SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(AUTONOMOUS)

QUESTION BANK

Year / Semester: III B.Tech VI Semester **Regulation: R23**

Subject and Code: Deep Learning & 23CSM361T

SYLLABUS

PRE-REQUISITES: **Machine Learning basics**

COURSE EDUCATIONAL OBJECTIVES:

1. **Demonstrate the major technology trends driving Deep Learning**
2. **Build, train, and apply fully connected deep neural networks**
3. **Implement efficient (vectorized) neural networks**
4. **Analyse the key parameters and hyper parameters in a neural network's architecture**
5. **Demonstrate the sequence modeling and Networks of Deep Learning**

UNIT-I: LINEAR ALGEBRA, PROBABILITY AND NUMERICAL COMPUTATION (9)

Linear Algebra: **Scalars, Vectors, Matrices and Tensors, Matrix operations, types of matrices, Norms, Eigen decomposition, Singular Value Decomposition, Principal Components Analysis.**

Probability and Information Theory: **Random Variables, Probability Distributions, Marginal Probability, Conditional Probability, Expectation, Variance and Covariance, Bayes' Rule, Information Theory.**

Numerical Computation: **Overflow and Underflow, Gradient-Based Optimization, Constrained Optimization, Linear Least Squares.**

UNIT-II: MACHINE LEARNING AND DEEP FEED FORWARD NETWORKS (9)

Machine Learning: **Basics and Under fitting, Hyper parameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood, Bayesian Statistics, Supervised and Unsupervised Learning, Stochastic Gradient Descent, Challenges Motivating Deep Learning.**

Deep Feed forward Networks: **Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and other Differentiation Algorithms.**

UNIT-III: REGULARIZATION AND OPTIMIZATION OF DL MODELS (9)

Regularization for Deep Learning: **Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop and Manifold Tangent Classifier.**

Optimization for Training Deep Models: **Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms.**

UNIT-IV: CONVOLUTIONAL NETWORKS (9)

Convolutional Networks: **The Convolution Operation, Pooling, Convolution, Basic Convolution Functions, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, Basis for Convolutional Networks.**

UNIT-V: SEQUENCE MODELING (9)

Sequence Modeling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, Echo State Networks, LSTM, Gated RNNs, Optimization for Long-Term Dependencies, Auto encoders, Deep Generative Models.

Prepared by G. Yuva Raj & Dr Rajani Kanth. VELURU

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Max Marks: 10

S.No.	CO	Questions	BT
Unit I: (LINEAR ALGEBRA, PROBABILITY AND NUMERICAL COMPUTATION)			
1	**1**	**a.** Explain Scalars, Vectors, Matrices and Tensors with examples. (5M) **b.** Discuss different types of matrices used in DL. (5M)	**L4**
2	**1**	**Compute Eigenvalues and Eigenvectors** of matrix A = [[2,1],[1,2]]. Interpret geometrically.	**L3**
3	**1**	Compare Eigen Decomposition and Singular Value Decomposition with suitable example.	**L4**
4	**1**	**Solve Linear Least Squares problem** for given data points using normal equation method.	**L3**
5	**1**	Evaluate the importance of Principal Component Analysis in dimensionality reduction.	**L5**
6	**1**	a) Define Random Variable and Probability Distribution. (5M) b) Derive expressions for Expectation and Variance. (5M)	**L4**
7	**1**	**Using Bayes' theorem**, calculate posterior probability for a binary classification example.	**L3**
8	**1**	Analyze Entropy and Cross-Entropy with mathematical expressions.	**L5**
9	**1**	Discuss Gradient-Based Optimization and explain overflow and underflow issues.	**L4**
10	**1**	**Minimize $f(x,y)=x^2+y^2$ subject to $x+y=1$ using Lagrange multipliers.**	**L3**
11	**1**	**Compute Covariance matrix** for a small 2D dataset and interpret correlation.	**L3**

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S.No.	CO	Questions	BT
Unit II: (MACHINE LEARNING AND DEEP FEED FORWARD NETWORKS)			
1	2	**a.** Explain Bias–Variance tradeoff. (5M) **b.** Discuss underfitting and overfitting with diagram. (5M)	L4
2	2	Derive Maximum Likelihood Estimator for Gaussian distribution.	L3
3	2	Differentiate Supervised and Unsupervised Learning with applications.	L4
4	2	Perform one iteration of Stochastic Gradient Descent for linear regression with given dataset.	L3
5	2	Evaluate challenges motivating Deep Learning.	L5
6	2	Design a network to solve XOR problem and compute output for given inputs.	L4
7	2	Describe Hidden Units and activation functions.	L3
8	2	Analyze Backpropagation algorithm with derivation of weight update rule.	L5
9	2	Discuss architecture design considerations in Feedforward Networks.	L4
10	2	**Compute forward pass and backward pass** for a simple 2-layer neural network.	L3
11	2	Compare Bayesian Statistics and Frequentist approach in ML.	L4

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S.No.	CO	Questions	BT
Unit III: (REGULARIZATION AND OPTIMIZATION OF DL MODELS)			
1	3	**a.** Explain L1 and L2 regularization mathematically. (5M) **b.** Show how L2 acts as weight decay. (5M)	L4
2	3	Compute effect of L1 and L2 penalties on given weight vector.	L3
3	3	Analyze Dropout technique and its impact on generalization.	L4
4	3	Explain Dataset Augmentation techniques.	L3
5	3	Evaluate Ensemble Methods such as Bagging.	L5
6	3	Discuss Parameter Sharing and Sparse Representations.	L4
7	3	Explain Early Stopping with graphical interpretation.	L3
8	3	Analyze challenges in Neural Network Optimization.	L5
9	3	Compare update equations of AdaGrad, RMSProp and Adam.	L4
10	3	Perform one Adam optimization step for given gradients.	L3
11	3	Discuss Approximate Second-Order Methods.	L3

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S.No.	CO	Questions	BT
Unit IV: (CONVOLUTIONAL NETWORKS)			
1	**4**	**a.** Explain convolution operation mathematically. (5M) **b.** Discuss pooling techniques. (5M)	**L4**
2	**4**	**Perform 2D convolution** on a 3×3 input matrix using given kernel.	**L3**
3	**4**	Analyze structured outputs in CNNs.	**L4**
4	**4**	Explain different data types used in convolutional networks.	**L3**
5	**4**	Evaluate efficient convolution algorithms (FFT-based).	**L5**
6	**4**	Calculate output dimension of convolution layer with given stride and padding.	**L4**
7	**4**	Explain random and unsupervised feature learning.	**L3**
8	**4**	Critically analyze design challenges in deep CNN architectures.	**L5**
9	**4**	Compare convolutional and fully connected layers.	**L4**
10	**4**	Compute parameters count in a CNN layer for given configuration.	**L3**
11	**4**	Explain role of padding and stride in convolution.	**L3**

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S.No.	CO	Questions	BT
Unit V: (SEQUENCE MODELING)			
1	5	**a.** Explain unfolding computational graphs. (5M) **b.** Discuss Recurrent Neural Networks. (5M)	L4
2	5	**Perform forward propagation in a simple RNN** for one time step.	L3
3	5	Analyze Bidirectional RNNs and Encoder–Decoder architecture.	L4
4	5	Explain Deep Recurrent Networks.	L3
5	5	Evaluate challenges of long-term dependencies in RNNs.	L5
6	5	**Derive LSTM cell equations** and explain each gate.	L4
7	5	Explain Gated RNNs and GRU architecture.	L3
8	5	Critically analyze optimization strategies for sequence models.	L5
9	5	**Compute output of a GRU cell** for given inputs and weights.	L4
10	5	Explain Autoencoders and Deep Generative Models.	L3
11	5	**Calculate cross-entropy loss** for a sequence prediction example.	L3

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating

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Instruction to Faculty Members:

The Six Levels of Bloom's Taxonomy:

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).

Instruction to Faculty Members:

- **Strictly follow the prescribed question paper template without deviation.**
- **Text book reference to quoted end of the fifth unit**
- **Set a** minimum of ten (11) **and a** maximum of fifteen (15) **subjective questions per unit. Each question shall carry** ten (10) marks**.**
- **Questions may include sub-questions as per the prescribed pattern: B.Tech: 10M** or **5M + 5M** or **6M + 4M**