Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)

Curriculum Structure and Syllabus

of

M. Tech. Artificial Intelligence and Data Science

(Regulations 2026)

Effective from Academic Year 2026-27

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

EOMS Policy

"We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute's social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS)."

Course Approval Summary

Board of Studies - Department of Information Technology

Sr. No.	Name of the Course	Course Code	Page Number	Signature and Stamp of BoS Chairman
1.	Data Science	**MIT31PC01**	13-14	
2.	Artificial Intelligence and Machine Learning(AI&ML)	**MIT31PC02**	17-18	
3.	Programme Elective -I			
	1. Deep Learning	**MIT31PE01A**	21-22	
	2. Computer Vision and Video Processing	**MIT31PE01B**	25-26	
4.	Programme Elective -II			
	1. Advanced Data Visualization and Analytics	**MIT31PE03A**	28-29	
	2. Recommender System	**MIT31PE03B**	31-32	
5.	Data Science Lab	**MIT31PC03**	15-16	
6.	AI & ML Lab	**MIT31PC04**	19-20	
7.	Programme Elective-I Lab			
	1. Deep Learning Lab	**MIT31PE02A**	23-24	
	2. Computer Vision and Video Processing Lab	**MIT31PE02B**	27	
8.	Programme Elective -II Lab			
	1. Advanced Data Visualization and Analytics Lab	**MIT31PE04A**	30	
	2. Recommender System Lab	**MIT31PE04B**	33-34	
9.	Research Methodology & IPR	**MIT32PC01**	36-37	
10.	Programme Elective –III			
	1. Natural Language Processing	**MIT32PE01A**	38-39	
	2. Generative AI	**MIT32PE01B**	42-43	
11.	Programme Elective –IV			
	1. Big Data Technologies	**MIT32PE03A**	46-47	
	2. Data Analytics and its Applications	**MIT32PE03B**	50-51	
	3. Nature Inspires Optimization Algorithms	**MIT32PE03C**	54-55	
12.	Attacks against ML Models Lab	**MIT32PC02**	59-60	
13.	Programme Elective –III Lab			
	1. Natural Language Processing Lab	**MIT32PE02A**	40-41	
	2. Generative AI Lab	**MIT32PE02B**	44-45	
14.	Programme Elective –IV Lab			
	Big Data Technologies Lab	**MIT32PE04A**	48-49	

Approved by Academic Council:

Chairman, Academic Council

Pimpri Chinchwad College of Engineering

INDEX

CURRICULUM FRAMEWORK
(Regulation 2024)

LIST OF ABBREVIATIONS

Sr. No.	Abbreviation	Type of Course/Course Full Name
1.	PCC	Programme Core Course
2.	PEC	Programme Elective Course
3.	VSEC	Vocational Skill Enhancement Course
4.	ELC	Experiential Learning Courses
5.	Internship (OJT)	Internship (On Job Training)
6.	MOOC	Massive Open Online Course

COURSE WISE CREDIT DISTRIBUTION

Sr. No.	Type of Course	No. of Courses	Total Credits	
			NO.	%
1	PCC	06	14	17
2	PEC	08	20	25
3	VSEC	01	02	03
4	ELC	05	44	55
	Total	**20**	**80**	**100**

SEMESTER-WISE COURSE DISTRIBUTION

Course Distribution: Semester Wise						
Sr. No.	**Type of Course**	**No. of Courses / Semester**				**Total**
		1	**2**	**3**	**4**	
1.	**PCC**	04	02	--	--	**06**
2.	**PEC**	04	04	--	--	**08**
3.	**VSEC**	--	01	--	--	**01**
4.	**ELC**	--	01	03	01	**05**
Total		**08**	**08**	**03**	**01**	**20**

SEMESTER-WISE CREDIT DISTRIBUTION

Credit Distribution: Semester Wise						
Sr. No.	**Type of Course**	**No. of Credits / Semester**				**Total**
		1	**2**	**3**	**4**	
1.	**PCC**	10	04	--	--	**14**
2.	**PEC**	10	10	--	--	**20**
3.	**VSEC**	--	02	--	--	**02**
4.	**ELC**	--	04	20	20	**44**
Total		**20**	**20**	**20**	**20**	**80**

Curriculum Structure

M. Tech.

Artificial Intelligence and Data Science

CURRICULUM STRUCTURE

First Year M.Tech.(Artificial Intelligence and Data Science)
Semester – I& II

First Year M.Tech. Artificial Intelligence and Data Science (Regulations 2026) (With effect from Academic Year 2026-27)															
Semester I															
Course Code	**Course Name**	**Credit Scheme**				**Teaching Scheme (Hours/Week)**			**Evaluation Scheme and Marks**						
		L	**P**	**T**	**Total**	**L**	**P**	**T**	**FA**		**SA**	**TW**	**PR**	**OR**	**Total**
									FA1	**FA2**					
MIT31PC01	Data Science	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT31PC02	Artificial Intelligence and Machine Learning (AI & ML)	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT31PE01	Programme Elective-I	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT31PE03	Programme Elective-II	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT31PC03	Data Science Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT31PC04	AI & ML Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT31PE02	Programme Elective-I Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT31PE04	Programme Elective-II Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
Total		**12**	**08**	**-**	**20**	**12**	**16**	**-**	**80**	**80**	**240**	**200**	**-**	**200**	**800**

L-Lecture, **P**-Practical, **T**-Tutorial,**FA**–Formative Assessment,**SA**-Summative Assessment, **TW**-Term Work, **OR**-Oral, **PR**-Practical

First Year M.Tech. Artificial Intelligence and Data Science (Regulations 2026) (With effect from Academic Year 2026-27)															
Semester II															
Course Code	**Course Name**	**Credit Scheme**				**Teaching Scheme (Hours/Week)**			**Evaluation Scheme and Marks**						
									FA		**SA**	**TW**	**PR**	**OR**	**Total**
		L	**P**	**T**	**Total**	**L**	**P**	**T**	**FA1**	**FA2**					
MIT32PC01	Research Methodology & IPR	02	-	-	02	02	-	-	20	-	30	-	-	-	50
MIT32PE01	Programme Elective -III	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT32PE03	Programme Elective -IV	03	-	-	03	03	-	-	20	20	60	-	-	-	100
MIT32PC02	Attacks against ML Models Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT32PE02	Programme Elective-III Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT32PE04	Programme Elective-IV Lab	-	02	-	02	-	04	-	-	-	-	50	-	50	100
MIT32VS01	Professional and Communication Skill Development Lab	-	02	-	02	-	04	-	-	-	-	100	-	-	100
MIT32EL01	Research Internship	-	04	-	04	-	08	-	-	-	-	100	-	100	200
Total		**08**	**12**	**-**	**20**	**08**	**24**	**-**	**60**	**40**	**150**	**300**	**-**	**300**	**850**

L-Lecture, **P**-Practical, **T**-Tutorial,**FA**–Formative Assessment,**SA**-Summative Assessment,**TW**-Term Work, **OR**-Oral, **PR**-Practical

CURRICULUM STRUCTURE

Second YearM.Tech.(Artificial Intelligence and Data Science)
Semester – III & IV

Second Year M.Tech. Artificial Intelligence and Data Science (Regulations 2026) (With effect from Academic Year 2026-27) Semester III															
Course Code	Course Name	Credit Scheme				Teaching Scheme (Hours/Week)			Evaluation Scheme and Marks						
									FA		SA	TW	PR	OR	Total
		L	P	T	Total	L	P	T	FA1	FA2					
MIT33EL01	Dissertation Phase - I [Company/ In-house project]	-	08	-	08	-	16	-	-	-	-	100	-	100	200
MIT33EL02	Internship (OJT)	-	08	-	08	-	16	-	-	-	-	100	-	100	200
MIT33EL03	MOOC's	04	-	-	04	04	-	-	-	-	-	100	-	-	100
Total		**04**	**16**	**-**	**20**	**08**	**32**	**-**	**-**	**-**	**-**	**300**	**-**	**200**	**500**

Second Year M.Tech. Artificial Intelligence and Data Science (Regulations 2026) (With effect from Academic Year 2026-27) Semester IV															
Course Code	Course Name	Credit Scheme				Teaching Scheme (Hours/Week)			Evaluation Scheme and Marks						
									FA		SA	TW	PR	OR	Total
		L	P	T	Total	L	P	T	FA1	FA2					
MIT34EL01	Dissertation Phase – II [Company/ In-house project]	-	20	-	20	-	40	-	-	-	-	250	-	250	500
Total		**-**	**20**	**-**	**20**	**-**	**40**	**-**	**-**	**-**	**-**	**250**	**-**	**250**	**500**

L-Lecture, **P**-Practical, **T**-Tutorial,**FA**–Formative Assessment,**SA**-Summative Assessment,**TW**-Term Work, **OR**-Oral, **PR**-Practical

LIST OF ELECTIVES

Semester I				
Sr. No.	**Course Code**	**Programme Elective –I**	**Course Code**	**Programme Elective –II**
1	**MIT31PE01A**	Deep Learning	**MIT31PE03A**	Advanced Data Visualization and Analytics
2	**MIT31PE01B**	Computer Vision and Video Processing	**MIT31PE03B**	Recommender System

Semester II				
Sr. No.	**Course Code**	**Programme Elective –III**	**Course Code**	**Programme Elective –IV**
1	**MIT32PE01A**	Natural Language Processing	**MIT32PE03A**	Big Data Technologies
2	**MIT32PE01B**	Generative AI	**MIT32PE03B**	Data Analytics and its Applications
			MIT32PE03C	Nature Inspired Algorithms

Course Syllabus

Semester-I

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	I
Course:	Data Science					Code:	MIT31PC01
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

Basic Mathematic, relational algebra

is essential

Course Objectives:

1. To introduce the fundamentals of Data Science.
2. To apply statistics and probability in different domains
3. To facilitate learning of data pre-processing.
4. To introduce plotting and visualization.
5. To explore data science in business

Course Outcomes:

1. After learning the course, the students will be able to:
2. Interpret the process of data science.
3. Apply statistics and probability methods to solve real-life problems.
4. Make use of pre-processing techniques for real-life data.
5. Select effective visualization techniques for given data.
6. Examine data science in business applications.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Introduction Defining data science and big data, Recognizing the different types of data, Machine Learning Definition and Relation with Data Science, Data Science Process: Data collection; Data preparation; Training a model on the data; Evaluation of the model performance; Data visualization techniques and inferences.	08
2	Statistics Describing a Single Set of Data, Correlation, Simpson's Paradox, Some Other Correlational Caveats, Correlation and Causation, Statistical Methods for Evaluation- Parametric and nonparametric Hypothesis testing, type 1 type 2 errors, Measure of Relationship: Covariance, Karl Pearson's Coefficient of Correlation.	08
3	Probability Theory Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial, Poisson, Normal Distribution, Hypergeometric Distributions, The Central Limit Theorem.	08

4	Data Pre-Processing Understanding the Data, Data cleaning, Data Reduction, Data Normalization, Data Transformation, Data Discretization, Importing and Exporting data, Turning categorical variables into quantitative variables, and Accessing Databases.	07
5	Data Visualization Basic principles, ideas, types, and tools for data visualization, Visualization of Numerical Data, Visualization of Non-Numerical Data, The Visualization Dashboard.	07
6	Data Science in Business Saving lives using Data Science, Establishing Data Science in Companies, Applications of Data Science, prerequisite to becoming a Data Scientist, Recruiting for Data Science, and Careers in Data Science.	07
	Total	45

Text Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2. Introduction to Probability and Statistics for Engineers and Scientists, S. Ross, 3rd Edition, Elsevier, 2004.
3. Data Mining: Concepts and Techniques, 3rd Edition. Jiawei Han, MichelineKamber, Jian Pei.

Reference Books:

1. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
2. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014, Cathy O'Neil and Rachel Schutt
3. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013, Foster Provost and Tom Fawcett.

E-resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs32/
2. https://www.coursera.org/specializations/introduction-data-science

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:		I	
Course:	Data Science Lab			Code:		MIT31PC03	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior Knowledge of:

1. Linear algebra, programming skills

is essential

Course Objectives:

1. To learn how to manipulate datasets using Python libraries.
2. To build a statistical and probability foundation to infer insights.
3. To apply data pre-processing techniques and interpret through various graphs.

Course Outcomes:

After learning the course, the students will be able to:

1. Apply appropriate pre-processing techniques to the datasets.
2. Analyze the data by using the hypothetical test.
3. Apply probability distributions to thedata.
4. Make use of various graphs to visualize the data using Python libraries.

Guidelines:

1. For each laboratory assignment, it is essential for students to write the title, aim, topic theory, algorithm, mathematical background, and data set description (as applicable).
2. Laboratory Journal- Program codes with sample output of all performed assignments are to be submitted as softcopy.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments (Use Python / MS Excel / Any Equivalent Platform)
1	Explore the dataset to understand its structure, and identify potential features. Perform basic data pre-processing steps such as handling missing values, outliers, and noise.
2	Write a Python script to find descriptive statistics on the datasets. a. Find the correlation matrix on the iris dataset. b. Plot the correlation plot on the dataset and visualize giving an overview of relationships among data on iris dataset.
3	Perform the following non-parametric hypothetical test for a single sample and related samples. Chi-square Test Wilcoxon Signed-Rank Test
4	Perform the following parametric hypothetical test for a single sample and related samples. 1)T test 2)ANOVA
5	Perform the following Discrete Probability Distributions on data. Discrete Distribution Binomial Distribution

	Poisson Distribution Hypergeometric Distribution
6	Perform the following Continuous Probability Distributions on data. Normal Distribution Uniform Distribution Weibull Distribution
7	Perform various Data Transformation and Error Correction techniques on the datasets.
8	Visualize the data using Python libraries matplotlib, seaborn by plotting the graphs.
9	Mini Project: Develop a case study on real-life problem using the Data Science paradigm.

Reference Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
3. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014, Cathy O'Neil and Rachel Schutt.

E-resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs32/

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			I
Course:	Artificial Intelligence and Machine Learning (AI & ML)			Code:			MIT31PC02
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

1. Basics of Data Structure and Algorithms
2. Basics of Linear Algebra

is essential

CourseObjectives:

This course aims at enabling students

1. To understand fundamental concepts of Artificial Intelligence and machine learning and their various algorithms.
2. To understand various strategies of generating models from data and evaluating them.
3. To apply ML algorithms on given data and interpret the results obtained.
4. To design appropriate ML solutions to solve real world problems in AI domain.

CourseOutcomes:

After learning the course, the students will be able to:

1. Interpret fundamental principles of Artificial Intelligence.
2. Apply Constraint Satisfaction and Game Theory algorithms.
3. Analyze different types of Regression and Classification techniques.
4. Apply and analyze appropriate clustering techniques and association rule mining.
5. Interpret different ensemble techniques.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Artificial Intelligence Introduction of AI, Intelligent Agents: Agents and Environments, Concept of Rationality, Types of Environment, Structure of Agents; Problem Solving by Search: State Space Search, Uninformed Search Strategies, Problem Solving Agents, Informed strategies: A* search, heuristic functions, hill-climbing.	09
2	Constraint Satisfaction and Game Theory Constraint Satisfaction Problems, Game Theory, Optimal Decisions in Games, Game playing, Adversarial search, Minimax algorithm, Alpha-beta pruning, Knowledge Representation and Reasoning	08
3	Data Pre-processing Machine Learning: Types of Machine Learning- Supervised, Unsupervised and Reinforcement Learning, Bias, Variance, Underfitting, Overfitting, Training, Testing, data pre-processing methods, Feature Selection and Extraction, Dimensionality reduction techniques- PCA	09

4	Regression and Classification Linear regression with one variable, Cost function, Target Function, Gradient Descent, Gradient Descent For Linear Regression, Linear Regression with Multiple Variables, Multiple Features, Gradient Descent for Multiple Variables. Need and applications of classification, Naïve Bayes Algorithm, K-Nearest Neighbors, Support Vector Machines, Decision Tree, Random Forest, Ensemble Learning, Bagging and Boosting.	10
5	Clustering and Association Rule Mining Need and applications of clustering, Partitioned methods, Hierarchical methods, Density based methods. Need and application of Association Rules learning, Basic concepts, Apriori Algorithm, FP-Growth, Performance Measures – Support and Confidence.	09
	Total	45

Text Books:

1. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall
2. E. Alpaydin, “Introduction to Machine Learning”, PHI, 2005.
3. Mitchell M., T., Machine Learning, McGraw Hill (1997) 1st Edition.

Reference Books:

1. Andreas Muller and Sarah Guido, ”Introduction to Machine Learning with Python: A Guide for Data Scientists”, Shroff/O’Reilly, 2016
2. AurolienGeron, ”Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O’Reilly”, 2017

E-sources:

1. NPTEL Artificial Intelligence : Search Methods For Problem solving https://onlinecourses.nptel.ac.in/noc22_cs67/preview
2. NPTEL Introduction to Machine Learning: https://onlinecourses.nptel.ac.in/noc24_cs51/preview
3. NPTEL Machine Learning, ML: https://onlinecourses.nptel.ac.in/noc24_cs60/preview

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			I
Course:	AI & ML Lab			Code:			MIT31PC04
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:

1 Basics of Data Structure and Algorithms
2. Basics of Linear Algebra

is essential

Course Objectives:

This course will enable students

1 Make use of Data sets in implementing the machine learning algorithms.
2 Implement the machine learning concepts and algorithms in any suitable language of choice.

CourseOutcomes:

After learning the course, the students will be able to:

1 Apply AI algorithms in problem solving.
2 Develop a model using classification, regression and clustering algorithms.
3 Implement different ensemble methods to build real-life problems.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Implement Informed Search algorithm for real life problems.
2.	Implementation of games (any one): 8 puzzle, Tic-Tac-Toe, tower of Hanoi, water jug problems.
3.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs.
4.	Write a program to demonstrate the working of the decision tree based ID3 algorithm.
5.	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier.
6.	Write a program to demonstrate the working of the DBSCAN/CURE/BIRCH algorithm. Use an appropriate data set.
7.	Implement K-Means Clustering algorithm.
8.	Implement ensemble methods using Random Forest or AdaBoost Algorithm.

Reference Books:

1 George F Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Edu., 4th Edition.
2 Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.
3 E. Alpaydin, “Introduction to Machine Learning”, PHI, 2005.
4 AurolienGeron, ”Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O’Reilly”, 2017

E-resources:

1. NPTEL Artificial Intelligence : Search Methods For Problem solving
   https://onlinecourses.nptel.ac.in/noc22_cs67/preview
2. https://ds1-iiith.vlabs.ac.in/exp/depth-first-search/index.html
3. https://ds1-iiith.vlabs.ac.in/exp/breadth-first-search/index.html

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	I
Course:	Deep Learning					Code:	MIT31PE01A
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior Knowledge of

1. Basics of Machine Learning

is essential.

Course Objectives:

1. To get acquainted with deep neural networks.
2. To understand the role of optimization on deep learning models.

Course Outcomes:

After learning the course, the students will be able to:

1. Build Feed Forward Neural Networks.
2. Apply Convolution Neural Networks to build deep learning models.
3. Make Use of Recurrent Neural Networks for building deep learning models.
4. Analyze the enhanced accuracy/performance of Pre-trained Transformers.
5. Demonstrate the Generative Adversarial Networks

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	**Neural Networks and Deep Learning** Neuron, Perceptron as Neurons, Neural Network, Feed Forward Neural Networks, Underfitting, Overfitting, Bias, Variance, Supervised Learning, Unsupervised Learning,Binary Classification, Logistic Regression, Activation Function- Sigmoid,Tanh, Relu, Softmax, Derivatives, Gradient Descent, Stochastic GD, Back-Propagation, HyperparameterTunning, Regularization,L2 regularization, Training, Testing and Validation set, K-fold cross validation, Ensemble methods, Dropout, Building Model	09
2	**Convolution Neural Networks** Convolution Neural Networks, Foundational layers of CNN, Convolution Network Architecture, Convolution Layers, Pooling Layers, Filters and Feature Maps, Shortcomings of Feature Selection, Scaling Problem in Vanilla Deep Neural Networks.	09
3	**Recurrent Neural Networks** Sequence Modeling: Recurrent Neural Networks (RNNs), Bidirectional RNNs, Encoder, Decoder, Sequence-to-Sequence Modeling, Analyzing Variable	09

	Length Inputs, Deep Recurrent Network, Recursive Neural Networks and Echo State networks, LSTMs, Bidirectional RNN.	
4	**Pre-Trained Models** Self-Supervised Pretraining, AlexNet, VGG, NiN, GoogleNet, Residual Network (ResNet), DenseNet, Region-Based CNNs (R-CNNs) – Transfer Learning - FSL	09
5	**Advanced Neural Networks** Generative Adversarial Networks – Generator, Discriminator, Training, Autoencoder: Architecture, Denoising and Sparcity; DALL-E, DALL-E 2 and IMAGEN.	09
	Total	**45**

Text Books:

1. Ian Goodfellow, YoshuaBengio, and Aaron Courville. "Deep learning." MIT press, 201.
2. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
3. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, Amazon Senior Scientists, “Dive into Deep Learning”.

Reference Books:

1. Nikhil Buduma and Nicholas Locasio,” Fundamentals of Deep Learning”, O-Reilly, 2017r
2. Josh Patterson, Adam Gibson, “Deep Learning: A Practitioner's Approach”, O‟REILLY, SPD, ISBN: 978-93-5213- 604-9, 2017 Edition 1st
3. Tom Mitchell “Machine Learning” McGraw Hill Publication, ISBN : 0070428077 9780070428072

E-resources:

1. https://onlinecourses.nptel.ac.in/noc20_cs62/
2. https://www.coursera.org/learn/neural-networks-deep-learning/

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:		I
Course:	Deep Learning Lab				Code:		MIT31PE02A
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior Knowledge of:
Machine Learning, programming skills
is essential

Course Objectives:

1. To understand deep neural network frameworks and learn to implement them.
2. To learn to use pre-trained models effectively and use them to build potential solutions.

Course Outcomes:

After learning the course, the students will be able to:

1. Build and evaluate deep learning models using artificial neural network (ANN) and convolution neural network (CNN).
2. Create novel applications of deep learning using recurrent neural network (RNN) and LSTM.
3. Build and evaluate mini project using deep learning concepts and evaluate its performance.

Guidelines:

1. For each laboratory assignment, it is essential for students to write the title, aim, topic theory, algorithm, mathematical background, and data set description (as applicable).
2. Laboratory Journal- Program codes with sample output of all performed assignments are to be submitted as softcopy.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Python Primer Revisiting Data Preprocessing Setting up Deep-Learning workstations Working with different data types and file formats
2.	Classification Tasks Train a Deep learning model to classify input images using a pre-trained model.
4.	Train a CNN model from scratch i) Tune the hyperparameters and visualize filters ii) Fine tune a pre-trained model for any real world applications Object detection using Convolution Neural Network.
5.	Perform Sentiment Analysis in network graph using RNN/Text Generation Using LSTM
6.	Develop and Evaluate the performance of a mini project ` Use the concept CNN/RNN/Residual neural network/Transfer Learning/BERT/ Generative Adversarial Networks

Reference Books:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O'Reilly.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer
3. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014, Cathy O'Neil and Rachel Schutt.

E-resources:

https://onlinecourses.nptel.ac.in/noc22_cs32/

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	I
Course:	Computer Vision and Video Processing					Code:	MIT31PE01B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:
Computer Fundamentals
is essential

Course Objectives:
This course aims at enabling students
1. To comprehend the digital image fundamentals
2. To comprehend analog and digital videos
3. To demonstrate video processing basics

Course Outcomes:
After learning the course, the students will be able to:
1. Illustrate the image fundamentals and its perception
2. Categorize analog and digital video processing
3. Extend video segmentation for video applications
4. Analyze the video processing applications

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Digital Image Fundamentals A Simple Image Formation Model, Image sampling and quantization, Monocular imaging system, Orthographic & Perspective Projection, Mathematical Tools Used in Digital Image Processing, Cameras – lenses, projections, sensors, Representation – color spaces.	09
2	Image Perception Visibility Function, Monochrome Vision Model, color representation, color Matching and Reproduction, color coordinate System, color vision model, Temporal properties of Vision	09
3	Introduction to Video Processing Digital video processing, Analog Video, Digital Video, Digital video standards, Digital Video Applications- digital Television, Digital Cinema, Video Streaming over Internet, Computer Vision Scene/Activity	09
4	Video Segmentation and Tracking Image Segmentation, Change Detection, Motion Segmentation, Motion Tracking, Video Segmentation, challenges and limitations of video segmentation, application of Video Segmentation	09
5	Video Processing Applications Content Based Video retrieval (CBVR), Video Surveillance, Traffic Monitoring, Intelligent Transport System, Human Action Recognition Self Study- A case study on Pattern Recognition	09
	Total	45

Text Books: 1. Gonzalez, Rafael C, Woods, Richard E, “Digital Image Processing”, 3rd edition, Harlow: Pearson Prentice Hall 2. Jain K. Anil, “Fundamentals of Digital Image Processing”, Prentice Hall Information and System Sciences Series
Reference Books: 1. Tekalp Murat A, “Digital Video Processing” 2nd Edition, Prentice Hall. 2. Richard Szeliski , “Computer Vision: Algorithms and Applications”, 2nd Edition, @2022 Springer.
E-sources: 1. Computer Vision, https://nptel.ac.in/courses/106105216 2. Computer vision and Image Processing https://nptel.ac.in/courses/108103174

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			I
Course:	Computer Vision and Video Processing Lab			Code:			MIT31PE02B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:

1 Programming and Problem Solving

is essential

Course Objectives:

This course will enable students to:

2 To understand Image Processing and Computer vision

3 To learn computer Vision Processing Tools

Course Outcomes:

After learning the course, the students will be able to:

1 Install and configure video processing tools

2 Distinguish between image and video processing through tools

3 Develop video applications for real life situations.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Practice Open Source Tools for Image Processing and Computer Vision - OpenCV, OpenGL
2.	Read Video frames from an input video and applying Image Morphology Operations on extracted frame
4.	Read a video, extract visual frames and apply point processing techniques on extracted visual frames and create a new modified video.
5.	Perform color image segmentation using HSV/YUV/CMY or any suitable color space.
6.	Train simple object detection and tracking model to identify and count helmets from a traffic video.
7.	Write a program to demonstrate generation of large number of slightly varying objects with bindless rendering in Open GL.
8.	Real Life case study/mini-project in domain of Computer Vision and Video processing

Reference Books:

1. González, R.C.; Woods, R.E. Digital image processing. 3rd ed, Harlow: Pearson Prentice Hall
2. A. Jain, Fundamentals of Digital Image Processing. Information and System Sciences Series, Prentice Hall
3. Yao Wang, JornOstermann, Ya-Qin Zhang, 'Video Processing and Communications', Prentice
4. David A. Forsyth and Jean Ponce: Computer vision: A modern approach, Prentice Hall
5. A. Bovik (Ed.), The Essential Guide to Video Processing. Academic Press

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:	I		
Course:	Advanced Data Visualization and Analytics				Code:	MIT31PE03A		
Credits	Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial		FA		SA	Total
					FA1	FA2		
03	03	-	-		20	20	60	100

Prior knowledge of:

1. Basics of Machine Learning
2. Python Programming Language
3. Basics of Probability

is essential

Course Objectives:

1. This course will provide knowledge on visualization design principles and deciding the type of visualization chart to choose for the given sets
2. This course will teach on creating simple to advanced chart types using python modules and libraries.
3. This course will explore, visualize and analyze various types of data sets such as time series,
4. Geospatial and multimodal data.
5. This course helps the students to work on visualization tools and enable the students to understand the visual analytics such as dashboards and storytelling with a hands-on tutorial on tableau and PowerBI.

Course Outcomes:

After learning the course, the students will be able to:

1. Explain the importance of Data Visualization
2. Describe how to create basic charts by applying visualization design principles
3. Interpret the advanced visualization of time series data
4. Explore and Analyze Time series, Geospatial and multimodal data
5. Build interactive/animated dashboards and construct data stories.
6. Summarize important trends/patterns in the datasets

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Overview of Data Visualization Importance and benefits of good data visualization– Design principles - Introduction to python libraries for visualization: seaborn, plotly express, pygal Exploring Data – Reduce Items and Attributes: Filter and Aggregate.	09
2	Creation of basic visualization Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts. Creation of Advanced Visualization: Heat Map– Facet Grid – Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees	10

3	Visualization of Time series data Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data.	09
4	Visualization of Geospatial data Spatial join - overlapping geospatial data to maps and adding special cues - Case Study-Visualization of multimodal data and analysis-case study sensor data and health care, genome and biomedical data.	08
5	Business Analytics and Visualization Tools Tableau, PowerBI, Creating Interactive Dashboards and charts to organize data using visualization principles, Data Storytelling	09
	Total	45

Text Books:

1. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.
2. Scott Murray, Interactive Data Visualization for the Web, O'Reilly, 2013.
3. Vander Plas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc",2016

Reference Books:

1. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012
2. Nathan Yau, Visualize This: The Flowing Data Guide to Design, Visualization and Statistics, John Wiley & Sons, 2011.

E-sources:

1. https://www.coursera.org/learn/advanced-data-visualization-with-tableau-public
2. https://onlinecourses.nptel.ac.in/noc21_cs45/preview

Program:	M. Tech. Artificial Intelligence and Data Science				Semester:		I
Course:	Advanced Data Visualization and Analytics Lab				Code:		MIT31PE04A
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:

1. Basics of Machine Learning
2. Python Programming Language

is essential.

Course Objectives:

This course will enable students

1. To learn visual analytics with a hands-on tutorial using Tableau, a leading self-service data visualization tool.
2. Learn to create effective charts and interactive dashboards.

Course Outcomes:

After learning the course, the students will be able to:

1. Describe the main concepts of data visualization
2. Create ad-hoc reports, data visualizations, and dashboards using Tableau Desktop
3. Publish the created visualizations to Tableau Server and Tableau Public.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Implement basic data visualization plots: Line plots, Area plots, Histograms, Bar charts, Pie charts, Box plots, Scatter plots
2.	Perform various visualization operations on data in Tableau.
3.	Implement binning visualizations for any real time dataset, Implement linear regression techniques.
4.	Visualize the clusters for any synthetic dataset, Implement the program for converting the clusters into histograms.
5.	Write a program to implement agglomerative clustering technique, write a program to implement divisive hierarchical clustering technique.

Reference Books:

1. Visualization Analysis & Design by Tamara Munzner (2014) (ISBN 9781466508910)
2. VanderPlas J. Python data science handbook: essential tools for working with data O'Reilly Media. Inc",2016
3. Practical Tableau: 100 Tips, Tutorials, and Strategies from a Tableau Zen Master, Ryan Sleeper, Oreilly Publications, 2018
4. Data Visualization with R: 111 Examples by Thomas Rahlf, Springer, 2020

E-sources:

1. https://www.coursera.org/learn/advanced-data-visualization-with-tableau-public
2. https://onlinecourses.nptel.ac.in/noc21_cs45/preview

Program:	M. Tech. Artificial Intelligence and Data Science					Semester:	I
Course:	Recommender System					Code:	MIT31PE03B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	--	--	20	20	60	100

Prior knowledge of:

1. Linear Algebra
2. Machine Learning

is essential

Course Objectives:

1. Understand the basics of information retrieval and recommender system.
2. Introduce the techniques for collaborative filtering and content-based recommendation.
3. Impart the knowledge on design approaches for hybrid recommendation system.
4. Evaluate the recommender system to provide quality recommendation.
5. Learn the recent developments of recommender systems.

Course Outcomes:

After learning the course, students will be able to:

1. Explain the concept of information retrieval and recommender systems.
2. Apply the techniques for collaborative filtering
3. Apply the techniques of content-based recommendation system
4. Analyze the hybrid approaches of recommendation system
5. Evaluate the recommendation system to provide quality recommendation
6. Identify the recent developments of recommender systems

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Introduction Introduction: Overview of Information Retrieval, Retrieval Models, Relevance Feedback, User Profiles, Understanding ratings, Matrix Operations, Recommender system functions, Variance - Covariance matrix, Applications of recommendation systems, Issues with recommender system	08
2	Collaborative Filtering Collaborative Filtering: User-based nearest neighbor recommendation, Item-based nearest Neighbor recommendation, Model based and pre-processing based approaches, Attacks on collaborative recommender systems.	08

3	Content-based recommendation Content-based recommendation: High level architecture of content-based systems, Content Representation and Content Similarity, Similarity based retrieval, Classification algorithms, Advantages and drawbacks of content based filtering, Knowledge based recommendation: Knowledge representation and reasoning, Constraint based recommenders, Case based recommenders.	08
4	Hybrid approaches Hybrid approaches: Opportunities for hybridization, Hybridization design: Monolithic - Feature combination, Feature augmentation, Parallelized hybridization design - Weighted, Switching, Mixed, Pipelined hybridization design - Cascade, Meta-level, Limitations of hybridization	08
5	Evaluation Evaluating Recommender System: Introduction, General properties of evaluation research, Evaluation designs, Evaluation on historical datasets, Error metrics, Decision-Support metrics, User-Centered metrics	07
6	Recent Developments of Recommender Systems Recommender Systems and communities: Communities, collaboration and recommender systems in personalized web search, Social tagging recommender systems, Trust and recommendations, Group recommender system	06
	Total	45

Text Books:

1. Jannach D., Zanker M., FelFering A., Friedrich G., "Recommender Systems: An Introduction", CambridgeUniversity Press(2011), Illustrated ed.
2. Ricci F., Rokach L., Shapira D., "Recommender Systems Handbook", Springer-Verlag New York Inc (2016), 2nd ed.

Reference Books:

1. Manouselis N., Drachsler H., Verbert K., Santos O., "Recommender Systems for Technology Enhanced Learning", Springer-Verlag New York Inc (2016), 1st ed.
2. RounakBanik, " Hands-On Recommendation Systems with Python: Start building powerful and personalized recommendation engines with Python", Packt Publishing (2018), 1st Ed.

E-resources:

1. https://charuaggarwal.net/Recommender-Systems.pdf

Program:	M. Tech. Artificial Intelligence and Data Science				Semester:	I	
Course:	Recommender System Lab				Code:	MIT31PE04B	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	--	04	--	50	50	--	100

Prior knowledge of:

1. Python
2. TensorFlow

is essential

Course Objectives:

1. To learn and understand collaborative filtering.
2. To learn and understand content-based recommendation.
3. Understand the hybrid approaches.
4. Evaluate the recommender system.

Course Outcomes:

After learning the course, students will be able to:

1. Design and apply collaborative filtering
2. Design and apply content-based recommendation techniques.
3. Design and apply hybrid approaches for recommendation.
4. Evaluate the recommender system in terms of accuracy.

Guidelines:

1. Use appropriate standard data set to perform following practicals.
2. Perform suggested assignments using Python and TensorFlow.
3. Prepare a Laboratory Journal contains essential theory, program code and sample outputs.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1	Demonstrate collaborative filtering to recommend items (e. g. movies) to the user using standard appropriate data set.
2	Demonstrate content-based recommendation to recommend items (e.g. books) to the user using standard appropriate data set.
3	Demonstrate hybrid approach recommendation to provide personalized recommendation to the user using standard appropriate data set.
4	Evaluate the recommender system on historical data in terms of accuracy of prediction and accuracy of classification.
5	Case Study : Recommender systems in personalized web search
6	Case Study: Social tagging recommender systems

Reference Books:

1. Jannach D., Zanker M., FelFering A., Friedrich G., “Recommender Systems: An Introduction”, CambridgeUniversity Press(2011), Illustrated ed.
2. Ricci F., Rokach L., Shapira D., “Recommender Systems Handbook”, Springer-Verlag New York Inc (2016), 2nd ed.
3. Manouselis N., Drachsler H., Verbert K., Santos O., “Recommender Systems for Technology Enhanced Learning”, Springer-Verlag New York Inc (2016), 1st ed.
4. RounakBanik, " Hands-On Recommendation Systems with Python: Start building powerful and personalized, recommendation engines with Python", Packt Publishing (2018), 1st Ed.

E-resources:

1. https://charuaggarwal.net/Recommender-Systems.pdf

Course Syllabus

Semester-II

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Research Methodology & IPR					Code:	MIT32PC01
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
02	02	-	-	20	-	30	50

Prior knowledge of:
1.Probability theory, Statistics
is essential

Course Objectives:

This course aims at enabling students

1. To select and define appropriate research problems with appropriate methodology.
2. To apply statistical techniques to make predictions and decisions for the data set using open-source software.
3. To formulate mathematical model and write a research paper using systematic approach.
4. To understand fundamental aspects of Intellectual Property Rights

Course Outcomes:

After learning the course, the students will be able to:

1. Apply appropriate research methodology to define a research problem.
2. Formulate a mathematical model for the chosen problem statement.
3. Build capability to analyze and synthesize research findings to draft a research report.
4. Demonstrate a capacity to identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Research Problem and Research Design Objectives, Motivation, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Criteria of Good Research, Definition and Feasibility study of research problem, Sources of research problem,Meaning of Hypothesis, Characteristics of Hypothesis, Errors in selecting a research problem, Concept & need of research design.	07
2	Mathematical Modeling and prediction of performance Types of Modeling, Types of solutions to mathematical models, Steps in Setting up a computer model to predict performance of experimental system, Validation of results, Multi-scale modeling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Sensitivity analysis.	08

3	Research Report writing and Publication Research Report: Dissemination of research findings, outline and structure of research report, different steps and precautions while writing research report, methods and significance of referencing. Publishing Research work: Selection of suitable journal for publishing research work, Open access Vs Subscription Journals, Identifying indexing of selected journals, Impact factor of the journal, structure of research paper, Check for plagiarism of the article, Research paper submission and review process.	08
4	Intellectual property Rights Definition of IPR, Classification of IP, Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents. Prior Art Search, Patentability Criteria, Patent Filing Procedure, Forms and Fees, Case Study of Patent, Copyright.	07
	Total	30

Text Books:

1. Dr. C. R.Kothari , "Research Methodology: Methods and Trends", New Age International, 2nd Edition, 1985
2. RanjitKumar , "Research Methodology: A Step by Step Guide for Beginners", 2ndEdition, 2010.

Reference Books:

1. Stuart Melville and WayneGoddard, "Research Methodology: An Introduction for Science & Engineering students"
2. Dr. S.D. Sharma, " Operational Research", KedarNath Ram Nath&Co.
3. Wayne Goddard and Stuart Melville, Research Methodology: An Introduction, Juta and Company Ltd, 2004
4. Ramkrishna B, Anil Kumar H S, "Fundamentals of IPR", NotionPress, 2016
5. Virendra Kumar Ahuja, Lexis NexisButterworths , "IPR in India",WadhwaNagpur

E-sources:

1. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Natural Language Processing					Code:	MIT32PE01A
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

1 Basics of Machine Learning, Python Programming Language, Basics of Probability **is essential**

Course Objectives:

This course aims at enabling students

1. Understand leading trends and systems in natural language processing.
2. Describe concepts of morphology, syntax, semantics and pragmatics of the language.
3. Understand language models and their evaluation.

Course Outcomes:

After learning the course, the students will be able to:

1. Discover the processes and representations used in syntax, semantics, and other components of natural language processing.
2. Determine the models used for word/sentence representations for various NLP applications.
3. Analyze machine learning and deep learning algorithms for natural language processing applications.
4. Compare and apply the different feature extraction and embedding processes for text documents.
5. Choose the appropriate tools for performing text analytics in a variety of contexts.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Natural Language Processing Techniques: Terminologies, tokenization, stemming, word and sentence segmentation, part-of-speech tagging, chunking, syntax parsing, dependency parsing, and word-sense disambiguation.	08
2	Text Representations and Embeddings: One-hot encoding, Word embeddings, Bag-of-Words (BoW) Dictionary,Term Frequency – Inverse Document Frequency (TF IDF), N-gram. Named Entity Recognition, Sentiment analysis, Text summarization, Text categorization and Logistic Regression.	09
3	Deep learning and language Machine learning methods for NLP: perceptron, support vector machines, memory-based learning. Vector representations of language, architecture of deep learning, Spatial and temporal filtering CNN and RNN. Question answering with sequential models such as RNNs, LSTMs, and end-to-end memory networks. Transformers.	10

4	Feature Extraction and Text Embeddings One-Word Learning Architecture, Word2Vec Continuous BOW and Skip-gram Models), Doc2Vec, Reduction of Complexity, sub-sampling and Negative Sampling. Embedding by direct computation, learning to embed (procedural embeddings, textual similarity, GloVe, BERT, and XLNet.	09
5	Applications and Case Studies: Latent Semantic Analysis (LSA), Latent Dirichlet Allocation (LDA), NLP toolkits such as nltk, Spacy, Chatbots, Gensim, ChatGPT, Hugging Face Transformers, PyTorch, Rasa, etc. Use Case: Create a new sales channel through an AI assistant built with Rasa	09
	Total	45

Text Books:

1. Stephan Raaijmakers, “Deep Learning for Natural Language Processing," Manning Publications, 2022.
2. SowmyaVajjala, BodhisattwaMajumder, Anuj Gupta, and HarshitSurana, “Practical Natural Language Processing”, O'Reilly Media, Inc., Grayscale Indian Edition, 2020
3. SohomGhosh and Dwight Gunning, “Natural Language Processing Fundamentals, publishing, 1st Edition, 2019.
4. James Allen, “Natural Language Processing with Python”, O’Reilly Media, July 2009

Reference Books:

1. Daniel Jurafsky and James H. Martin ”Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition,” ,Prentice Hall PTR, 2000.
2. Jacob Perkins, ”Python 3 text processing with NLTK 3 cookbook,” Packt Publishing Ltd, 2014.
3. Ian Goodfellow, YoshuaBengio, and Aaron Courville, Deep Learning, MIT Press, 2016
4. C.D. Manning et al, “Foundations of Statistical Natural Language Processing,” MitPress. MIT Press, 1999.

E-sources:

1. https://www.mygreatlearning.com/academy/learn-for-free/courses/introduction-to-natural-language-processing
2. https://www.coursera.org/specializations/natural-language-processing
3. https://onlinecourses.nptel.ac.in/noc23_cs45

Program:	M. Tech. Artificial Intelligence and Data Science				Semester:	II	
Course:	Natural Language Processing Lab				Code:	MIT32PE02A	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:
Python / R programming
is essential

Course Objectives:
This course will enable students

1. To provide practical knowledge of language processing that involves various operations that can be performed on text data.
2. To become familiar with fundamental topics in language processing that include tokenization,
   stemming, tagging, classification, and information extraction using Python programs.
3. To perform NLP operations on existing corpora and build simple AI Applications

Course Outcomes:
After learning the course, the students will be able to:

1. Apply the concept of natural language processing (NLP) using tools.
2. Evaluate text corpora with tokenization, stemming, lemmatization, POS tagging, and apply visualization techniques.
3. Develop applications using natural language processing concepts

Guidelines:

1. Continuous assessment of laboratory work should be based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.
2. Mini project assessment will be based on parameters such as Understanding of Project Topic, Implementation, Demonstration and Team Work.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Perform preprocessing such as tokenization, stemming, and lemmatization of the data.
2.	Implement automatic, N-gram and Transformation based tagging for text data.
3.	Implement Part of Speech (POS) tagging.
4.	Write a program to demonstrate Mapping Words to Properties Using Python Dictionaries.
5.	Use a simple method to classify positive or negative sentiment in tweets

6.	Write a simple English-to-French translation algorithm using pre-computed word embeddings and locality sensitive hashing to relate words via approximate k-nearest neighbors search
7.	Write your own Word2Vec model that uses a neural network to compute word embeddings using a continuous bag-of-words model
8.	Train a neural network with GLoVe word embeddings to perform sentiment analysis of tweets
9.	Translate complete English sentences into French using an encoder/decoder attention model
10.	Build a transformer model to summarize text.
11.	Use T5 and BERT models to perform question answering.
12.	Classification of product reviews on ecommerce websites.
13.	Mini Project: One real life natural language application to be implemented. (Use standard dataset available on the web.)

Reference Books:

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2nd Edition, Pearson Education, 2009.
2. NitinIndurkhya and Fred J. Damerau, Handbook of Natural Language Processing, 2ndEdition, Chapman and Hall/CRC Press, 2010.
3. TanveerSiddiqui, U.S. Tiwary, Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
4. NitinHardaniya, Jacob Perkins, Natural Language Processing: Python and NLTK, Packt Publishers,2016

E-resources:

https://nlp-iiith.vlabs.ac.in
https://www.mygreatlearning.com/academy/learn-for-free/courses/introduction-to-natural-language-processing
https://www.coursera.org/specializations/natural-language-processing

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Generative AI					Code:	MIT32PE01B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

1. Basics of Machine Learning
2. Deep Learning Basics

is essential.

Course Objectives:

This course aims at enabling students

1. Investigate language models, distinguishing between traditional and deep learning-based approaches, examining parameters, and exploring multimodal learning.
2. Analyze various Generative AI frameworks, including GPT, LLaMA, LaMDA, PaLM, and associated evaluation metrics.

Course Outcomes:

After learning the course, the students will be able to:

1. Evaluate Generative AI basics and ethical concerns.
2. Determine the significance of language model components.
3. Evaluate image generation techniques and Contrastive Language-Image Pre-Training.
4. Analyze prompt design strategies, and simplify prompt evaluation in various contexts.
5. Determine the societal implications of Generative AI.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Generative AI Introduction to Generative AI, Definition and scope of Generative AI, Overview of generative models and their applications, Importance of Generative AI in various domains, ethical considerations and challenges Introduction to language models and their role in AI Traditional, approaches to language modeling Deep learning-based language models and their advantages.	08
2	Large Language Models Weight, Bias and Parameters of Language Models, , Multimodal Learning and Embeddings, Memory and Efficiency Optimization, GPT, LLaMA, LaMDA, PaLM, Gemini, Falcon, BLOOM, Zero-shot and Few-shot Learning, Evaluation Metrics for LLMs, Generative AI and LLM Frameworks.	10
3	Image Generative Models: Autoencoder and its Variants, Style Transfer and Image Transformation, Latent Diffusion Model, Stable Diffusion, DALL.E, Contrastive Language-Image Pre-Training (CLIP), Attention Mechanisms in Image Generation, Hierarchical Text-Conditional Image Generation with CLIP	09

4	Prompt Engineering: Prompt Design Strategies, Task Formulation in Prompts, Prompt Patterns, Prompt Tuning Techniques, Fine-tuning Prompts for Specific Tasks, domain-specific Prompt Engineering, Dynamic and Adaptive Prompting, Zero-shot learning, Chain-of-thought, Self-consistency, Evaluating Prompt Performance	08
5	Security, Ethics and Bias in Generative AI Deepfakes and Misinformation, Privacy and Data Security, Privacy-Preserving Generative Models, Explainability and Transparency, Bias Detection and Mitigatio, Impact of Generative AI on Society, Accountability and Responsibility.	10
	Total	45

Text Books:

1. "GANs in Action: Deep learning with Generative Adversarial Networks" by JakubLangr and Vladimir Bok, published in 2019.
2. "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster, published in 2019.

Reference Books:

1. "Advanced Deep Learning with Keras: Apply deep learning techniques, autoencoders, GANs, variationalautoencoders, deep reinforcement learning, policy gradients, and more" by Rowel Atienza, published in 2018.
2. "Learning Generative Adversarial Networks: Next-generation deep learning simplified by KuntalGanguly, published in 2017.

E-sources:

1. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:		II
Course:	Generative AI Lab.				Code:		MIT32PE02B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
04	-	04	-	50	50	-	100

Prior knowledge of:

1. Basics of Machine Learning

is essential.

Course Objectives:

This course will enable students

1. Explore and utilize generative AI tools, learning hands-on ways to integrate them into daily routines through crafting text prompts for diverse tasks.

Course Outcomes:

After learning the course, the students will be able to:

1. Implement proficient generative AI techniques for practical applications, selecting suitable methodologies for effective execution.
2. Evaluate experimental results rigorously to assess generative model performance, supporting conclusions with thorough analysis and comparison.
3. Create novel applications of generative AI to address real-world challenges, justifying approach selections based on potential impact and feasibility.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Develop a basic Generative Adversarial Network (GAN) from scratch using TensorFlow or PyTorch. Experiment with different architectures, loss functions, and training strategies. Evaluate the model's performance on a dataset of your choice..
2.	Explore state-of-the-art transformer-based models such as GPT (Generative Pre-trained Transformer) for text generation tasks. Fine-tune a pre-trained language model on a specific dataset and evaluate its ability to generate coherent and contextually relevant text
3.	Investigate image-to-image translation techniques using conditional GANs or other generative models. Implement a model capable of translating images from one domain to another, such as converting satellite images to maps or day scenes to night scenes.
4.	Implement a style transfer model using convolutional neural networks (CNNs) and experiment with different style and content images.
5.	Explore conditional generative models for image generation tasks. Implement a conditional GAN or VAE capable of generating images conditioned on additional information, such as class labels or textual descriptions

6.	Research generative models for anomaly detection, such as VAEs or GANs. Develop a model capable of identifying anomalies in complex datasets, such as medical images or network traffic.
7.	Study recurrent neural networks (RNNs) for music generation. Develop a model capable of generating musical sequences in a specific genre or style, considering factors such as melody, harmony, and rhythm.
8.	Investigate recurrent generative models for video generation tasks. Implement a model capable of generating realistic video sequences frame by frame, considering factors like temporal coherence and consistency.
9.	Investigate the use of generative adversarial networks for improving the robustness of machine learning models against adversarial attacks. Develop a defense mechanism based on generative adversarial training and evaluate its effectiveness against various attack strategies
10.	Explore the ethical implications of generative AI technologies, including issues related to privacy, bias, and misuse. Write a critical analysis paper discussing ethical considerations and proposing guidelines for responsible development and deployment of generative AI systems
11.	Explore generative models for 3D object generation. Implement a model capable of generating three-dimensional objects from scratch or from partial inputs, leveraging techniques such as 3D-GANs or voxel-based methods.
12.	Mini Project Based on GAN concepts

Text Books:

1. "GANs in Action: Deep learning with Generative Adversarial Networks" by JakubLangr and Vladimir Bok, published in 2019.
2. "Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play" by David Foster, published in 2019.

Reference Books:

1. "Advanced Deep Learning with Keras: Apply deep learning techniques, autoencoders, GANs, variationalautoencoders, deep reinforcement learning, policy gradients, and more" by Rowel Atienza, published in 2018
2. "Learning Generative Adversarial Networks: Next-generation deep learning simplified by KuntalGanguly, published in 2017.

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Big Data Technologies					Code:	MIT32PE03A
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

1. Probability theory, Statistics, Python/R

is essential

Course Objectives:

This course aims at enabling students

1. To interpret the big data concepts and big data analytics lifecycle.
2. Make use of the big data analytics technologies.
3. To apply big data visualization tools and techniques.
4. To get acquainted with advancements in tools and techniques used for big data analytics.

Course Outcomes:

After learning the course, the students will be able to:

1. Apply the big data analytics life cycle to solve real life problem.
2. Make use of various technologies for the big data analytics
3. Analyze the use of Hadoop and its ecosystem elements.
4. Apply different programming platforms for big data analytics.
5. Analyze big data applications using different data visualization tools.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Technologies for Big Data Analytics Big data characteristics, architectures, Data analysis process, Data analytics lifecycle, Distributed and Parallel Computing for Big Data, Cloud Computing and Big Data, In-Memory Computing Technology for Big Data, Introduction to Hadoop, HDFS, MapReduce, YARN, HBase, Combining HDFS and HBase Case Study: Using MapReduce to scale algorithms for Big Data analytics.	09
2	Hadoop Ecosystem for Big Data Analytics Hadoop ecosystem: Sqoop, Impala, Apache Flume, Pig, Hive, Data transformation and analysis using Pig, Data analysis using Hive and Impala, Mahout, Oozie, Zookeeper etc. Case Study: Sentiment analysis	09
3	Big Data Analytics with Apache Spark Apache Spark, Spark core, Interactive data analysis with spark shell, Writing a spark application, Spark RDD Optimization Techniques, Spark Algorithm, Spark SQL Case Study: Big data for maintaining HER: healthcare records.	09

4	Programming Languages for Big Data Analytics Big data analytics with PySpark: Python and Apache Spark Big data analytics with RHadoop: R and Hadoop, Text mining in RHadoop, Data mining in Hive, Data Analysis MapReduce techniques using RHadoop Case Study : Cloudera platform: western union bank	09
5	Visualization Techniques and Tools For Big Data Visualizing Big Data, Importance of data visualization, Challenges, Need for advanced visualization techniques, Tools used in data visualization, Big Data Visualization with R/Python/Tableau/other tools Case Studies (if any) Industrial Big Data Visualization: A Case Study Using Flight Data Recordings.	09
	Total	45

Text Books:

1. DT Editorial Services, *Big Data: Black Book*, 2016 Edition, Dreamtech Press, 2016.
2. Tom White, *Hadoop: The Definitive Guide*, Fourth Editon, O'reily Media, 2015

Reference Books:

1. SeemaAcharya, SubhasiniChellappan, *Big Data Analytics*, Second Edition, Wiley India Pvt. Ltd, 2019.
2. Alex Holmes, *Hadoop in practice*, Second Edition, Dreamtech press, 2014.

E-sources:

1. Big Data Complete Course: https://www.udemy.com/course/big-data-complete-course
2. Big Data Hadoop Course: https://intellipaat.com/big-data-hadoop-training
3. Big Data Computing: https://onlinecourses.nptel.ac.in/noc21_cs86/preview

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:	II	
Course:	Big Data Technology Lab				Code:	MIT32PE04A	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:

1. Logic and Set Theory.
2. Computer Programming and Problem Solving

is essential

Course Objectives:

This course will enable students to:

1. Apply different Big Data technologies and tools for data analytics.
2. Analyze data visualization tools for big data analytics.

Course Outcomes:

After learning the course, the students will be able to:

1. Apply MapReduce on the installed Hadoop framework.
2. Analyze large datasets using Apache Spark.
3. Execute different data manipulation tasks using Hive and PIG.
4. Design the big data application using data visualization tools.

Guidelines:

1. Continuous assessment of laboratory work should be based on parameters such as timely completion, performance, efficient codes, and punctuality.
2. For each laboratory assignment, it is essential for students to write the title, aim, topic theory, algorithm, mathematical background, and data set description (as applicable).
3. Laboratory Journal- Program codes with sample output of all performed assignments will be submitted as softcopy.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	A. Installation and configuration of the Hadoop framework. B. Implement the following file management tasks in Hadoop: 1. Adding files and directories 2. List files 3. Retrieving files 4. Deleting files 5. Shutting down HDFS C. Run a basic word count Map Reduce program to understand MapReduce Paradigm

2.	A. Implement a Map Reduce program to process the sales transaction dataset and calculate the total sales amount for each product across all stores. Use the key-value pair approach, where the product ID is the key and the total sales amount is the value. B. Demonstrate the need for a combiner in MapReduce program by comparing the execution time and network traffic with and without the combiner. C. Evaluate the performance of your Map Reduce program with and without the combiner on a dataset of varying sizes (small, medium, large) to observe the impact on job execution time and resource utilization.
3.	Implement a program to analyze server log files using HadoopMapReduce, leveraging NLine and Multiline Input Formats to process log entries spanning multiple lines efficiently.
4.	Implement a Spark application to process and analyze a large dataset.
5.	A. Set up Hive and execute various database and table management tasks using HiveQL. B. Create, alter, and drop databases, tables, views, functions, and indexes to demonstrate proficiency in using Hive for data management tasks.
6.	Write a script to analyze user activity data from an e-commerce platform using Apache Pig. The goal is to sort, group, join, project, and filter the data to gain insights into user behavior and preferences.
7.	Design an application to manipulate RDD using Apache Spark.
8.	A case study based on Industrial big data using data visualization tools.

Reference Books:

1. SeemaAcharya, SubhasiniChellappan, *Big Data Analytics*, Second Edition, Wiley India Pvt. Ltd, 2019.
2. Alex Holmes, *Hadoop in practice*, Second Edition, Dreamtech press, 2014.

E-resources:

1. Big Data Hadoop Course: https://intellipaat.com/big-data-hadoop-training
2. Big Data Computing: https://onlinecourses.nptel.ac.in/noc21_cs86/preview

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Data Analytics and Its Application					Code:	MIT32PE03B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:

1 Linear Algebra, Basic Programming skill

is essential

CourseObjectives:

This course aims at enabling students

1 To understand the foundational principles of data analytics.
2 To explore various data analysis techniques and algorithms.
3 To gain proficiency in data visualization and interpretation.
4 To analyze ethical and societal implications of data analytics applications.
5 To develop critical thinking and problem-solving skills through hands-on projects and case studies.
6 To apply data analytics techniques in practical scenarios across different domains.

CourseOutcomes:

After learning the course, the students will be able to:

1 Apply fundamental concepts in data analytics.
2 Apply Statistical techniques for data analysis.
3 Build interactive dashboards.
4 Apply ethical considerations in data analytics applications.
5 Evaluate data analytics techniques on real-world case studies across various domains.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Introduction to Data Analytics Overview of data analytics and its significance, Types of data: structured, unstructured, semi-structured, Data Structures and Algorithms for Data Analytics: Basics of data structures, Trees, graphs, and their applications in data analytics Algorithm design techniques, Data lifecycle: collection, storage, processing, analysis, visualization.	08
2	Statistics for Data Analytics Descriptive statistics: Mean median, mode, variance, and standard deviation. Probability: Dependence and Independence, Probability distributions: normal, binomial, and Poisson. Inferential statistics: hypothesis testing, confidence intervals.	10
3	Data Visualization and Interpretation Principles of data visualization, Tools for data visualization: Matplotlib, Seaborn, plotly, Bokeh, Tableau/ PowerBI, Dashboard creation and interactive visualization.	10

4	Data Ethics and Privacy Ethical considerations in data analytics, Privacy preserving techniques. Regulatory compliance: GDPR, CCPA.	07
5	Advanced Data Analytics and Applications Time series analysis and forecasting, Anomaly detection, Reinforcement learning. Application of data analytics techniques to a real-world problem, Real-world case studies and examples from various domains such as finance, healthcare, marketing, etc.	10
	Total	45

Text Books:

1. David Freedman, Robert Pisani, Roger Purves. *Statistics*. 4th Edition, W. W. Norton & Company, 2007.
2. Wes McKinney. *Python for Data Analysis*. 3rd Edition, O'Reilly Media, Inc., 2022.
3. Claus O. Wilke. *Hands-On Data Visualization with R*, O'Reilly Media, Inc., 2019.

Reference Books:

1. Kieran Healy. *Data Visualization: A Practical Introduction*., Princeton University Press, 2019.
2. Colin Ware. *Information Visualization: Perception for Design*. 4th Edition, Elsevier, 2021.

E-sources:

1. https://www.mygreatlearning.com/academy/learn-for-free/courses/basics-of-data- visualization-for-data-science
2. https://www.mygreatlearning.com/data-visualization/free-courses

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:		II
Course:	Data Analytics and Its Application Lab				Code:		MIT32PE04B
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:

1 Linear Algebra.
2 Basic Programming Skill

is essential

Course Objectives:

This course will enable students

1. To apply data analytics techniques in practical scenarios across different domains.
2. To develop critical thinking and problem-solving skills through hands-on projects and case studies

Course Outcomes:

After learning the course, the students will be able to:

1 Apply and analyse statistical techniques for data analysis.
2 Design interactive dashboards on real-world case studies across various domains.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Assignment based on Data Analysis, including cleaning, pre-processing, analysis and visualization on any dataset (e.g. Healthcare, finance, social media).
2.	Build a decision tree model to classify patients into risk categories for heart disease based on the provided features such as age, gender, blood pressure, cholesterol level, and more
3.	A social media platform provides data on user interactions, including friendships, likes, comments, and shared posts. Represent the network of user interactions as a graph and analyze the structure to identify influential users, community clusters, and patterns of engagement.
4.	In finance, stock prices often follow a normal distribution due to market fluctuations.Analyze historical stock price data and fit a normal distribution to model the data's behavior.
5.	Assignment based on formulation of Null and alternative hypothesis and choose appropriate statistical tests(e.g. T-test, chi-square test) for hypothesis testing.
6.	Assignment based on Application of statistical concepts to a Dataset (Healthcare, Finance, Marketing).
7.	Choose a dataset with continuous or categorical data, such as network traffic, sensor readings, or financial transactions. Implement anomaly detection methods such as z-score analysis, IQR, isolation forests, or clustering techniques.

8.	Assignment based on Time series analysis (weather forecasting, price prediction).
9.	Mini Project: Dashboard creation, using Tableau/ PowerBI, in various cases such as Healthcare, Finance, Marketing, Social Media

Reference Books:

Wes McKinney. *Python for Data Analysis*. 3rdEdition, O'Reilly Media, Inc., 2022.
Claus O. Wilke. *Hands-On Data Visualization with R*, O'Reilly Media, Inc., 2019.

E-resources:

https://azure.microsoft.com/en-in/products/power-bi

Program:	M.Tech. Artificial Intelligence and Data Science					Semester:	II
Course:	Nature-Inspired Optimization Algorithms					Code:	MIT32PE03C
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
03	03	-	-	20	20	60	100

Prior knowledge of:
Mathematical foundations, algorithmic complexity
is essential

CourseObjectives:
This course aims at enabling students

1. Introduce fundamental concepts of nature-inspired computing and various optimization techniques derived from biological, swarm, and physical systems.
2. Develop the ability to analyze, design, and apply bio-inspired algorithms for solving complex optimization problems in engineering, AI, and data science

CourseOutcomes:
After learning the course, the students will be able to:

1. Understand the principles of natural computing and distinguish between traditional and nature-inspired optimization techniques.
2. Apply evolutionary algorithms such as Genetic Algorithms and Differential Evolution to solve optimization problems.
3. Analyze swarm intelligence algorithms like PSO, ACO, and ABC for real-world applications.
4. Apply physics-based optimization algorithms such as Simulated Annealing and Sine Cosine Algorithm.
5. Make use of neural, fuzzy, and immune-inspired systems for pattern recognition and anomaly detection.
6. Design and evaluate hybrid and advanced bio-inspired techniques for multi-objective optimization and AI-based applications.

Detailed Syllabus:

Unit No.	Description	Duration [Hrs]
1	Foundations to Nature-Inspired Computing Concept of natural computing, Biological inspiration (evolution, swarm, immune systems), Overview of optimization problems (single-objective, multi-objective), Traditional vs. nature-inspired optimization techniques, Characteristics of nature-inspired algorithms, Exploration vs. exploitation concept, Applications in engineering, AI, and data science	07
2	Evolutionary Algorithms Principles of natural evolution, Evolution Strategies: Genetic Algorithms, Genetic Programming, Differential Evolution (DE), Bee Swarm Algorithm (BSA), Fitness functions, selection, crossover, mutation, Performance comparison and limitations, Applications: Optimization problems, Feature selection in ML	09

3	Swarm-Based Algorithms Fundamentals of swarm intelligence, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Artificial Bee Colony (ABC), Firefly & Bat algorithms, Grey Wolf Optimization (GWO), Mathematical modeling and working principles, Parameter tuning and convergence analysis, Case studies and real-world applications.	08
4	Neural & Immune Inspired Systems Artificial Neural Networks (ANN), Self-Organizing Maps (SOM), Artificial Immune Systems (AIS), Fuzzy Systems, Neuro-Fuzzy Systems, Applications: Pattern recognition, Anomaly detection	06
5	Hybrid &Advanced Bio-Inspired Techniques Hybrid algorithms (GA + PSO, etc.), Multi-objective optimization, Bio-inspired deep learning optimization: Parameter tuning strategies, Applications in AI &Data Science: Image processing, medical diagnosis, Smart systems / IoT optimization	07
	Total	45

Text Books:

1. Xin-She Yang, *Nature-Inspired Optimization Algorithms*, Elsevier, 2014 / 2021D
2. Seyedali Mirjalili, Jin Song Dong, Andrew Lewis,*Nature-Inspired Optimizers: Theories, Literature Reviews and Applications*, Springer, 2020
4 Andreas Antoniou, Wu-Sheng Lu, "Practical optimization algorithms and engineering applications", Springer, 2007.

Reference Books:

1. Rajesh Kumar Arora, "Optimization Algorithms and Applications", Chapman & Hall, CRC, 2015
2. A Schrijver, "Theory of Linear and Integer Programming" (Wiley Series in Discrete Mathematics & Optimization)
3 V. Chvatal, "Linear Programming"

E-sources:

3 https://www.mygreatlearning.com/academy/learn-for-free/courses/basics-of-data- visualization-for-data-science

4 https://www.mygreatlearning.com/data-visualization/free-courses

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			II
Course:	Nature Inspired Optimization Algorithms Lab			Code:			MIT32PE04C
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:
Probability and Statistics
is essential

Course Objectives:
This course will enable students
1. Provide practical understanding of nature-inspired optimization algorithms.
2. Apply and evaluate optimization techniques for real-world problems.

Course Outcomes:
After learning the course, the students will be able to:
1. Formulate real-world problems as optimization models using appropriate mathematical representation.
2. Implement nature-inspired algorithms such as GA, PSO, ACO, DE, and SA for solving complex problems.
3. Analyze and compare algorithm performance based on convergence, accuracy, and efficiency.
4. Design and evaluate hybrid optimization approaches for improved solution quality.

Guidelines:
Continuous assessment of the laboratory is done based on overall performance and laboratory assignments performance of students. Each laboratory assignment assessment will assign marks based on parameters with appropriate weights. Suggested parameters for overall assessment as well as each laboratory assignment assessment include - Neatness and cleanliness in Experimental write-up, Efficient Code, Innovation, Interpretation of results and conclusions, Punctuality, Overall behaviour, attitude and performance.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	**Classical vs Heuristic Optimization** **Scenario:** A company uses hill climbing for optimization but faces stagnation issues. **Task:** • Implement Hill Climbing, Random Search, Simulated Annealing • Compare performance on same problem **Analyze:** • Why does SA escape local minima? • When is randomness beneficial?
2.	**Evolutionary Algorithms** **Experiment 3: Genetic Algorithm for Resource Allocation** **Scenario:** A smart agriculture system must allocate fertilizers optimally across fields with cost constraints. **Task:**

	• Formulate as optimization problem • Implement GA (selection, crossover, mutation) **Analyze:** • Trade-off between cost vs yield • Sensitivity of mutation rate
3.	**Scenario:** Optimize hyperparameters of a regression model (learning rate, regularization). **Task:** • Implement DE • Compare with GA **Analyze:** Why DE performs better in continuous search space?
4.	**PSO for Neural Network Optimization** **Scenario:** Traditional backpropagation is slow for training neural networks in medical imaging. **Task:** • Use PSO to optimize ANN weights • Compare with gradient descent **Analyze:** • Convergence speed • Accuracy comparison
5.	**ACO for Smart Routing** **Scenario:** Design optimal path for ambulance routing (you already worked on this domain). **Task:** • Model as TSP • Implement ACO **Higher Thinking:** • Impact of pheromone evaporation • Real-time adaptability
6.	**I**n a hospital MRI unit, patients arrive at different times and require varying scan durations. The objective is to determine an optimal scheduling sequence that minimizes total patient waiting time while satisfying scheduling constraints. $\min \sum_{i=1}^{N} (s_i - a_i)$,subject to $s_{i+1} \geq s_i + d_i,\ s_i \geq a_i$ Apply Simulated Annealing (SA) obtain a near-optimal solution and to study the trade-off between convergence speed and solution quality.
7.	**Hybrid ANN + Optimization** **Scenario:** Brain tumor classification accuracy is limited using standard training. **Task:** • Train ANN • Optimize weights using GA/PSO **Analyze:** • Hybrid vs standalone learning
8.	**Hybrid GA + PSO** **Scenario:** A single optimization algorithm fails to achieve global optimum in complex AI model tuning.

	Task: • Combine GA (diversity) + PSO (fast convergence) **Analyze:** • When hybridization helps
Reference Books: 1. Andreas Antoniou, Wu-Sheng Lu, "Practical optimization algorithms and engineering applications", Springer, 2007 2. Rajesh Kumar Arora, "Optimization Algorithms and Applications", Chapman & Hall, CRC, 2015 3. A Schrijver, "Theory of Linear and Integer Programming" (Wiley Series in Discrete Mathematics & Optimization) 4. V. Chvatal, "Linear Programming"	
E-resources: 1. https://www.coursera.org/learn/optimization-for-decision-making 2. https://www.coursera.org/learn/solving-algorithms-discrete-optimization	

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			II
Course:	Attacks against ML Models Lab			Code:			MIT32PC02
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
02	-	04	-	50	50	-	100

Prior knowledge of:
1. Machine Learning algorithms

is essential

Course Objectives:
1. To understand the adversarial attacks and evaluate the machine learning models against it.
2. Learn about federated learning, data poisoning attacks and evasion attacks.
3. Explore backdoor attacks, model stealing attacks and membership inference attacks against ML Models

Course Outcomes:
After learning the course, the students will be able to:
1. Analyze the different types of attacks and implement adversarial attack.
2. Simulate and analyze the effects of model poisoning on collaborative machine learning.
3. Evaluate the impact of crafting adversarial text samples on model performance.
4. Analyze the effectiveness of membership inference attacks against privacy-preserving models.
5. Implement backdoor attacks by inserting hidden triggers into training data.
6. Demonstrate model stealing attacks against deployed models.

Guidelines:
Continuous assessment of laboratory work should be based on parameters, such as timely completion, performance, innovation, efficient codes, and punctuality.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Study and analyze the different types of attacks on Machine Learning Models.
2.	Study and demonstrate the Federated Learning tools.
3.	Implement a targeted adversarial attack on a pre-trained image classification model.
4.	Simulate a model poisoning attack in a federated learning setting, where multiple clients collaboratively train a global model. Inject malicious data into selected clients to degrade the performance of the global model.
5.	Develop an evasion attack against a text classification model (e.g., sentiment analysis or spam detection). Generate adversarial text samples that cause the model to misclassify inputs.
6.	Implement a membership inference attack on a privacy-preserving machine learning model (e.g., a differentially private model or a federated learning model). Determine whether specific data points were used during the model's training.

7.	Design a backdoor attack on an image recognition model by inserting a hidden trigger into the training data. Demonstrate how the model exhibits unexpected behavior (e.g., misclassifying inputs containing the trigger).
8.	Perform a model stealing attack against a black-box machine learning model deployed as a web service. Use query-based techniques to infer the model's architecture or approximate its functionality.

Text Books:

1. "Machine Learning: A Probabilistic Perspective",Kevin P. Murphy,ISBN-13: 978-0262018029
2. "Adversarial Machine Learning",Anthony D. Joseph, Blaine Nelson, Benjamin I. P. Rubinstein, J. D. Tygar, ISBN-13: 978-1627058838
3. "Attacks on Machine Learning: Learning and Security in the Era of AI", Battista Biggio, Fabio Roli, DavideAriu, ISBN-13: 978-3319684212

Program:	M. Tech. Artificial Intelligence and Data Science				Semester:		II
Course:	Professional and Communication Skill Development Lab				Code:		MIT32VS01
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Practical	Hour	Tutorial	TW	OR	PR	Total
02	04	04	-	100	-	-	100

Prior knowledge of:

1. Basic Communications skills

is essential

Course Objectives:

This course will enable students

1. To facilitate holistic development of students through effective language and communication skills.
2. To enhance students' personal and professional skills.

Course Outcomes:

After learning the course, the students will be able to:

1. Interpret effectively through verbal/oral communication skills.
2. Build the ability for group discussion/meetings/interviews and presentations.
3. Develop the ability to work well in diverse, multidisciplinary teams by learning about leadership, interpersonal interactions, dispute resolution, and teamwork.

Guidelines:

1 Students need to perform five experiments out of six.
2 Six hours need to be dedicated for each experiment.
3 Students can form a team of 2 to 3 wherever required to perform assignments.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Reading and Listening Skills: The batch can be divided into pairs. Each pair will be given an article by the facilitator. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students would be asked questions and needful corrections in the article. The facilitator can evaluate the students for reading and listening skills.
2.	Writing Skills: Resume Writing: Identifying job requirement and key skills Activity: Prepare an Electronic Resume, Interview Skills: Placement/Job Interview, Group Discussions, and Activity: Mock Interview and mock group discussion. Report Writing: language and Mechanics of Writing, Study Skills: Note making, Interpreting skills: Interpret data in tables and graphs, Activity: Transcoding.
3.	Presentation Skills: Oral Presentation using Digital Tools, Activity: Oral presentation on the given topic using appropriate non-verbal cues, Problem Solving Skills: Problem Solving & Conflict Resolution, Activity: Case Analysis of a Challenging Scenario.

4.	Public Speaking: Any one of the following activities may be conducted : 1. Prepared speech (Topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver.) 2. Extempore speech (Students deliver speeches spontaneously for 5 minutes each on a given topic)
5.	Personal Interaction: Introducing Oneself-one's career goals, Activity: SWOT Analysis, Interpersonal Interaction: Interpersonal Communication with the team leader and colleagues at the workplace, Activity: Role Plays/Mime/Skit, Social Interaction: Use of Social Media, Social Networking, gender challenges, Activity: Creating LinkedIn profile, blogs.
6.	Group Discussion: Make students aware of proper and globally accepted ethical way to handle work, colleagues and clients. Develop group communication skills. Learn to speak up one's opinion in a forum. Cultivate the habit of presenting solution-driven analytical arguments making them contributors in any team.

Test Books:

1 Barun K Mitra, "Personality Development and Soft Skills", Oxford higher education, Second edition, with free online resources.

2 Stephen Lucas and Paul Stob, "The Art of Public Speaking: 2023 Release" ISBN10: 1265455643 | ISBN13: 9781265455644.

References Books:

1 Marcia Ruth Weaver, "Empowering Employees through Basic Skills", ISBN: 0527762970 / 9780527762971, publisher Quality Resources.

2 Gerald Ratigan, "Aced: Superior Interview Skills to Gain an Unfair Advantage to Land Your DREAM JOB!", Kindle edition.

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:	II	
Course:	Research Internship				Code:	MIT32EL01	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
04	-	08	-	100	100	-	200

Prior knowledge of:
Basics of programming language such as Java, MATLAB, Python etc.
is essential.

Course Objectives:
This course will enable students

1. To provide the opportunities to learn, understand and sharpen the research acumen, as well as the communication/ technical/managerial skills required for conducting research.
2. To enhance their problem-solving and critical-thinking abilities.
3. To provide an opportunity to the students to carry out research in a real work environment with supervisor guidance over a specific period.
4. To familiarize students with research methods, analytical tools and techniques along with their appropriate usage.

Course Outcomes:
After learning the course, the students will be able to:

1. Develop the ability to learn the concept of Literature Review, Technical Reading, critical evaluation, Attributions and Citations.
2. Identify and apply the algorithm or mechanism to solve the research problem.
3. Adapt Ethics in Engineering Research.
4. Prepare a technical report based on the results obtained.

Guidelines:

1. Individual student need to attempt for research internship under the guidance of allocated supervisor.
2. Student can do research internship in the industry or in the institute under guidance of allocated supervisor.
3. Student doing research internship in the industry can work on the problem statement provided by the industry.
4. For student doing internship in the institute, supervisor will assign a research task (problem statement or part of funding proposal).
5. Student is supposed to provide a feasible solution to the assigned problem statement.
6. Student will synthesize research findings by drafting a research report.
7. Three reviews will be scheduled to assess progress of the research work.
8. Review-I: Student will present current state of the art of the literature for the assigned research task.
9. Review-II: Explanation of the partial results obtained through implementation of the proposed algorithm is expected.
10. Review-III: Demonstration and explanation of the complete solution of the assigned research task is expected.
11. Student should publish good review paper/research paperin the reputed conference, journal or register a patent.
12. Student is supposed to submit research internship report as a compliance of term work

associated with subject.	
Detailed Syllabus:	
Assignment No.	**Suggested List of Assignments**
1.	Assignment of research task: a) Presentation of domain knowledge in the interested area of research b) Guide allotment c) Assignment of research task by supervisor
2.	Finalize problem statement and define objectives
3.	Conducting critical literature review: a) Selection of appropriate research papers b) Critical reading and thinking c) Comparative analysis of the papers d) Finding a research Gap
4.	Review-1 (Will be conducted in Week 5-6): Expectation: Discussion on the problem statement and defined objectives
6.	Data Collection: Techniques of data collection. Sources used for Data collection, creation and publishing own Data Sets if required
7.	Implementation of the problem statement: Identification of technology/methodology/algorithm, system architecture, flow diagram, mathematical modeling, front end, back end
9.	Review-2 (Will be conducted in Week 11): Expectations: Discussion on methodology, system architecture, implementation and partial results.
10.	Result Analysis and discussion.
11.	Write a research paper/funding proposal/patent draft. Use following tools or equivalent platforms. Software for paper formatting like LaTeX/MS Officeetc can be used Citing styles and tools such as Google scholar, Mendleyetc. Reference Management Software like Zotero/Mendeley

Course Syllabus

Semester-III

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			III
Course:	Dissertation Phase – I [Company/In-house project]			Code:			MIT33EL01
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
08	-	16	-	100	100	-	200

Prior knowledge of:

1. Basics of Software Engineering and Computer Programming Concepts
2. Basics of Programming Languages

is essential

Course Objectives:

This course will enable students

1. To understand the software Development Process.
2. To engage in independent research, apply theoretical concepts to practical problems, and make a meaningful contribution to the field of study.

Course Outcomes:

After learning the course, the students will be able to:

1. Identify a realistic problem of societal, industry, or research relevance.
2. Compare the literature to find the most appropriate and feasible solution for the selected problem statement.
3. Apply the research methodology tools for data collection and analysis.
4. Design real-life applications considering Emerging areas in technology

Guidelines:

1. Students should get the approval of authorities for the dissertation title.
2. Students shall provide an overview of the research problem, its significance, and the objectives of the study. Briefly discuss the background literature and highlight the gap your research aims to address.
3. Students shall conduct a comprehensive review of relevant literature and research in the chosen field. Critically analyze existing work and identify gaps, controversies, or areas needing further exploration.
4. Students shall describe the research methodology he/she intends to employ. This includes detailing the research design, data collection methods, tools or instruments to be used, and any statistical techniques for data analysis.
5. Students should outline the specific tasks or activities he/she plans to undertake in Phase I of your dissertation. This may include literature survey, preliminary data collection, feasibility studies, or development of prototypes.
6. Students should clearly articulate the expected outcomes or contributions of the research.
7. Students shall develop a realistic timeline for completing Phase I of their dissertation. They can break down the tasks into smaller milestones and allocate time for each activity.
8. Students shall identify the resources they need to carry out their research effectively. This may include access to databases, laboratory facilities, equipment, or software tools.

9. Students need to design and demonstrate projects under the guidance of an allocated guide.
10. Sponsored Project Internship is acceptable considering postgraduate scope.
11. Project Report-1 should be submitted as a compliance of term work associated with the subject.
12.At least 1 Paper publication is expected as research outcome of Project Stage-I (Scopus indexed Conference or Journal) and 40% of planned project work should be completed for submission of Dissertation Phase-I.

Detailed Syllabus:

Assignment No.	Description
1	Week 1, 2, 3: Guide allotment, applying for sponsorship and project internship, finalization of topic and platform, Planning of the work.
2	Week 4,5,6:Literature review, Specification and Methodology Finalization, Review1 for finalization of topic and specification
3	Week 7, 8,9: Understanding platform for implementation and related software flow and execute block level design , Review 2 to understand the progress of the project
4	Week 10,11: Simulation of proposed methodology on appropriate software tools and finalization of hardware platform
5	Week 12, 13, 14, 15: Project Report writing and publication or copyright planning and Execution. Demonstration of Project work and Final Review for submission and term work compliances

Program:	M.Tech. Artificial Intelligence and Data Science				Semester:	III	
Course:	Internship (On Job Training)				Code:	MIT33EL02	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
08	-	16	-	100	100	-	200

Prior knowledge of:

1. Basics of Computer Programming Concepts
2. Knowledge about internship area and program in which internship is interested

is essential.

Course Objectives:

This course will enable students

1. To identify personal strengths and weaknesses.
2. To know the industry practices.
3. To gain the employability-enhancing activities.
4. To understand cutting edge technology in the chosen area.

Course Outcomes:

After learning the course, the students will be able to:

1. Enhance the employability and adaptability to corporate culture.
2. Develop work habits and attitudes necessary for the job success.
3. Bridging academic knowledge with industry input.
4. Develop abilities of true professional using ethical practice and fulfilling social responsibilities.

Guidelines:

1. Individual student need to attempt for internship by their own or with help of PCCoE T&P cell under the guidance of allocated guide.
2. If not get selected for any internships, students can choose opportunity of Entrepreneurship from PCCoE related to Information Technology considering recent trends and its societal importance.
3. The idea presentation is expected from the students based on their topics.
4. Internship Report should be submitted as a compliance of term work associated with subject.
5. Total Duration: 3 months
6. The students need to submit the internship certificate and details to the course coordinator in order to get the internship credited. The students are also required to submit working project demonstrating the acquired skills if it is permitted by the industry where students are doing internship.

Detailed Syllabus:

Assignment No.	Suggested List of Assignments
1.	Week 1,2:Guide allotment, Application of internships, Presentation of domain knowledge in the interested area of internship
2.	Week 3,4 : Finalization of topic , Planning of the work, Review-1 conduction
3.	Week 5,6,7,8:Internship/Entrepreneurship activity implementation as per requirements.
4.	Week 9,10:Review-2 of Activities.

5.	Week 11,12:Interaction of Guides with Industry, Poster Presentation.
6.	Week 13, 14, 15: Internship Report writing and publication or copyright planning Final Review conduction.

Program:	M.Tech. Artificial Intelligence and Data Science			Semester:			III
Course:	MOOC's			Code:			MIT33EL03
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
04	04	-	-	100	-	-	100

Course Objectives:

1. To provide diversified knowledge and skills in a single platform
2. To provide opportunity to students to explore new areas of interest
3. To foster student engagement in self learning

Course Outcomes:

After learning the course, the students will be able to:

1. To acquire knowledge about various technical domains.
2. To apply domain experiences in solving real life problems.
3. To analyze the new state- of- art for life-long learning.

Guidelines for Students:

1. Individual students can register for MOOC courses of their interest in III Semester as MOOC Course offered by the institute.
2. Selection of Course: Students can select any MOOC Course from an Online Certification provider with guidance from MOOC Mentor.
3. The selected course should not be from courses offered in the program curriculum earlier.
4. The selected MOOC course should be approved by the Department.
5. The selected course should be from Nptel / Any foreign University approved course.
6. Certification and Grade report is mandatory for the course to be selected.
7. Duration of Course: A selected course should be of Minimum 60 Hrs(or two courses of 30 Hrs each)
8. Selected MOOC course should be of 8/12 weeks.

Assessment of Course :

1. At the end of Course submission the MOOCs report of 10-15 Pages in hardcopy is mandatory along with certificate of completion.
2. Assessment will be done through Certification exam report.
3. Assessment will be done by MOOC Mentor.

Evaluation Guidelines and Rubrics:

1. MOOC Mentor will observe the progress of the student.
2. Students will be evaluated progressively for a total 100 Marks. (i.e. 70 Marks Progressive and 30 Marks Completion of Certificate).

Sr. No.	Rubrics	Marks
1	Presentation of the topic Selected	20
2	Scores of Assignments	50
3	Certificate Completion	30
Total		100

Course Syllabus

Semester-IV

Program:	M.Tech. Artificial Intelligence and Data Science			**Semester:**			IV
Course:	Dissertation Phase – II [Company/ In-house project]			**Code:**			MIT34EL01
Credits	**Teaching Scheme (Hrs./Week)**			**Evaluation Scheme and Marks**			
	Lecture	**Practical**	**Tutorial**	**TW**	**OR**	**PR**	**Total**
20	-	40	-	250	250	-	500

Prior knowledge of:

1. Basics of Software Engineering and Computer Programming Concepts
2. Basics of Programming Languages

is essential

Course Objectives:

This course will enable students

1. To understand the Software Development Process.
2. To conduct original research, contribute new knowledge or insights to the field, and demonstrate mastery of the subject matter.

Course Outcomes:

After learning the course, the students will be able to:

1. Develop a prototype based on the design of the project.
2. Analyze and synthesize research findings to the agreed area of research.
3. Evaluate the methods and knowledge to solve the specific research problem.
4. Write thesis/report based on evaluation and analysis undertaken.

Guidelines:

1. Semester III major project is continued to be completed in this section under the guidance of allocated project guide.
2. Provide a brief recap of the research problem, objectives, and methodology outlined in Phase I. Highlight any adjustments or refinements made based on Phase I feedback.
3. Detail the steps taken to implement your proposed solution or research methodology. This may involve software development, prototype construction, experimental setup, or data collection procedures.
4. Describe the experiments or studies conducted to test your hypotheses or validate your solution. Provide details on the experimental setup, data collection methods, and any variables or parameters investigated.
5. Present the results of your experiments or studies in a clear and organized manner. Use tables, charts, graphs, or other visual aids to summarize your findings. Analyze the data to draw meaningful conclusions and insights.
6. Interpret the results of your research in the context of existing literature and theoretical frameworks. Discuss any unexpected findings, limitations of your study, and implications for theory or practice.

7. If applicable, discuss the validation of your solution or methodology. Address any validation criteria or benchmarks used to assess the effectiveness or performance of your work.
8. Summarize the key findings of your research and their implications. Reflect on how your work contributes to the existing body of knowledge in your field and any future research directions.
9. Reflect on your overall research experience, including challenges faced, lessons learned, and strategies for overcoming obstacles. Discuss any changes in your understanding of the research problem or your approach to solving it.
10. Final Project Report including all process of project should be submitted as a compliance of term work associated with subject and permission to appear for examination.
11. Atleast twopaper publications are expected as research outcome of Dissertation Phase - I and II (UGC Care Journal, Scopus Indexed Conference or Journal) and 100% of planned project workshould be completed for submission of Dissertation Phase-II.

Detailed Syllabus:

Assignment No.	Description
1	Week1, 2: 60%Work should be completed.
2	Week 3,4: Software Simulation and Hardware Implementation should be completed. Review1 conduction.
3	Week 5,6,7: Paper Publication should be in process or completed during this week,80% work should be completed.
4	Week 8,9,10: Compliance of 100% work. Review-2 will be conducted
5	Week 11,12: Department Reviews will be conducted to check the quality of project and requirements fulfillment to permit project submission
6	Week 13,14,15: Project Report writing and copyright planning and execution. Demonstration of Project work and Final Research Review Committee (RRC) reviews will be conducted for submission and term work compliances.

Mission and Vision of Information Technology Department

VISION

To become a front-runner in the western region in preparing Information Technology engineers with academic excellence and research skills empowering their roles in technology and society.

MISSION

1. To equip students with the skills and knowledge through a dynamic learning environment.
2. To collaborate with industries to nurture proficient Information Technology engineers.
3. To cultivate a spirit of research, innovation, and entrepreneurship to address community and business challenges.
4. To imbibe work ethics and leadership skills through co-curricular and extracurricular activities.

Programme Educational Objectives (PEOs)

I. To provide students with a substantial understanding of Information Technology fundamentals todevelop their technical competence to address the real life problems.
II. To train the students with the knowledge and skills in the area of Information Technology for analysis, design and implementation of real life problems.
III. To groom the students overall personality for professional growth.
IV. To inculcate values and ethics among the students and making them aware about their social commitments.

Program Specific Outcomes (PSOs)

Engineering Graduates will be able to:
1. Provide IT services, manage IT infrastructure, monitor and safeguard data.
2. Apply standard practices and strategies using various programming paradigms to develop a quality product for business success.