SRM UNIVERSITY
FACULTY OF ENGINEERING & TECHNOLOGY
DEPARTMENT OF BIOINFORMATICS

BI0354 – COMPUTATIONAL NEUROSCIENCE

LESSON PLAN

SEMESTER: VI
CODE: BI0354

Course: Computational Neuroscience
Staff Handling: Mr. P.P. Karthikeyan

Day	Topic	Learning outcome
1.	**UNIT I INTRODUCTION** Domains in Computational Neuroscience	• Introduction to Computational Neuroscience • Hodgkin – Huxley equation application • Mechanism of Action and Nernst potential initiation in Brain.
2.	Brain metaphors-computer and brain	
3.	Basic neuroscience	
4.	Basic synaptic mechanisms and the generation of action potentials	
5.	Nernst Potential	
6.	Hodgkin-Huxley equations	
7.	The propagation of action potentials	
8.	**UNIT II SPIKING NEURONS AND RESPONSE VARIABILITY** Spiking neurons- concept neurons- the neural code	• Various models and their mechanism of action. 1. Spiking Neuron models, 2. Integrate and firing models, 3. Noise in spiking neuron models, 4. Compartmental modeling. • Knowledge on the importance of Hodgkin – Huxley model
9.	Spike trains- cable theory- Spike time variability	
10.	Post synaptic potential(PSP)	
11.	firing threshold and action potential	
12.	Neurons in a Network- Population Dynamics	
13.	Rate code and Information in spike trains	
14.	Population coding and decoding- single neuron models	
15.	Hodgkin-Huxley Model, spiking neuron models	
16.	Integrate and firing model	
17.	Noise in spiking neuron models- compartmental modeling	
18.	**UNIT III FEED-FORWARD MAPPING NETWORKS** From artificial neural network to realistic neural	• Application of Hebian plasticity.

	networks	• Study of mapping networks and their advantages.
19.	Perception, function representation, and look-up tables	
20.	The sigma node as perception	
21.	Multi-layer mapping networks	
22.	Learning, generalization and biological interpretations	
23.	Self-organizing network architectures and genetic algorithms	
24.	Mapping networks with context units	
25.	Probabilistic mapping networks	
26.	Associators and synaptic plasticity	
27.	Associative memory and Hebbian learning	
28.	Hebian plasticity- features of associators and Hebbian learning.	
29.	**UNIT IV AUTO-ASSOCIATIVE MEMORY AND NETWORK DYNAMICS** Associative memory networks- Short-term memory and reverberating network activity	• Application of Grossberg – Hopfield model in neuronal activity. • Chaotic and Competitive networks occurrence in brain.
30.	Long-term memory and auto-associators	
31.	Point attractor networks	
32.	The Grossberg-Hopfield model	
33.	sparse attractor neural networks	
34.	Chaotic networks, biologically more realistic variations of attractor networks	
35.	Continuous attractor and competitive networks	
36.	**UNIT V SUPERVISED LEARNING AND REWARDS SYSTEMS** Motor learning and control, supervised learning	• Various learning systems in Computational neuroscience. • Hypothesis and their application in models.
37.	The delta rule and back propagation	
38.	Generalized delta rules, plasticity and coding	
39.	Reward learning, System level organization and coupled networks	
40.	System level anatomy of the brain, Modular mapping networks	
41.	Coupled attractor networks, working memory	
42.	Attentive vision, an interconnecting workspace hypothesis	
43.	**UNIT VI CASE STUDY** Introduction to the MATLAB programming environment	• Introduction to MATLAB programming • Simple programming in
44.	A MATLAB guide to computational neuroscience	

45.	Spiking neurons and numerical integration in MATLAB	MATLAB for spiking neurons and their numerical integration.

TEXT BOOKS

- Thomas Trappenberg, *Fundamentals of Computational Neuroscience*, oxford University Press, June 2002
- Lytton, William W, *From Computer to Brain - Foundations of Computational Neuroscience*, Springer publications, 2002

REFERENCE BOOKS

- Gerstner and Kistler, *Spiking Neuron Models. Single Neurons, Populations, Plasticity* -Cambridge University Press, 2002
- Eric L. Schwartz, *Computational Neuroscience*, MIT Press, 1993

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