# BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI Hyderabad Campus

**SECOND SEMESTER 2023-2024**

# Course Handout (Part II)

09/01/2024

In addition to Part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

***Course No.* : BITS F418**

***Course Title* : Introduction to Biomedical Engineering**

***Instructor-in-Charge:* KAVI DEVRAJ**

# Course Description:

Introduction; Engineering principles applied for physiological phenomena; Bio-implant materials: Metallics, Ceramics; Polymeric materials for Bio-applications; Protein-biomaterials, Surface Interactions and modification of surface of the biomaterials; Tissue engineering; Drug delivery systems: principles, and applications; Biomedical sensors; Modeling and simulation.

1. **Scope and Objective of the course:** Biomedical Engineering is a relatively new branch of engineering that involves the use of cutting-edge technologies to help improve human healthcare. Biomedical engineers are involved in the design and creation of medical devices, implants such as stents, instruments and materials for clinical use.

# Text Book (T):

**T1**: Introduction to Biomedical Engineering, Third Edition, JD. Enderle, JD Bronzino, Academic Press Series Editor, Trinity College—Hartford, Connecticut: Put as Text book. Year 2011.

**T2:** Principles of Biomedical Engineering Second Edition Sundararajan V. Madihall, © 2020 Artech House 685 Canton Street Norwood, MA 02062

**T3:** Biomedical Instrumentation and Measurements; 2nd Ed., 2007, Cromwell.L, Weibell, F.J, Pfieffer, E.A: Pearson Education.

# Reference Books (R):.

**R1:** Bronzino Biomedical Engineering Handbook, CRC and IEEE Press, Boca Raton, FL, 2000

**R2:** Moore J.E. and Zouridakis G. Editors-in-Chief Biomedical Technology and Devices Handbook CRC Press, 2003. 2. J. D

**R3:** Drug Delivery Systems Edited by Kewal K. Jain, MD Jain PharmaBiotech, Basel, Switzerland, Humana Press

**R4:** Encyclopedia of Biomedical Engineering (vol. 1-3): Min Wang, Xiaojun Yu, Cato Laurencin, Roger Narayan; 2018; Elsevier

**R5:** John G. Webster, Medical Instrumentation: Application and Design, John Wiley & Sons, 3rd Edition, 2004.

**R6:** W. Mark Saltzman, Biomedical Engineering, Cambridge University Press, 2009.

# Course Plan:

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| --- | --- | --- | --- |
| **Lecture No.** | Learning Objectives | **Topics to be covered** | **Reference Chap./Sec**  **(Book)** |
| 1-3 | Introduction | Overview, role, history of biomedical engineering, moral and ethical issue | T2 Ch 1,  T1 Ch 1 |
| 4-5 | Physiological Modeling | Hemodynamic Modeling, Neural Control of Saccadic Eye Movements, Cochlear Mechanics, Pulmonary compliance, Homeostasis and feedback paths in physiological systems, Renal Blood Flow Dynamics | T1, R6, Ch 13  Lecture notes |
| 6-9 | Biomaterials | Bio-implant materials: Metallics, Ceramics; Polymeric and protein-based materials for Bio-application, Surface Interactions, and modification of surface of the biomaterials | T1 Ch, Lecture notes, Research reviews |
| 10-11 | Biomechanics | Introduction, Basic Mechanics, Mechanics of Materials, Viscoelastic Properties. Biomechanics of Neurovasculature, Cartilage, Ligament, Tendon, and Muscle | T1 Ch 4, Lecture Notes, Research reviews |
| 12-15 | Tissue Engineering and cellular engineering | Materials Used in Tissue Regeneration, Scaffold Formation Techniques, Cell Culture Microenvironment, Characterization and Utilization of Products, Cellular Processes, Storage of Cells and Tissues | T1 Ch 6,  T2 Ch 6.5 & Ch 7 |
| 16-18 | Neuroengineering / Introduction to Bioelectricity (5) | Bioelectric potentials, Biopotential Electrodes, Different potentials and their propagation, Electrodes, signals and artifacts, Optogenetics, Calcium Imaging, Electrical Stimulation of CNS, Comparing electrodes, Epileptic seizures, and Neuromodulation | T2 Ch 3  Lecture notes |
| 19-26 | Transport dynamics across biological membranes | Characteristics of peripheral, CNS membranes (epithelial, endothelial) and associated transport mechanisms, kinetics. Blood-Brain Barrier (BBB) and its role in CNS homeostasis | Lecture notes, Research reviews |
| 27-31 | Drug delivery systems: principles, and applications | Overview of various drug delivery systems, and strategies for CNS drug delivery, impact of CNS barriers. Therapeutic antibodies | R3 Ch 1, Lecture notes |
| 32-34 | Biosensors and Biomedical Signal Processing | Optical Sensors, Chemical Biosensors Transducers, Sensors and Electrodes in Medical Instrumentation, Biosensors Design and application, neuroimaging tools, EEG and its application, Artificial Intelligence in signal processing | Ch6 (R2), T1 Ch 11  Lecture notes |
| 35-38 | Design of Medical Devices and Diagnostic Instrumentation (3) | Medical Product Design, Cardiovascular Devices, Design and Product Development, Six Sigma and its Applications | T1 Ch 5 |
| 39-40 | Rehabilitation Engineering (2) | Technology and Disability, applied universal Design, Home Modification Design, and automation | Lecture notes and Research reviews |

**6. Evaluation Scheme:**

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| --- | --- | --- | --- | --- |
| **Component** | **Duration** | **Weightage (%)** | **Date** | **Remarks** |
| Mid-Sem Exam | 90 min | 30 | 11/03 - 4.00 - 5.30PM | CB |
| Project/ Assignments | – | 30 | – | OB |
| Comprehensive  Exam | 180 min | 40 | 07/05 AN | CB/OB |

**7.** Chamber Consultation Hour: Tentatively every Friday, 5 PM (On call at **9319851158**)

**8.** Notices: Notices concerning the course will be communicated through email or CMS.

**9.** Make-up policy: As per the clause 4.07 in the Academic regulations booklet. Only hospitalized cases will be considered for makeup.

**10.** Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

# Instructor-in-Charge

# BITS F418