Course Code	BIO531
Course Name	Introduction to Mathematical Biology
Credits	4
Course Offered to	UG/PG
Course Description	The aim of this course is to introduce mathematics as applied in quantitative study of biological systems and biological data analysis. Use of ordinary and partial differential equations (ODEs) will be emphasized in this course. Both exact and numerical solutions will be discussed. We also plan to briefly introduce dynamical systems analysis for ODEs.

Pre-requisites

Pre-requisite (Mandatory)	Pre-requisite (Desirable)	Pre-requiste (Other)
MTH-101 (for UG); Summer Refresher Course (for CB PG students); Others - Instructor's approval	Molecular biology and biochemistry, cell biology	None

*Please insert more rows if required

Post Conditions

CO1	CO2	CO3	CO4	CO5
Students are able to apply mathematical tools for quantitative analysis of biological systems	Students are able to analyze data obtained from biological / clinical experiments (such as SPR, FRAP, disc diffusion)	Students are able to analyze simple biochemical kinetics using ODEs	Students are able to model simple problems on spatial fluctuations using PDEs	Students are able to apply the concepts of mathematical biology in some problems of systems biology and Monte Carlo simulations

Weekly Lecture Plan

Week Number	Lecture Topic	COs Met	Assignments/Lab/Tutorial
Week 1-2	Review of linear first and second order differential equations (exact solution and analytical approaches). Introduction to dynamical systems theory	CO1	HW assignment 1: Kinetic analysis of data obtained from surface plasmon resonace experiments for measuring receptor-ligand binding affinity; Data analysis of SPR experiments for death ligand affinity (mutant) variants. Ref: Apoptosis 14:778-787 (2009)
Week 3-4	ODEs as a tool for quantitative study of biological systems and biological data analysis	CO1, CO2, CO3	HW assignment 1; in-class ODE problem solving based on applications in (i) design of affinity variant ligands, (ii) pathogen detection based on affinity (design of nanotechnology based
Week 5-6	Numerical solution (using MATLAB / Scilab) of ODEs Use of parallel computation in numerical solution of ODEs	CO1, CO2, CO3	HW assignment 2:Aggregation kinetics of amyloid proteins, data analysis of dimeric receptor-ligand binding experiments;
Week 7	Dynamical systems theory as applied to elucidate biological processes/kinetics; analysis of enzyme-mediated biochemical kinetics	CO1, CO2, CO3	In-class problem solving based on dynamical systems analsysis of amyloid aggregation and enzyme mediated biochemical kinetics
Week 8-9	to elucidate biological processes; analysis of cellular regulatory networks; brief introduction to stochastic approaches and stochastic	CO1, CO2, CO3, CO5	HW assignment 3: Dynamical systems analysis of receptor-ligand binding kinetics (sensitivity to affinity variation). In- class problem solving to elucidate dynamical mechanisms for cellular regulatory networks
Week 10	Partial differential equations (analytical methods for solving PDEs: the method of separation of variables and the method of characteristics)	CO1, CO2, CO4	HW assignment 4: Estimation of minimum inhibitory concentration of an antibiotic by analyzing data from disk diffusion experiments (PDE modeling of spatial fluctuations)
Week 11-13	PDEs as a tool for quantitative study of spatial fluctuations in biological systems; Brief discussion of numerical solution of PDEs and stochastic PDEs	CO1, CO2, CO4, CO5	HW assignment 4. In-class PDE problem solving based on applications to polymeric drug delivery systems
Week 16	Endsem Review	CO1, CO2, CO4	
Week 17	Endsem Exam		

*Please insert more rows if required

Assessment Plan

Type of Evaluation	% Contribution in Grade
Mid-sem	35
End-sem	35
Assignments	30

*Please insert more row for other type of Evaluation

Resource Material

Type	Title
Textbook	1. A primer on mathematical models in biology by Lee A Segel and Leah Edelstein-Keshet. Pub: SIAM, 2013.
Textbook	2. Computational Cell Biology edited by C.P. Fall, E.S. Marland, J.M. Wagner and J.J. Tyson. Pub: Springer (2002)
Textbook	3. Advanced Engineering Mathematics by Erwin Kreyszig. Pub: Wiley India (8th / 9th Edition).