VASIREDDY VENKATADRI INSTITUTE OF TECHNOLOGY
NAMBUR-522508 ANDHRA PRADESH, INDIA

Course Code:	**Subject Title: Deep Learning**
Year and Semester: III Year II semester	

Course Objectives:
1) To understand basic concepts of neural networks.
2) To emphasize learning and optimization techniques.
3) To learn CNN, and its variant models for CV.
4) To learn effective training methods to solve real-world problems.
5) To learn RNN, and its variant models for NLP.

UNIT – I

Deep learning basics: Introduction, the perceptron, Overfitting and generalization, linear perceptron, learning XOR function with non-linear functions, feedforward neural networks, types of activation functions, types of loss functions, Back-Propagation.

UNIT – II

Optimization: Challenges in neural network optimization, Regularization, Gradient Descent, Stochastic Gradient Descent, Momentum Optimizer, AdaGrad, RMSProp, Adam, Batch normalization.

UNIT – III

Deep Learning for Computer Vision: Building blocks of CNN, Local receptive fields, Shared weights and bias, stride, Pooling layers, Max-pooling, Average pooling, CNN for image classification – AlexNet, VGG, GoogleNet, ResNet architectures. CNN for segmentation – Unet.

UNIT – IV

Effective training of Deep Neural Networks: Early stopping, Dropout, Instance Normalization, Group Normalization, Transfer Learning, Data Augmentation.

UNIT – V

Deep Learning for Natural Language Processing: Computational representation of language, one-hot representation of words, word vectors – the skip-gram word2vec model, The CBOW word2vec model, word vector arithmetic, RNN, LSTM.

Content beyond syllabus:

Recent Trends in Deep Learning Architectures: Residual Network, Skip Connection Network. Basic concepts of Pattern Recognition and examples of Pattern Recognition Systems, Linear Decision Functions with examples illustrating various cases, concept of pattern space and weight space.

Text Books:
1. Deep Learning- Ian Goodfellow, Yoshua Benjio, Aaron Courville, The MIT Press
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition - Aurélien Géron, O'Reilly Media, Inc. ISBN: 9781492032649
3. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.

Reference Books:
1. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.
2. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.

3. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
4. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001.
5. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.

E-Resources & other digital material:

1. NPTEL Lecture material - Lecture Series on Deep Learning by Prof. P. K. Biswas, Department of Electrical & Electronic Communication Engineering, IIT Kharagpur.
   https://onlinecourses.nptel.ac.in/noc22_cs22/preview#:~:text=Week%201%3A%20Introduction%20to%20Deep,Multilayer%20Perceptron%2C%20Back%20Propagation%20Learning

Course Outcomes: At the end of the course student will be able to
CO1: Demonstrate the building of fully connected feedforward neural networks
CO2: Perform optimized training of the feedforward neural networks
CO3: Design convolutional neural networks for solving basic computer vision problems
CO4: Apply effective training techniques
CO5: Design RNNs for NLP

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	3	-	-	2	1	-	-	-	-	-	-	-	3	1
CO-2	3	-	-	2	2	-	-	-	-	-	-	-	3	1
CO-3	3	-	-	2	2	-	-	-	-	-	-	-	3	1
CO-4	3	-	-	2	2	-	-	-	-	-	-	-	3	1
CO-5	3	-	-	2	3	-	-	-	-	-	-	-	3	1

Micro Syllabus of Deep Learning

UNIT I **(14 Hrs.)**

Deep learning basics: Introduction, the perceptron, Overfitting and generalization, linear perceptron, learning XOR function with non-linear functions, feedforward neural networks, types of activation functions, types of loss functions, Back-Propagation.

Unit	Module	Micro Content	No. of Hrs.
UNIT I	Introduction	Feature space, linearly separable classes	2
	Overfitting and generalization	Capacity of the model selected and complexity of the task	1
	The perceptron	How it learns linear functions, and fails to learn XOR function	2
	Feedforward Neural Networks	How the nonlinear units enable the learning of any nonlinear function	2
	Types of activation functions	Types of loss functions used in neural networks, their derivatives and use cases.	2
	Types of loss functions	Regression loss functions: MSE, MAE, Huber loss function, classification loss functions: binary cross-entropy, categorical cross-entropy	2
	Back-propagation	Propagation errors form output layer back to the input layer via hidden layers for updating parameters using gradient descent algorithms,	2
		Examples of back propagation algorithm	1

UNIT – II **(12 Hrs.)**

Optimization: Challenges in neural network optimization, Regularization, Gradient Descent, Stochastic Gradient Descent, Momentum Optimizer, AdaGrad, RMSProp, Adam, Batch normalization.

Unit	Module	Micro Content	No. of Hrs.
UNIT II	Introduction	Understanding loss landscape	1
		Challenges in neural network optimization	2
	Regularization	L2 and L1 regularization	2
	Gradient Optimization and its variants	Gradient descent, and SGD	2
		Momentum optimizer	1
		AdaGrad	1
		RMSProp	1
		Adam	1
		Batch normalization	1

UNIT– III **(12 Hrs.)**

Deep Learning for Computer Vision: Building blocks of CNN, Local receptive fields, Shared weights and bias, stride, Pooling layers, Max-pooling, Average pooling, CNN for image classification – AlexNet, VGG, GoogleNet, ResNet architectures. CNN for segmentation – Unet.

Unit	Module	Micro Content	No. of Hrs.
UNIT III	Building blocks of CNN	1D and 2D Convolutional layers, stride, and Parameter calculations.	2
		Local receptive fields, shared weights and biases	2
		Pooling layers: Max-pooling, Average pooling	2
	CNN for image classification	AlexNet, VGG, GoogleNet, ResNet architectures	4
	CNN for image segmentation	Unet	2

UNIT – IV **(10 Hrs.)**

Effective training of Deep Neural Networks: Early stopping, Dropout, Instance Normalization, Group Normalization, Transfer Learning, Data Augmentation.

Unit	Module	Micro Content	No. of Hrs.
UNIT IV	Early stopping	Avoid overfitting using early stopping	2
	Feature Normalization	Instance normalization, group normalization	2
	Dropout	Dropout as regularization	2
	Transfer learning	Applying transfer learning for downstream tasks for faster training	2
	Data augmentation	Importance of data augmentation, types of data augmentations with respect to image classification.	2

UNIT V **(12 Hrs.)**

Deep Learning for Natural Language Processing: Computational representation of language, one-hot representation of words, word vectors – the skip-gram word2vec model, The CBOW word2vec model, word vector arithmetic, RNN, LSTM.

Unit	Module	Micro Content	No. of Hrs.
UNIT V	Computational representation of language	Vector representation of words, one-hot encoding	2
	word vectors	skip-gram word2vec model	2
		The CBOW word2vec model	2
		word vector arithmetic	2
	RNN	RNN	2
	LSTM	LSTM	2

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