(BM-432) - Neuroscience and Neural Networks

Course Outline:

Theory:

1. **Introduction to neuroscience**
    1. Nervous system
    2. Sympathetic
    3. Parasympathetic and motor nervous system and their functions
    4. Brain and its functions
    5. Neurons and glia, structure of a neuronal cell, types of glia.
    6. Blood brain barriers.
2. **Neuronal Circuits**
    1. Neuronal circuit in emotional control
    2. Neuronal circuit in reward and addiction
    3. Neuronal regulation of stress
3. **Receptors**
    1. Ionotropic and metabotropic receptors
    2. signal transduction pathways
    3. G-proteins
    4. protein phosphorylation
    5. Signaling to the nucleus
    6. regulation of gene expression
4. **Neurotransmitters**
    1. Excitatory and inhibitory amino acid neurotransmitters
    2. Functions in the brain
    3. Pain pathways in brain
    4. Role of excitatory neurotransmitter in learning and memory
    5. Diseases associated with the malfunctioning of these neurotransmitters
    6. Neuronal degeneration
5. **Catecholamines**
    1. Functions in the brain
    2. Diseases associated with the malfunctioning.
6. **Neural basis of behavioral plasticity**
    1. Human and animal memory
    2. Cellular mechanisms of neural plasticity
7. **Neuroendocrine and motivational systems**
    1. Endocrine systems
    2. Feeding behavior
    3. Stress
8. **Diseases of the nervous system**
    1. Addiction
    2. Depression
    3. Schizophrenia
    4. Epilepsy
    5. Alzheimer
    6. Parkinson
    7. Prion
    8. Motor Neuron Disease
9. **Introduction to Artificial Intelligence**
    1. Foundations of AI
    2. Agents and Environments.
10. Structure of Agents.
11. Problem Solving Agents.

1. **Problem Solving by Searching**
    1. Searching for Solutions.
    2. Uninformed Search Strategies
    3. Informed Search Strategies
12. Informed (Heuristic) Search Strategies:
13. Greedy Best-first Search.
14. A* Search.
15. Heuristic Functions.
    1. **Reasoning and Knowledge Representation**
        1. Introduction to Reasoning and Knowledge Representation.
        2. Propositional Logic.
        3. First order Logic.
        4. Reasoning with Uncertainty & Probabilistic Reasoning
        5. Acting Under Uncertainty.
        6. Bayes' Rule.
    2. **Learning**
        1. Decision Trees
        2. ID3 Algorithm
        3. Statistical Learning.

List of Practicals:

1. To study basics of Artificial Neural Network.
2. To study how a self-organizing map neural network can cluster iris flowers into classes topologically, providing insight into he types of flowers and a useful tool for further analysis.
3. Classification of wine vintage (using GUI) and crabs (through coding) using pattern recognition and classification network in Matlab.
4. Identification and prediction of relationship between independent and dependent variables using regression analysis.
5. Implementation of basic logic operations of ANN
6. To Work on the Command Line of Matlab to build fuzzy logic based application.
7. Study various methods to improve cognitive skills.
8. Study different methods to check memory skills
9. To understand the working of EEGLAB software for the analysis of EEG signals.
10. To study different processing tools available in EEGLAB software for the processing of EEG data.
11. To study about importing channels locations for EEG data using EEGLAB software.
12. To understand the working of SLORETA software for EEG analysis of the deep cortical structures.

Suggested Teaching Methodology:

- Lecturing
- Written Assignments Report Writing

Suggested Assessment:

Theory (100%)

- Sessional (20%)
- Quiz (12%)
- Assignment (8%)
- Midterm (30%)
- Final Term (50%)

Laboratory (100%)

- Labs
- Open-Ended Labs

Recommended Text and Reference Books:

1. Russell S.; Norvig P.; "Artificial intelligence – A Modern Approach", Latest Edition, Prentice Hall.
2. Luger G.F.; Artificial Intelligence – Structures and Strategies for Complex Problem Solving", Latest Edition, Pearson Higher Education.
3. Progress in Neuroscience, Readings from Scientific American, John Wiley.
4. Philip, G. Srauge, Brain Biochemistry and Brain Disorders, Oxford Press.
5. George, J. Siegal, B. W. Agranoff, S. K. fisher , M. D. Uhler, Basic Neurochemistry: Molecular, Cellular and Medical Aspects, Lippincott D. Uhler.
6. Darakhshan Haleem, Neurochemistry, Neuropharmacology and Behavior, 2010.
7. Mark F. Bear, Barry W. Connors & Michael A. Paradiso, Neuroscience: Exploring the brain, 2006