Amrita Vishwa Vidyapeetham
Amrita School of Computing, Amritapuri.
Department of Computer Science and Engineering

Course Plan

1. Course Information

Course code/Title: 23CSE473 NEURAL NETWORKS AND DEEP LEARNING

L-T-P-C: 3-0-0-3

Academic year and term: 2025-2026 Odd Semester
Program/Batch/Semester: BTech. / 2023-2027 / Semester V

2. Course Mentors: Sarath S

3. Course Objectives

To introduce to student's different deep neural network architectures, training strategies/algorithms, possible challenges, tools and techniques available in designing and deploying solutions to different practical/engineering problems.

4. Course Outcomes

CO#	Outcome
CO1	Understand the learning components of neural networks and apply standard neural network models to learning problems.
CO2	Analyze the learning strategies of deep learning – regularization, generalization, optimization, bias and variance.
CO3	Analyze regular deep learning models for training, testing and validation in standard datasets.
CO4	Apply neural networks for deep learning using standard tools.
CO5	Understand the mathematics for Deep learning.

5. CO-PO Affinity Map

PO/ PSO CO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2
CO1	3	2	2	3	-	3	2
CO2	3	2	3	2	2	3	2
CO3	3	2	3	2	3	3	2
CO4	3	1	2	1	2	3	2
CO5	3	1	2	1	-	3	2

6. CO-PO Affinity Justification

CO-PO Justification			
CO	**PO/PSO**	**Affinity**	**Justification**
1	PO1	3	Builds strong theoretical foundations in neural networks and learning principles, enabling analytical and mathematical reasoning.
	PO2	2	Introduces learners to analysing simple problems using neural networks; encourages exploration and application.
	PO3	2	Supports development of basic design skills using standard models, though not fully emphasizing implementation complexity.
	PO4	3	Reinforces knowledge application in well-defined engineering problems, especially classification and prediction tasks.
	PSO1	3	Equips students to design standard learning-based solutions for interdisciplinary problems using tools like TensorFlow, PyTorch.
	PSO2	2	Encourages foundational learning of AI paradigms like deep learning that are critical for future research engagement.
2	PO1	3	Strengthens mathematical analysis and understanding of model behavior and performance metrics.
	PO2	2	Facilitates the identification and improvement of learning processes using theoretical tools and metrics.
	PO3	3	Enables in-depth evaluation of learning strategies and their influence on model performance and reliability.
	PO4	2	Provides insights into efficient model design and evaluation, though limited hands-on optimization implementation.
	PO5	2	Encourages awareness of ethical and sustainability factors in model design through generalization and overfitting mitigation.
	PSO1	3	Lays the groundwork for implementing efficient models with optimization strategies for real-world problems.
	PSO2	2	Aids in understanding modern deep learning advances necessary for innovation and research.

3	PO1	3	Develops the ability to understand and analyze model performance on standard datasets.
	PO2	2	Provides scope for investigating error sources and performance variation in models.
	PO3	3	Strongly supports design, training, and evaluation of solutions using industry practices.
	PO4	2	Promotes moderate ability to conduct experiments and analyze results for validation.
	PO5	3	Strengthens understanding of standard testing and validation protocols which contribute to engineering best practices.
	PSO1	3	Supports hands-on development and assessment of models that meet application-specific requirements.
	PSO2	2	Encourages usage of datasets and evaluation methods relevant to emerging research.
4	PO1	3	Application of neural networks improves technical competency in using computational tools.
	PO2	1	Low-level exposure to analysis of applied systems; mostly tool usage-oriented.
	PO3	2	Moderate contribution to system-level design and model implementation.
	PO4	1	Minimal involvement in complex problem analysis or experimentation.
	PO5	2	Tools used require understanding of data preprocessing and reproducibility in engineering tasks.
	PSO1	3	Strongly supports PSO1 through development of practical and optimal solutions using deep learning libraries.
	PSO2	2	Introduces modern deep learning frameworks that support experimentation in new computing paradigms.
5	PO1	3	Reinforces mathematical reasoning and theoretical modeling essential for deep learning.

	PO2	1	Provides limited practical problem analysis directly but supports conceptual clarity.
	PO3	2	Contributes to model understanding and formulation but lacks direct implementation emphasis.
	PO4	1	Indirect contribution to investigation as it focuses more on foundations than experimentation.
	PSO1	3	Supports deep comprehension required for designing advanced models with mathematical insight.
	PSO2	2	Lays theoretical foundation necessary for innovation and further research in emerging deep learning fields.

7. Syllabus

Unit 1
Perceptrons – classification - limitations of linear nets and perceptrons - multi-Layer Perceptrons (MLP); Activation functions - linear, softmax, tanh, ReLU; error functions; Feed-forward networks - Backpropagation - recursive chain rule (backpropagation); Learning weights of a logistic output -Loss functions - learning via gradient descent; Optimization – momentum method; Adaptive learning rates – RMSProp - mini-batch gradient descent; Bias-variance trade off - Regularization - overfitting - inductive bias – drop out - generalization.

Unit 2
Convolutional Neural Networks - Basics and Evolution of Popular CNN architectures; CNN Applications: Object Detection and Localization, Face Recognition, Neural Style Transfer Recurrent Neural Networks - GRU - LSTM – Transformers Networks; Applications: NLP and Word Embeddings, Attention Models,

Unit 3
Restricted Boltzmann Machine, Deep Belief Networks, Auto Encoders and Applications: Semi-Supervised classification, Noise Reduction, Non-linear Dimensionality Reduction; Introduction to GAN - Encoder/Decoder, Generator/Discriminator architectures; Challenges in NN training - Data Augmentation - Hyper parameter Settings; Transfer Learning - Developing and Deploying ML Models (e.g., Tensor Flow/PyTorch)

Textbook(s)

- Ian Goodfellow, Yoshua Bengio and Aaron Courville. “Deep Learning”, MIT Press, Second Edition; 2016.

Reference(s)

- Koller, D. and Friedman, N. “Probabilistic Graphical Models”. MIT Press;2009.
- Hastie, T., Tibshirani, R. and Friedman, J. “The Elements of Statistical Learning”. Second edition, Springer; 2009.

- Bishop, C. M. “Neural Networks for Pattern Recognition”. Oxford University Press;1995.
- Aggarwal, Charu C. "Neural networks and deep learning." Springer, 2018.

9. Evaluation Policy

Sl. No.	Exam	CO Coverage	Weightage%
1	Midterm	CO1, CO2, CO5	20
2	**Practice Lab (Data Camp) Submission + Assessment**	CO3, CO4	10
3	Project	CO3, CO4, CO5	40
4	End Semester Exam (50 marks exam)	CO1, CO2, CO3, CO5	30
	Total		100

Evaluation Plan

Continuous Evaluation – 50 marks

- 3 Datacamp course submissions and assessment (10 marks)
  - **Introduction to deep learning using PyTorch** - Basics of deep learning and neural networks, Optimizing a neural network with backward propagation, Building deep learning models, Fine-tuning models.
  - **Intermediate Deep Learning with PyTorch** - Training Robust Neural Networks, Images & Convolutional Neural Networks, Sequences & Recurrent Neural Networks, Multi-Input & Multi-Output Architectures.
  - **Deep Learning for Images with PyTorch** - Image Classification with CNNs, Object Recognition, Image Segmentation, Image Generation with GANs
- Project (40 marks)

Week	**Submission**	**Details**	**Marks**
Week 4	Project Proposal	Problem statement – Dataset to be used – Model idea and tools	5
Week 6	Interim Progress Report	Literature summary (3–5 papers) - Preliminary model architecture - Data preprocessing status	5
Week 8	Model Implementation Submission	Working code – Training outputs – Initial results (e.g., accuracy)	10
Week 10	Results Presentation with Viva	Viva/presentation	10

Week 11	Final Report/Paper	Complete report (structured, with references)/ Technical report in IEEE format	10

10. Direct Assessment Tools

Sl. No	Direct Assessment Tools	Weightage	Max Exam Marks	CO wise mark distribution				
				CO1	CO2	CO3	CO4	CO5
1	Midterm Exam	20	50	✓	✓			✓
2	Practice Sessions + Assessment	5 + 5	10			✓	✓	
3	Project	40	40			✓	✓	✓
5	End Sem - Exam	30	100	✓	✓	✓		✓

11. CO Attainment Levels

Attainment Level	Target %
High	>= 70
Medium	>= 50
Low	< 50

12. Course Delivery Plan

Week	Topics	Objective	CO	PO	PSO
Week 1	Introduction to deep learning, History of Deep Learning, Deep Learning a big Picture, Application areas of Deep learning, Models listing	To introduce the deep learning concepts and list the domains it is applicable to.	CO1, CO5	PO1, PO2, PO5	PSO1
Start with PyTorch: Do Practice lab on Datacamp					
Week 2	• MP Neuron • Perceptron • Sigmoid Neuron • Gradient Descent Optimization • Universal Approximation Theorem • Non-Linearly separable data	Introduction to Neural Networks	CO1, CO5	PO1, PO2, PO5	PSO1
MP Neuron /Perceptron model. Do Practice lab on Datacamp					

Week 3	• Feed-Forward NN-Hyper parameter Tuning • Gradient descent Variants (Stochastic, Batch, Mini Batch) • Gradient Descent Optimisation (Vanilla, momentum, Nestero Accelerated, Adagrad, MSProp) • Activation Functions (Sigmoid, tanh, ReLu, Leaky ReLu) • Overfitting, Underfitting, Bias, Variance trade-off, Batch Normalisation, Drop out	Introduction to Feed forward Neural Network and Back Propagation	CO1, CO2, CO5	PO1, PO2, PO3, PO5	PSO1
Practice lab Datacamp course 2					
Week 4	• Convolution • 3D convolution • Padding • Stride • Pooling • Handcrafted Features- HOG/SIFT • CNN basic Architecture • Sparse Connection and Weight sharing • How CNN trained? • Diff CNN architectures- listed • Writing custom data set loaders and transforms • LeNet-5 Architecture	Introduction to CNN	CO1, CO5	PO1, PO2, PO5	PSO1
Project Proposal Submission					
Week 5	CNN Architectures, LeNet-5 Architecture, Alex-Net, ZFNet, VGG GoogLeNet, ResNet and Visualizing Convolutional Neural Networks	Exploring the different CNN Architectures	CO2, CO5	PO1, PO2, PO3, PO5	PSO1
MidTerm Examination					
Week 6	Object Localisation and Detection-RCNN /Faster RCNN /Yolo	Object Localisation	CO3, CO5	PO1, PO2, PO3, PO4, PO5	PSO1
Interim Progress Report of Project Submission					
Week 7	Autoencoders	Introducing autoencoders	CO3, CO5	PO1, PO2, PO3,	PSO1

				PO4, PO5	
Practice lab Datacamp course 2					
Week 8	Sequential Models • RNN • LSTM • GRU	Introduction to Sequential models and different types of sequential models	CO3, CO5	PO1, PO2, PO3, PO4, PO5	PSO1
Model Implementation Submission Practice lab Datacamp course 3					
Week 9	Encoder Decoder Models, Attention Mechanism, Attention over images, Hierarchical Attention	Attention mechanism	CO3, CO5	PO1, PO2, PO3, PO4, PO5	PSO1
Practice lab Datacamp course 3					
Week 10	Generative Adversarial Networks (GANs)	Introduction to GAN	CO3, CO5	PO1, PO2, PO3, PO4, PO5	PSO1, PSO2
Final Results Presentation with Viva					
Week 11	Data Augmentation – Hyperparameter Settings; Transfer Learning – Developing and Deploying ML Models	Uses and implementing GAN	CO4, CO5	PO1, PO2, PO3, PO4, PO5	PSO1, PSO2
Final Report/Paper Submission / End Semester					

13. Faculty Information with Signature

Faculty Name	Class	Signature
Sarath S	S5 CSE C & D	
Anjali T	S5 CSE A & B	