Course Code	BIO534
Course Name	Introduction to Computational Neuroscience
Credits	4
Course Offered to	UG/PG
Course Description	This introductory neuroscience provides basic understanding of neuronal systems and their respective mathematical models that describes the behavior of the neurons under various conditions. The aim of this course is to encourage Computational biology students to diversify into the area of neuroscience. This course in not about neural networks and machine learning, but about the use of the tools of dynamical systems theory to undertand oscillatory properties of single cell neurons. Nonlinear ODE and PDE models will be constructed, analyzed and simulated using MATLAB to understand different firing patterns of the neuronal systems under normal and pathalogical conditions.

Pre-requisites

Pre-requisite (Mandatory)	Pre-requisite (Desirable)	Pre-requisite(other)
None	Calculus, linear algebra and ODE/PDE and coding in MATLAB	None

*Please insert more rows if required

Post Conditions

CO1	CO2	CO3	CO4	CO5
Explain and classify different properties of neurons like spike, threshold, depolarization and electrophysiological properties of neurons	Develop and analyze computational models of neurons like Hodgkin-Huxley and Integrate and Fire models. Introduce neuronal simulations.	various phase portraits of Hodgkin-Huxley model to understand different dynamical properties of neurons through simulations.	Ability to build simple PDE models of diffusion to understand signal propagation in neuronal systems	Hypothesizing, designing and analyzing new models of neurons for different pathological cases.

Weekly Lecture Plan

Week Number	Lecture Topic	COs Met	Assignment/Labs/Tutorial
Weeks 1-2	Description of neuronal properties like spikes, threshold, depolarization, repolarization, classification of different neurons and its firing properties, neurocomputational and electrophysiological properties.	CO1	Projects will be designed based on the recent papers and will be given to the students. They need to simulate and generate the results from the paper in groups. At the end of the semester, they need to present.
Week 3-4	Geometric and directional field analysis of one and two dimensional nonlinear models of neurons. Introduction to neuronal simulations	CO2	
Week 5-6	Introduction to planar vector fields, equilibria and phase protraits of nonlinear neuronal ODE models of HH and IF types	CO3	
Week 7-9	Linear cable theory and conductance based PDE models of neurons	CO3, CO4	
Week 10-11	Bifurcations, equilibrium, limit cycle	CO3, CO4	
Week 12	Geometric analysis of bursting neurons	CO5	
Week 13	Applications of neuronal models to Diabetes and cancer systems.	CO5	

Assessment Plan

Type of Evaluation	% Contribution in Grade
Quiz-I (Prior to midsem)	15
Quiz-II (Prior to endsem)	15
Home work	10
Project	20
Midsem	20
Endsem	20

*Please insert more row for other type of Evaluation

Resource Material

Type	Title
Reference	(i) Dynamical systems in Neuroscience. Eugene Izhikevich, MIT press
Reference	(ii) Nonlinear dynamics and chaos, Steven Strogatz, Levant Press