Course Outline/Syllabus:

Title: ***Computational Neuroscience***
Teacher: Sharba Bandyopadhyay, E&ECE
Credits: 3 (3-0-0)

Objectives: The objectives of the course is to expose engineers and scientists to the field of theoretical neuroscience that involves how actual biological neurons perform computations in the mammalian brain. Current understanding of the biophysics of computation is completely different from the field of artificial neural networks. The course covers the very basics of the biology involved in neuronal processing up to understanding how neurons encode sensory information and how such information is decoded in the brain. Further the course covers phenomena of learning and plasticity of neuronal circuits. Overall the course will equip students to provide different ways of solving problems related to learning using biologically plausible solutions and also allow interested candidates to take up research in neuroscience, a highly interdisciplinary field and contribute in areas of brain machine interface, neural prosthetics, biological sensors and many others.

Text Book
Theoretical Neuroscience - Computational and Mathematical Modeling of Neural Systems by Peter Dayan and L.F. Abbott

Reference Books
Biophysics of Computation by Christof Koch
Ion Channels of Excitable Membranes by Hille
Methods in Neuronal Modeling by Segev
Principles of Neural Science by Kandel and Schwartz
Neuronal Dynamics by Gerstner

Intended as an elective course for: 4$^{th}$ year BTech, 4$^{th}$ & 5$^{th}$ year BTech/MTech BSc/MSc Dual degree, 1$^{st}$ year MTech/MSc students from the Departments of E&ECE, CSE, EE, Physics, Maths, BioTech, SMST etc.

Prerequisites: None

Section 1: Single Neuron Modeling
Ion flux in membranes, Nernst Planck Equation, Ion-Channels, Excitable membranes, Spiking, Hodgkin Huxley models, Integrate and Fire Neurons

Section 2: Neural Encoding and Decoding
Spike train statistics, Receptive fields, Linear and Nonlinear models of Receptive fields, Applications of Information Theory in neural coding and decoding

Section 3: Plasticity: Adaptation and Learning
Synapses: structure and function, plasticity, Spike Timing Dependent Plasticity (STDP), Learning rules, Supervised and Unsupervised Learning, Classical conditioning, Reinforcement Learning.