Uka Tarsadia University

B. Tech.

Semester VI

DEEP LEARNING
AI5014

EFFECTIVE FROM June-2023

Syllabus version: 1.00

Subject Code	Subject Title	Teaching Scheme			
		Hours		Credits	
		Theory	Practical	Theory	Practical
AI5014	Deep Learning	3	2	3	1

Subject Code	Subject Title	Theory Examination Marks		Practical Examination Marks	Total Marks
		Internal	External	CIE	
AI5014	Deep Learning	40	60	50	150

Objectives of the course:

- To expose the student of this course from fundaments of neural networks to most advanced topics of the deep learning architectures.

Course outcomes:

Upon completion of the course, the student shall be able to,

CO1: Understand the types of neural networks with their topologies.
CO2: Understand and apply training of deep neural network architectures.
CO3: Understand and apply Radial Basis Function Networks.
CO4: Understand and apply Restricted Boltzmann Machines and recurrent networks.
CO5: Understand and apply Convolutional architectures and reinforcement learning.
CO6: Elaborate advanced topics like transformer and generative adversarial architectures.

Sr. No.	Topics	Hours
	Unit – I	
1	**Introduction to Neural Networks and Learning with Shallow Networks:** The basic architecture of neural networks, Training a neural network with back-propagation, Practical issues in neural network training, Common neural network architectures, Neural architectures for binary classification models, Neural architectures for multiclass models, Backpropogated saliency for feature selection, Matrix factorization with Autoencoders, Word2Vec, Neural networks for graph embeddings.	8

Unit – II		
2	**Training Deep Neural Networks and Teaching Deep Learners to Generalize:** Back-propagation, Setup and initialization issues, The vanishing and exploding gradient problems, Gradient-descent strategies, Batch normalization, The bias-variance trade-off, Generalization issues in model tuning and evaluation, Penalty based regularization, Ensemble methods, Early stopping, Unsupervised pretraining, Continuation and Curriculum learning, Parameter sharing.	8
Unit – III		
3	**Radial Basis Function (RBF) Networks:** Training an RBF network, Variations and special cases of RBF networks, Relationship with kernel methods.	7
Unit – IV		
4	**Restricted Boltzmann Machines (RBM):** Hopfield networks, The Boltzmann machine, Restricted Boltzmann Machines, Applications of Restricted Boltzmann Machines, Using RBMs beyond binary data types, Stacking RBMs. **Recurrent Neural Networks (RNNs):** The architecture of RNN, The challenges in training recurrent networks, Echo-state networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs), Applications of RNN.	8
Unit – V		
5	**Convolutional Neural Networks (CNN):** The basic structure of Convolutional network, Training a Convolutional network, Case studies of Convolutional architectures, Visualization and unsupervised learning, Applications of CNN. **Deep Reinforcement Learning:** Stateless algorithms, The basic framework of reinforcement learning, Bootstrapping for value function training, Policy gradient methods, Monte Carlo tree search, Case studies of reinforcement learning.	8
Unit – VI		
6	**Advanced Topics in Deep Learning:** Attention mechanism, Neural networks with external memory, Generative Adversarial Networks (GANs), Competitive Learning, Limitations of neural networks.	6

Sr. No.	Deep Learning (Practicals)	Hours
1	To implement and analyze back-propagation neural network architecture training with handwritten character datasets.	2
2	To implement RBF.	4
3	To implement and train RBM.	2
4	To implement RNN architecture.	2
5	To implement and train RNN for sequence prediction task.	4
6	To implement and train simple CNN on CIFAR100 dataset.	4
7	Hands-on with pre-trained state-of-art CNN models.	4
8	To implement deep reinforcement learning models.	4
9	Hands-on with pre-trained state-of-art transformer models.	4

Text book:

1. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer.

Reference books:

1. Ian Goodfelllow, Yoshua Benjio, Aaron Courville, "Deep Learning", The MIT Press.
2. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", John Wiley & Sons Inc.
3. Richard S. Sutton, Andrew G. Barto, and Francis Bach, "Reinforcement Learning: An Introduction", MIT Press, ISBN 978-0262039246.
4. Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, "Mathematics For Machine Learning", Cambridge University Press, ISBN 978-1108455145.
5. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor, "An Introduction to Statistical Learning: with Applications in Python", Springer Publication, ISBN 978-3031387463.

Course objectives and Course outcomes mapping:

- To expose the student of this course from fundaments of neural networks to most advanced topics of the deep learning architectures: CO1, CO2, CO3, CO4, CO5, and CO6.

Course units and Course outcomes mapping:

Unit No.	Unit Name	Course Outcomes					
		CO1	CO2	CO3	CO4	CO5	CO6
1	Introduction to Neural Networks and Learning with Shallow Networks	✓					
2	Training Deep Neural Networks and Teaching Deep Learners to Generalize		✓				
3	Radial Basis Function (RBF)			✓			

	Networks						
4	Restricted Boltzmann Machines (RBM) and Recurrent Neural Networks (RNNs)				✓		
5	Convolutional Neural Networks (CNN) and Deep Reinforcement Learning					✓	
6	Advanced Topics in Deep Learning						✓

Programme outcomes:

PO 1: Engineering knowledge: An ability to apply knowledge of mathematics, science, and engineering.

PO 2: Problem analysis: An ability to identify, formulates, and solves engineering problems.

PO 3: Design/development of solutions: An ability to design a system, component, or process to meet desired needs within realistic constraints.

PO 4: Conduct investigations of complex problems: An ability to use the techniques, skills, and modern engineering tools necessary for solving engineering problems.

PO 5: Modern tool usage: The broad education and understanding of new engineering techniques necessary to solve engineering problems.

PO 6: The engineer and society: Achieve professional success with an understanding and appreciation of ethical behavior, social responsibility, and diversity, both as individuals and in team environments.

PO 7: Environment and sustainability: Articulate a comprehensive world view that integrates diverse approaches to sustainability.

PO 8: Ethics: Identify and demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work.

PO 9: Individual and team work: An ability to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give/receive clear instructions.

PO 11: Project management and finance: An ability to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: recognition of the need for, and an ability to engage in life-long learning.

Programme outcomes and Course outcomes mapping:

Programme Outcomes	Course Outcomes					
	CO1	CO2	CO3	CO4	CO5	CO6
PO1	✓	✓				
PO2		✓	✓	✓		
PO3		✓	✓	✓		
PO4						
PO5				✓	✓	✓
PO6						
PO7						
PO8						
PO9						
PO10						
PO11						
PO12						