Course Code	Course Title	L	T	P	C
1152BM111	**Physiological system modeling**	**3**	**0**	**0**	**3**

Course Category: Program Electives

Preamble: This course provides an idea about how to represent the physiological system as a mathematical model

Pre-requisite: Control system, TPDE

Links to the courses: Anatomy & Human Physiology, AEIC, Signals and systems

Course outcomes:

S. No.	Course outcome	Skill level
1.	Illustrate the basic physiological system and its characteristics	K2
2.	Explain the application of Voltera kernel equation in parametric and non-parametric models	K2
3.	Formulate the electric circuit model in physiological systems	K3
4.	Develop the differential equations to describe the compartmental physiological model	K3
5.	Describe multi input/output modeling application to physiological system	K2

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H	L	M									L
CO2	H	M	M									L
CO3	M	M	L	M					M			L
CO4	M	M	M	M								M
CO5	M	L	M									L

UNIT I INTRODUCTION TO PHYSIOLOGICAL MODELING

Approaches: Techniques of mathematical modeling, classification of models, characteristics of models, time invariant and time varying systems for physiological modeling, Introduction to physiology-homeostasis, cell biology, physical system modeling, linear modeling, the Laplace transform, transfer functions and block diagram analysis.

UNIT II MODELING OF NON-PARAMETRIC SYSTEM

Volterra models.Wiener models.Efficient volterra kernel estimation Analysis of estimation errors. Parametric modeling: Basic parametric model forms and Estimation procedures. Volterra kernels of nonlinear differential equations.Discrete-time volterra kernels of NARMAX models. From Volterra kernel measurements to Parametric models. Equivalence between continuous and Discrete -parametric models.

UNIT III EQUIVALENT CIRCUIT MODELING

Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley's model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.

UNIT IV COMPARTMENTENTAL PHYSIOLOGICAL MODEL

Electrical analog of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modeling, of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

UNIT V MODELING OF MULTI STAGE SYSTEMS

Electrical circuit model of oxygenation.A model of immune response to disease (Block Diagram).Modeling of multi input/multi output systems: The Two-input case. Applications of Two-input modeling to physiological systems. The Multi input case spatio-temporal and spectro-temporal modeling.

TEXT BOOKS

1. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001.

REFERENCE BOOKS:

1. David T. Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.
2. Endarle, Blanchard &Bronzino, Introduction to Biomedical Engg. , Academic press.
3. Suresh.R.Devasahayam, Signals & Systems in Biomedical Engineering, Kluwer Academic/ Plenum Publishers.
4. V.Z. Marmarelis, Advanced methods of physiological modeling, Plenum Press.
5. J. Candy, Signal Processing: The Model Based approach, Mc. Graw Hill.
6. L.Stark, Neurological Control System, Plenum Press.
7. R.B. Stein, Nerve and Muscle, Plenum Press.