VIMAL JYOTHI
ENGINEERING COLLEGE (AUTONOMOUS)
CHEMPERI – KANNUR I WWW.VJEC.AC.IN

VJEC B. Tech. Syllabus 2024

Minor Degree in

Machine Learning

Offered By : Computer Science and Engineering

MINOR DEGREE STRUCTURE

Offered by Department of Computer Science & Engineering

In today's digital era, understanding the basics of computing has become essential across all fields of study. The CSE minor program at Vimal Jyothi Engineering College is crafted to offer students from other disciplines a valuable opportunity to delve into the dynamic world of computing. This program aims to equip them with fundamental knowledge and practical skills in computer science, enabling them to thrive in an increasingly tech-driven world.

- **Academic major** is the academic discipline to which an undergraduate student formally commits. A student who successfully completes all courses required for the major qualifies for an undergraduate degree.
- **Academic minor** is an academic discipline outside of the student's academic major in which he or she takes a small number of classes.

Objectives of the Minor Program

1. To impart to students both fundamental and applied knowledge in the field of Computer Science & Engineering.
2. To develop an appreciation for the transformative role of computing technologies in shaping modern society.
3. To provide students with a working knowledge of core CSE principles, including programming, algorithms, and system design.
4. To introduce students to the current state-of-the-art in computing, enabling them to integrate computer science concepts with their primary field of study**.**

Curriculum – Minor in CSE

Semester	Course Code	Course Title	L	T	P	R	C	CIA	ESE
S3	MNCST309	Mathematics For Machine Learning	3	1	0	0	4	40	60
S4	MNCST409	Python For Machine Learning	3	1	0	0	4	40	60
S5	MNCST509	Concepts in Machine Learning	3	1	0	0	4	40	60
S6	MNCST609	Concepts in Deep Learning	3	0	0	0	3	40	60
Total Credit							**15**		

SEMESTER S3

MATHEMATICS FOR MACHINE LEARNING

Course Code	**MNCST309**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs.30 Min.
Prerequisites (if any)	1.A sound background in higher secondary school Mathematics 2. Python for Machine Learning	**Course Type**	Theory

Course Objectives:

1. To introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built.
2. To provide an overview of Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems.
3. To help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**LINEAR ALGEBRA** : Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces - Linear Independence, Basis and Rank, Linear Mappings, Norms, - Inner Products - Lengths and Distances - Angles and Orthogonality - Orthonormal Basis - Orthogonal Complement - Orthogonal Projections. Matrix Decompositions - Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	**10**
2	**Vector Calculus:** Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation - Higher Order Derivatives- Linearization and Multivariate Taylor Series.	**9**

3	**Bayes' Theorem - Optimization:** Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming.	**10**
4	**Central Machine Learning Problems:** Data and Learning Model- Empirical Risk Minimization - Parameter Estimation - Directed Graphical Models. Linear Regression - Bayesian Linear Regression - Maximum Likelihood as Orthogonal Projection. Dimensionality Reduction with Principal Component Analysis. **Density Estimation with Gaussian Mixture Models** - Gaussian Mixture Model, Parameter Learning via Maximum Likelihood, EM Algorithm. Classification with Support Vector Machines.	**14**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination-3 (Written)	Total
5	**15**	**5**	**10**	**5**	**40**

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs):

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues & eigenvectors and orthogonality & diagonalization to solve computational problems.	**K3**
CO2	Perform calculus operations on functions of several variables and matrices, including partial derivatives and gradients	**K3**
CO3	Utilize the concepts, rules and results about probability, random variables, additive & multiplicative rules, conditional probability, probability distributions and Bayes' theorem to find solutions of computational problems.	**K3**
CO4	Train Machine Learning Models using unconstrained and constrained optimization methods.	**K3**
CO5	Illustrate how the mathematical objects - linear algebra, probability, and calculus can be used to design machine learning algorithms.	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**
CO1	H	M	M	M							
CO2	H	M	M								
CO3	H	M	M	M							
CO4	H	M	M	M		H					
CO5	H	M	L	M	L	H				M	

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Linear Algebra and Its Applications	Gilbert Strang	-	4/e
2	Linear Algebra Done Right	Axler, Sheldon	Springer	2015
3	Introduction to Applied Linear Algebra	Stephen Boyd, Lieven Vandenberghe	Cambridge University Press	2018
4	Convex Optimization	Stephen Boyd and Lieven Vandenberghe	Cambridge University Press	2004
5	Pattern Recognition and Machine Learning	Christopher M Bishop	Springer	2006
6	Learning with Kernels – Support Vector Machines, Regularization, Optimization, and Beyond	Bernhard Scholkopf and Smola, Alexander J Smola,	MIT Press	2002
7	Information Theory, Inference, and Learning Algorithms	David J. C MacKay	Cambridge University Press	2003
8	Machine Learning: A Probabilistic Perspective	Kevin P Murphy	MIT Press	2012
9	The Nature of Statistical Learning Theory	Vladimir N Vapnik	Springer	2000

Links	
SI No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc25_cs53/preview
2	https://onlinecourses.nptel.ac.in/noc25_ma03/preview
3	https://onlinecourses.nptel.ac.in/noc25_ma11/preview

SEMESTER S4

PYTHON FOR MACHINE LEARNING

(Common to CS/CD/CM/CR/CA/AD/AI/AM/CB/CN/CI)

Course Code	**MNCST409**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To equip students with Python tools for data preprocessing, analysis, and visualization in machine learning workflows.
2. To enable students to prepare data and build pipelines suitable for ML tasks.
3. To introduce Python-based frameworks that support scalable and reproducible ML experiments.
4. To provide hands-on experience with Python libraries essential for modern data science work.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Python Basics, Data Structures, and Data Handling:** Python basics - syntax, variables, data types, operators (arithmetic, relational, logical, membership, identity), control structures (if, if-else, while, for), functions, lambda expressions, exception handling. Core data structures - lists, tuples, dictionaries, sets, list comprehension, string handling and formatting.	7
2	**Data Handling and Visualization:** NumPy - arrays, operations, broadcasting, vectorization. Pandas - Series, DataFrames, data cleaning, handling missing data, reshaping, merging. Feature engineering basics - encoding categorical variables, feature scaling, discretization. File I/O - working with CSV, JSON. Matplotlib and Seaborn — plotting distributions, trends, relationships. Plotly or Altair — interactive and dynamic visualizations. Correlation analysis, outlier detection, feature importance visualization, dimensionality reduction with PCA. Building automated EDA reports using pandas-profiling or Sweetviz.	15

3	**Python Tools for ML Pipelines and Workflows** : Introduction to **scikit-learn** pipelines (excluding algorithm internals). Data splitting, cross-validation strategies, ensuring reproducibility with random seeds. Overview of hyperparameter tuning tools - GridSearchCV, RandomizedSearchCV (without model focus). Introduction to experiment tracking tools: MLflow, Weights & Biases.	**12**
4	**Essential Python Practices for Machine Learning Projects:** Writing reusable code with functions and modules. Organizing code with packages and scripts. Logging and error handling in ML scripts. Managing Python environments (virtualenv, conda). Using Jupyter Notebooks effectively for ML experimentation and reporting.	**9**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project Work	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination-3 (Written)	Total
5	**15**	**5**	**10**	**5**	**40**

Suggestion on Project Work:

Project groups limited to a maximum of 3 members.

- Students must implement a mini project related to any module.
- Project deliverables: source code, documentation/report, and presentation/demo.
- Evaluation will be based on the following rubrics:
    - Problem relevance and clarity (3 marks)
    - Implementation quality and correctness (5 marks)
    - Use of Python tools and techniques (3 marks)
    - Documentation and presentation (2 marks)
    - Individual contribution and teamwork (2 marks)

Sample Project Topics:

1. Data Cleaning and Feature Engineering for a Public Dataset
2. Interactive Data Dashboard using Plotly/Dash
3. End-to-End ML Pipeline using Scikit-learn
4. Automated EDA Report Generator Tool
5. Customer Segmentation using Clustering
6. Covid-19 Data Analysis and Visualization

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks. **(8x3 =24 marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate foundational Python programming skills including syntax and data structures for building ML-ready scripts. (Cognitive Knowledge level: Apply)	**K3**
CO2	Apply Python tools for data handling and visualization to support analysis and feature engineering. (Cognitive Knowledge level: Apply)	**K3**
CO3	Construct reproducible data pipelines and workflows using Python frameworks.(Cognitive Knowledge level: Apply)	**K3**
CO4	Prepare domain-specific data (text, time-series) using specialized Python libraries.(Cognitive Knowledge level: Apply)	**K3**
CO5	Apply best practices in Python-based data handling, visualization, and workflow integration to support reproducible and effective machine learning experiments. (Cognitive Knowledge level: Apply)	**K2**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1			M		M						H
CO2	H	M	M		M						M
CO3	H	M	M		M	H	H				
CO4	H	M	M		M		H				
CO5	H	M	M		M						

Note:1:Slight(Low), 2:*Moderate (Medium), 3:Substantial(High),-:No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Python for Data Analysis	Wes McKinney	O'Reilly Media	3/e, 2013
2	Introduction to Machine Learning with Python	Andreas C. Müller, Sarah Guido	O'Reilly Media	1/e, 2016
3	Machine Learning Engineering	Andriy Burkov	True Positive Incorporated	1/e, 2020

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Natural Language Processing with Python	Steven Bird, Ewan Klein, Edward Loper	O'Reilly Media	1/e, 2009
2	Data Visualization with Python and JavaScript	Kyran Dale	O'Reilly Media	1/e, 2016
3	Deep Learning with Python	François Chollet	Manning Publications	1/e, 2017
4	Automate the Boring Stuff with Python	Al Sweigart	No Starch Press	2/e, 2019

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://archive.nptel.ac.in/courses/106/106/106106212/
2	https://archive.nptel.ac.in/courses/106/106/106106139/

SEMESTER S5

CONCEPTS IN MACHINE LEARNING

Course Code	**MNCST509**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the fundamental concepts of machine learning, including key terminology, problem types, and the overall process of developing machine learning models.
2. To enable learners to understand and implement standard supervised learning algorithms including Linear Regression, Logistic Regression, Decision Trees, Bayesian Learning and Naive Bayes Algorithm.
3. To provide insights into advanced classification techniques, focusing on Support Vector Machines (SVMs) and kernel methods for non-linear decision boundaries.
4. This course helps the students to provide machine learning based solutions to real world problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Overview of machine learning -** Machine learning paradigms-supervised, semi-supervised, unsupervised, reinforcement learning. Basics of parameter estimation - maximum likelihood estimation(MLE) and maximum a posteriori estimation(MAP). Introduction to Bayesian formulation.	7
2	**Supervised Learning -** Regression - Linear regression with one variable, Linear regression with multiple variables, solution using gradient descent algorithm and matrix method, basic idea of overfitting in regression. Linear Methods for Classification- Logistic regression, Perceptron, Naive Bayes, Decision tree algorithm ID3. **Support Vector Machines (SVM) -** SVM - Introduction, Maximum Margin Classification, Mathematics behind Maximum Margin Classification, Maximum Margin linear separators, soft margin SVM classifier, non-linear SVM, Kernels for learning non-linear functions, polynomial kernel, Radial	15

	Basis Function(RBF).	
3	**Unsupervised Learning** - Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering, Expectation maximization (EM) for soft clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	**10**
4	**Classification Assessment -** Classification Performance measures - Precision, Recall, Accuracy, F-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve(AUC. Bootstrapping, Cross Validation, Ensemble methods, Bias-Variance decomposition. Case Study: Develop a classifier for face detection.	**8**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination - 2 (Written)	Internal Examination- 3 (Written)	Total
5	**15**	**5**	**10**	**5**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate Machine Learning concepts and basic parameter estimation methods. (Cognitive Knowledge Level: Apply)	K3
CO2	Demonstrate supervised learning concepts (regression, linear classification). (Cognitive Knowledge Level: Apply)	K3
CO3	Illustrate the concepts of Support Vector Machine. (Cognitive Knowledge Level: Apply)	K3
CO4	Describe unsupervised learning concepts and dimensionality reduction techniques. (Cognitive Knowledge Level: Apply)	K3
CO5	Solve real life problems using appropriate machine learning models and evaluate the performance measures (Cognitive Knowledge Level: Apply)	K3

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	**H**	**M**	**M**	**M**	**M**						
CO2	**H**	**M**	**M**	**M**	**M**						
CO3	**H**	**M**	**M**	**M**	**M**						
CO4	**H**	**M**	**M**	**M**	**M**						
CO5	**H**	**M**	**M**	**M**	**M**	**H**					

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Machine Learning	Ethem Alpaydin	MIT Press	2010
2	Data Mining and Analysis: Fundamental Concepts and Algorithms	Mohammed J. Zaki and Wagner Meira	Cambridge University Press	2016
3	Python Data Science Handbook	Jake VanderPlas	O'Reilly Media	2016
4	Machine Learning	Tom Mitchell	McGraw-Hill	1997

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Networks for Pattern Recognition	Christopher Bishop	Oxford University Press	1995
2	Machine Learning: A Probabilistic Perspective	Kevin P. Murphy.	MIT Press	2012
3	The Elements Of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome Friedman	Second edition Springer	2007
4	Elements of Machine Learning	P. Langley	Morgan Kaufmann	1995
5	Building Machine Learning Systems with Python.	Richert and Coelho	-	-
6	Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools	Davy Cielen, Arno DB Meysman and Mohamed Ali.	Dreamtech Press	2016

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc23_cs18/preview
2	https://onlinecourses.nptel.ac.in/noc19_cs52/preview

SEMESTER S6

CONCEPTS IN DEEP LEARNING

Course Code	**MNCST609**	**CIE Marks**	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	**ESE Marks**	60
Credits	3	**Exam Hours**	2 Hrs. 30 Min.
Prerequisites (if any)	None	**Course Type**	Theory

Course Objectives:

1. To introduce the fundamental concepts and algorithms in deep learning, a subfield of machine learning and artificial intelligence.
2. To familiarize students with key architectures such as deep neural networks, convolutional neural networks (CNNs), and recurrent neural networks (RNNs).
3. To provide an overview of the application areas of deep learning across various domains.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Introduction -** Key components - Data, models, objective functions, optimization algorithms, Learning algorithm. Supervised learning- regression, classification, tagging, web search, page ranking, recommender systems, sequence learning, Unsupervised learning, Reinforcement learning, Historical Trends in Deep Learning. Other Concepts - overfitting, underfitting, hyperparameters and validation sets, estimators, bias and variance.	9
2	**Optimization and Neural Networks -** Neural Networks –Perceptron, Gradient Descent solution for Perceptron, Multilayer perceptron, activation functions, architecture design, chain rule, back propagation, gradient based learning. Introduction to optimization– Gradient based optimization, linear least squares. Stochastic gradient descent, Building ML algorithms and challenges.	10
3	**Convolutional Neural Network and Recurrent Neural Network -** NN - Convolutional Neural Networks – convolution operation, motivation, pooling, Structure of CNN, Convolution and Pooling as an infinitely strong prior, variants of convolution functions, structured outputs, data types,	15

	efficient convolution algorithms. Practical challenges of common deep learning architectures- early stopping, parameter sharing, dropout. Case study: AlexNet, VGG, ResNet. Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs.	
4	**Application Areas -** Applications – computer vision, speech recognition, natural language processing, common word embedding: continuous Bag-of-Words, Word2Vec, global vectors for word representation (GloVe). Research Areas – autoencoders, representation learning, boltzmann machines, deep belief networks. Emerging Topics – agentic AI: autonomous agents, self-directed learning systems, agent architectures, applications of agentic AI in deep learning ecosystems.	**10**

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Internal Examination- 3 (Written)	Total
5	**15**	**5**	**10**	**5**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, Each carrying 3 marks **(8x3 =24marks)**	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate basic concepts in machine learning. (Cognitive KnowledgeLevel: Understand)	K2
CO2	Illustrate the validation process of machine learning models using hyper-parameters and validation sets. (Cognitive Knowledge Level: Understand)	K2
CO3	Demonstrate the concept of the feed forward neural network and its training process. (Cognitive Knowledge Level: Apply)	K3
CO4	Build CNN and Recurrent Neural Network (RNN) models for different use cases. (Cognitive Knowledge Level: Apply)	K3
CO5	Use different neural network/deep learning models for practical applications. (Cognitive Knowledge Level: Apply)	K3

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	L								
CO2	H	M	L	M							
CO3	H	M	M	M							
CO4	H	M	M	M							
CO5	H	M	M	M							

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Deep Learning	Ian Goodfellow, YoshuaBengio, Aaron Courville	MIT Press	2015
2	Dive into Deep Learning	Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola	Cambridge University Press	2019
3	Neural Networks and Deep Learning	Aggarwal, Charu C.	Springer International Publishing AG	2018

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Neural Smithing: Supervised Learning in Feedforward Artificial Neural Networks	Russell Reed, Robert J MarksII	A Bradford Book	2014
2	Practical Convolutional Neural Networks	MohitSewak, Md. Rezaul Karim, PradeepPujari	Packt Publishing	2018
3	Hands-On Deep Learning Algorithms with Python	Sudharsan Ravichandran	Packt Publishing	2019
4	Deep Learning with Python	Francois Chollet	Manning Publications Co.	2018

Video Links (NPTEL, SWAYAM…)	
SI No.	**Link ID**
1	https://onlinecourses.nptel.ac.in/noc25_ee16/preview
2	https://onlinecourses.nptel.ac.in/noc25_cs22/preview
3	https://onlinecourses.swayam2.ac.in/imb24_mg126/preview