

[Prerequisite -Nil]

Course Objectives

1. To Make Students Understand the Basic Concepts of Lab-On-Chip Architecture.
2. To Create Problem Solving Ability Among Students for On-Chip Solution Development.
3. To Encourage Students for Designing Lab-On-Chip Healthcare Products.
4. To Prepare Students for Advance Level Courses Lab on Chip Fabrication Technology

Course Content

Unit 1 Introduction To Lab-On-Chip

The Diffusion Of Molecules And Microscale Mixing, Technological Production Of Components: Mixers And Pumps, Separation, Purification, Concentration Technologies, Simulation And Design Of Mixing Devices For Chemical Reactors, Design And Simulation Of Lab-On-A-Chip Devices , A Considered Approach To Lab-On-A-Chip Fabrication, Fluidic Platforms And Components Of Lab-On-A-Chip Devices.

Unit-2 Fabrication Of Lab-On-Chip Products

DC Fields In Microsystems: Electro-Osmosis And Electrophoresis, AC Fields In Microsystems: Spectroscopy And Dielectrophoresis, Soft Lithography, Novel Methods And Fabrication Of Lab-On-A-Chip Devices, Detection Methods – Electrical, Optical, Thermal, Applications Of Paper-Based Diagnostics , Microfluidics In Planar Microchannels: Synthesis Of Chemical Compounds On-Chip .

Unit-3 Molecular Biology On A Chip

Sample Preparation: Fluid Conditioning For Cell And Cell Free Analysis; Microfluidic Immunoassay: Pregnancy Test, Homogeneous Phase Immunoassays, Heterogeneous Phase; Chips For Genomics And Proteomics: Microarray And DNA Based Molecules, Automated DNA Purification, Microfluidic Cdna Synthesizer, PCR Chips, Protein Immunoblotting On Chip, Protein Crystallization Chip; Electrospray Mass Spectrometry; Biochemical Analysis Using Force Sensors .

Unit-4 Cell-Based Chip For Biotechnology

Microfluidic Flow Cytometers; Cell Sorting: RBC Assays, Electrokinetic Routing Of Cells, Dean Flow In Spiral Microchannels, Cell Sorting Using Surface Acoustic Waves; Cell Trapping: Neuro Cages, PEG Microwells, PDMS Microwells, Dielectrophoretic Trap, Micromagnetic Traps, Hydrodynamic Traps, Trapping Cells Using Antibodies, Microdroplets Culture And Assays ; Microfluidic Cell Culture Laboratory; Micro Bioreactors; Patch Clamp Chips.

Course Materials

Text Books:

1. Oppenheim Oosterbroek and van den Berg (2003). Lab-on-a-chip : miniaturized systems for (bio)chemical analysis and synthesis. Elsevier.
2. Marc J. Madou (2002). Fundamentals of Microfabrication, The Science of Miniaturization. CRC Press.

Reference Books:

1. Tabeling (2005). Introduction to Microfluidics. Oxford.
2. Nguyen and Wereley (2002|2006). Fundamentals and applications of microfluidics. Artech.
3. Gescheke et al, (2004). Microsystems Engineering of Lab-on-a-Chip Devices. Wiley

BIOSTATISTICS

[VIIth Semester, 4th Year]

Course Description

Offered by Department:	Credits	Status	Code
Biomedical Engineering	3-0-0, (3)	Open Elective	BM107302BM

[Prerequisite -Nil]

Course Objectives

1. To impart training on basic biostatistics and use of various statistical tools for biomedical data analysis.
2. To apply bio-statistical tools in experimental design and clinical trials

Course Content

Unit 1 Need of Biostatistics

Descriptive statistics: Population and samples descriptive methods for categorical data descriptive methods for continuous data probability and probability distributions types of data frequency distribution measures of central tendency measures of variability kurtosis and skewness Z score

Unit-2 Inferential statistics

Parameters estimating and comparing the mean of population. Hypothesis testing: basic concepts and steps testing normal distribution - Kolmogorov-Simon test testing homogeneity of variance - Levine's test Z-tests dependent t-test, independent t-test, t-test as GLM, F-test, Chi-square test Type I and type II errors ANOVA, ANCOVA, factorial ANOVA, repeated-measures designs, mixed design ANOVA, post hoc procedures.

Unit-3 Non-parametric tests

Non-parametric and distribution-free tests - Mann-Whitney test Wilcoxon signed-rank test, Wilcoxon signed rank sum test, Kruskal-Wallis test, Friedman's ANOVA.

Unit-4 Correlation techniques

Bivariate correlation - Pearson's correlation coefficient, Spearman's correlation coefficient Partial correlation regression - method of least squares, assessing goodness of fit multiple regression. Experimental design and clinical
trials.

Course Materials

Text Books:

1. Eberly, L. E., Le, C. T. (2016). Introductory Biostatistics. Germany: Wiley.
2. Glaser, A. N. (2001). High-yield Biostatistics. United States: Lippincott Williams & Wilkins.

Reference Books:

1. Advances in Clinical Trial Biostatistics. (2003). United States: Taylor & Francis

Tissue Engineering Lab

[6thSemester, Third Year]

Course Description

Offered by Department	Credits	Status	Code
Biomedical Engineering	0-0-2, (1)	Open Elective	BM107401BM

[Prerequisite - Nil]

Course Content

Experiment 1	Synthesis of Graphene Oxide
Experiment 2	Synthesis of TiO_2 Nano-Tubes For Tissue Engineering
Experiment 3	Haemocompatability Study of Biomaterials
Experiment 4	Synthesis of Polyelectrolyte Complex Of Non-Mulberry Silk Fibroin
Experiment 5	Synthesis of Hydroxyapatite
Experiment 6	Study of MTT Assay
Experiment 7	Study of The Operation and Usage of Lyophilizer
Experiment 8	Study of The Operation of Electrospinning Machine
Experiment 9	Study of The Operation Of 3D Printer
Experiment 10	Synthesis of Simulated Body Fluid