Semester: V						
ARTIFICIAL NEURAL NETWORKS AND DEEP LEARNING **Category: Professional Core Course** **(Theory and Practice)**						
Course Code	**:**	**AI253IA**		**CIE**	**:**	**100+50 Marks**
Credits: L: T: P	**:**	**3:0:1**		**SEE**	**:**	**100 + 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 + 3.00 Hours**

Unit-I — **9Hrs.**

Neural Networks: Introduction to NN, models of neuron and network architectures. **Learning Processes**: Different types of learning processes, Learning with and without teacher, Memory, statistical learning theory.
Single layer perceptron: Adaptive filter problem, least mean square algorithm, learning rate, Learning rate annealing techniques, perceptron and perceptron convergence theorem.
Multilayer Perceptron: Back propagation algorithm, Sequential and batch modes of training, stopping criteria, XOR problem, and some numerical problems

Unit – II — **9Hrs.**

Convolutional Neural Networks: Introduction, Historical Perspective and Biological Inspiration. **Basic Structure of a Convolutional Network:** Padding, Strides, Typical Settings, The ReLU Layer, Pooling, Fully Connected Layers, The Interleaving Between Layers, Local Response Normalization, Hierarchical Feature Engineering.
Training a Convolutional Network: Back propagating Through Convolutions, Back propagation as Convolution with Inverted/Transposed Filter, Convolution/Back propagation as Matrix Multiplications, Data Augmentation.
Applications of CNN: Content based image retrieval, Object Localization, Object Detection, Natural Language and sequence learning, and Video classification

Unit –III — **9Hrs.**

Recurrent Neural Networks: Introduction and expressiveness of RNN. **Basic Structure of a RNN:** Language Modeling Example of RNN, Generating a Language Sample, Back propagation Through Time, Bidirectional Recurrent Networks, Multilayer Recurrent Networks. **Echo-State Networks, Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs)**
Applications of Recurrent Neural Networks: Automatic Image Captioning, Sequence-to-Sequence Learning and Machine Translation, Sentence-Level Classification, Token-Level Classification with Linguistic Features, Time-Series Forecasting and Prediction, Temporal Recommender Systems, Secondary Protein Structure Prediction, End-to-End Speech Recognition, Handwriting Recognition

Unit –IV — **9Hrs.**

Deep Reinforcement Learning: Introduction, **Stateless Algorithms:** Multi-Armed Bandits, Na¨ıve Algorithm, Greedy algorithm, Upper Bounding Methods
The Basic Framework of Reinforcement Learning: Challenges of Reinforcement Learning, Simple Reinforcement Learning for Tic-Tac-Toe, ole of Deep Learning and a Straw-Man Algorithm. **Bootstrapping for Value Function Learning:** Deep Learning Models as Function Approximators, Example: Neural Network for Atari Setting, On-Policy Versus Off-Policy Methods: SARSA, Modeling States Versus State-Action Pairs, **Monte Carlo Tree Search**
Case Studies: Alpha Go: Championship Level Play at Go, Alpha Zero: Enhancements to Zero Human Knowledge, Self-Learning Robots: Deep Learning of Locomotion Skills, Deep Learning of Visuomotor Skills, Building Conversational Systems: Deep Learning for Chat-Bots, Self-Driving Cars

Unit –V — **9Hrs**

Advanced Topics in Deep Learning: Attention Mechanisms, Attention Mechanisms for Machine Translation, Neural Turing Machines, Competitive learning, Limitations of neural networks. Cars
Generative Adversarial Networks (GANs): Training a GAN, Comparison with variational auto encoder, Using GANs for generating Image data, conditional GANs.

Laboratory Component
Group of two students belong to the same batch are required to implement an engineering application using any one of the deep learning techniques, CNN, RNN and Reinforcement learning. **Examples:** **CNN:** Biometric authentication using CNN, Object identification and recognition, Emotion recognition, Auto translation, Document classification etc. **RNN:** Language translation, Generating image descriptions, Speech recognition etc. **Reinforcement Learning:** Real-time bidding, Recommendation systems, Traffic control systems etc.

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Describe basic concepts of neural networks, its applications and various learning models
CO2	Analyze different network architectures, learning tasks, CNN, and deep learning models
CO3	Investigate and apply neural networks model and learning techniques to solve problems related to society and industry.
CO4	Demonstrate a prototype application developed using any NN tools and APIs.
CO5	Appraise the knowledge of neural networks and deep learning as an individual/as an team member.

Reference Books	
1	Neural Networks – A Comprehensive Foundation**,** Simon Haykin, 2nd Edition, PHI, 2005.
2	Neural Networks and Deep learning: A Textbook ,Charu C Aggarwal, Springer International Publishing AG, ISBN 978-3-319-94462-3 ISBN 978-3-319-94463-0 (eBook), https://doi.org/10.1007/978-3-319-94463-0, 2018
3	Deep Learning (Adaptive Computation and Machine Learning Series),,Ian Good fellow, Yoshua Bengio and Aaron Courville, MIT Press ,2017, ISBN-13: 978-0262035613.
4	Fundamentals of Artificial Neural Networks ,M H Hassoun, MIT Press, 2010, ISBN-13: 978-0262514675.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (20 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (20 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE (THEORY+LAB)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**