Course Code	BIO533
Course Name	Systems and synthetic biology
Credits	4
Course Offered to	UG/PG - Core
Course Description	This course introduces systems and synthetic biology to students with interest in applying mathematical techniques to biological problem. The main aim of this course is to train students to build mathematical models of complex biological systems and make predictions about the functions of the biological systems in-silico under various conditions. They will also learn conditions to build synthetic circuit in-silico to optimize its functions under various scenarios.

Pre-requisites

Pre-requisite (Mandatory): IMB and CBB	**Pre-requisite (Desirable) Probablity and statistics**	**Pre-requiste (Other)**
None		

*Please insert more rows if required

Post Conditions*(For suggestions on verbs please refer the second sheet)

CO1	**CO2**	**CO3**	**CO4**
Students will be able to analyze differential equations using geometric methods like vector fields in a line and phase plane analysis	Students will construct simple biological models from small networks and classify the types of bifurcations the model exhibits	Students can interpret the dynamics of the small network and relate the dynamics to functions	Students will be able to write MATLAB codes to carry out differential equation simulations

Weekly Lecture Plan

Week Number	**Lecture Topic**	**CO s met**	**Assignments/Lab/Tutorials**
Week 1-2-3	(i) Introduction to ODE and vector field analysis in line (ii) Introduction to 1D -bifurcation	CO1,CO2,C04	Assignment: ODE simulation using MATLAB and application of bifurcation to biological problems taken from journal papers
Week 4-5-6	(i) Introduction to 2D ODE and phase plane methods (ii) Introduction to bistablity and limit cycle oscillations (iii) Examples from biological systems	CO1,CO2,C04	Assignment: ODE simulation using MATLAB and application of bifurcation to biological problems taken from journal papers
Week 7-8-9	(i) Elements of Transcription Networks, Dynamics and Response Time of Simple Gene Circuits (ii) Autoregulation is a network Motif, response Time of Gene Circuits, robustness to fluctuations, Positive auto- regulation, cell-cell variability.	C01,C02,CO3,C04	Assignment: ODE simulation using MATLAB and problem solving
Week 10	(i) Structure of the feed forward loop circuit, dynamics of the Coherent FFL with AND-Logic, Sign- sensitive delay element, Incoherent FFL, a pulse generator and response accelerator (ii)	CO1,CO2,C03,C04	Assignment: ODE simulation using MATLAB and application of bifurcation to biological problems taken from journal papers
Week 11-12-13	(i)Single-Input Module (SIM) Network Motif (ii) temporal Expression programs,Topological Generalizations of Network Motifs, Bi-Fans and dense-overlapping regulons , global Structure of Sensory transcription networks (ii) Networks motifs in developmental signal-transduction and neuronal networks : Network Motifs in Developmental Transcription Networks,Positive feedback loops and bistability motifs in Signal Transduction Networks, Negative Feedback and Oscillator. Neuronal Network of C. Elegans (iii) Robustness Principle, The Barkai-Leibler model,	C01,C02,CO3,C04	Assignment given to understand how coding of proteins by various processes takes place. Mathematical model of Lac operon will be constructed and analyzed using MATLAB to understand switching processes in small gene networks

*Please insert more rows if required

Assessment Plan

Type of Evaluation	**% Contribution in Grade**
Mid-sem	15
End-sem	25
Assignments	20
Quiz	20
Project	20

*Please insert more row for other type of Evaluation

Resource Material

Type	**Title**
Textbook	Strogatz, Steven, Nonlinear dynamics applied to physics, biology, chemistry and engineering
Textbook	U. Alon, An introduction to systems biology.