

(BM-452) - Modelling and Simulation for Biomedical Engineers

Course Outline:

Theory:

1. Introduction

1. What is modeling and simulation
2. Application of Modeling and Simulation in Biomedical Engineering
3. Types of Models e.g. graphical model, Quantitative models, Multi-scale Models.
4. Hybrid models and its application in Biomedical Engineering
5. Conceptual modeling, why, when, where to use the conceptual model.
6. Conceptual model of cardiorespiratory system Subdivision of Physiology models and combining of basic elements of Conceptual models.
7. Things necessary before building a model.
8. One block model and its examples e.g. Heart, muscles, eye etc.
9. Hierarchical and integrated Model.

2. Mathematical Models

1. Mathematical Models and their importance in biomedical engineering
2. Mathematical models of Mechanical and Electrical systems.
3. Electrical and fluidic modeling of the blood flow through the artery.
4. Elementary Vascular Model and Its Electrical Analog
5. Electrical modeling of physiological System
6. Electrode electrolyte interface model

3. Application of Modeling and Simulation in Physiological System

1. Modeling of physiological systems
2. Examples of Physiological models
3. Medical imaging and its importance in modeling and Simulation
4. Importance of modeling and simulation according to new trends and technique
5. Modeling of human organs using 3D printing
6. Thermal modeling using Bio heat equations
7. Factors effecting thermal models
8. Application of thermal models on physiological System

4. Software Implementations

1. Implementation of Biomedical models using software.

List of Practicals:

1. Introduction to modeling using software
2. Design of conceptual model
3. Modeling of cardiovascular system
4. Simulation of Bio heat equation
5. Modeling and simulation of blood flow
6. Modeling and simulation arterial plaque
7. Modeling heat transfer through skin
8. Modeling of electrical stimulation
9. Modeling of human organs
10. Heat simulation using RF coil and high intensity focused ultrasound
11. Modeling through medical images
12. Simulation of light propagation in the eye
13. Glucose and insulin regulation model.
14. Renal clearance modeling using compartmental model
15. Skin Absorption Model using Ficks's Law
16. Open ended lab 1

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Modeling and simulation in biomedical engineering, Willem Van Meurs.
 2. Physiological Modeling: An Introductory Course for Biomedical Engineers , John Enderle
 3. Advances in Numerical Heat Transfer, Volume 3, W. J. Minkowycz.
 4. Introduction to Modeling in Physiology and Medicine, Claudio Cobelli and Ewart Carson
 5. Modeling and Simulation in Medicine, Frank C. Hoppensteadt, Charles S. Peskin,
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