Zeal Education Society's

ZEAL COLLEGE OF ENGINEERING & RESEARCH, PUNE – 41

(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

NAAC Accredited with A+ Grade / ISO 21001:2018

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Curriculum Structure and Syllabus of

T.Y. B. Tech. – Artificial Intelligence and Machine Learning

(With effect from - Academic Year 2026-2027)

(2024 Pattern)

VISION OF THE INSTITUTE

To be a premier institute in technical education by imparting academic excellence, research, social and entrepreneurial attitude.

MISSION OF THE INSTITUTE

- To achieve academic excellence through innovative teaching and learning process.
- To imbibe the research culture for addressing industry and societal needs.
- To inculcate social attitude through community engagement initiatives.
- To provide conducive environment for building the entrepreneurial skills.

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

VISION:

To be recognized as a center for quality education in the field of mechanical engineering, integrating top-tier teaching, innovative research, and fostering socially conscious and entrepreneurial engineers.

MISSION:

M1: To impart value-added education by creating an ambiance of academic excellence in teaching-learning processes.

M2: To inculcate a research approach through innovation and skill development centers.

M3: To inculcate a strong sense of social responsibility and empathy among the students.

M4: To imbibe the entrepreneur skill amongst the students by strengthening Industry- Institute interaction.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

PEO1: The ability to understand, analyze and develop computer programs in the areas related to algorithms, system software, multimedia, web design, networking, artificial intelligence and data science for efficient design of computer-based systems of varying complexities.

PEO2: The ability to apply standard practices and strategies in software project development using open-ended programming environments to deliver a quality product for business success.

PEO3: Successful Career and Entrepreneurship- The ability to employ modern computer languages, environments and platforms in creating innovative career paths to be an entrepreneur and to have a zest for higher studies.

PROGRAM OUTCOMES (POs):

PO1: **Engineering Knowledge:** Apply the knowledge of mathematics, natural science, computing, and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, and analyze complex engineering problems, reaching substantiated conclusions with consideration for the holistic nature of the problem..

PO3: **Design/Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge and research methods, including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.

PO5: **Engineering Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling — recognizing their limitations — to solve complex engineering problems. (Previously titled "Modern Tool Usage.").

PO6: **The Engineer and the World:** analyze and evaluate societal and environmental aspects while solving complex engineering problems, considering their impact on sustainability with reference to economy, health, safety, legal frameworks, culture, and the environment.

PO7: **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; and adhere to relevant national and international laws. (Diversity and inclusion are now explicit additions.)

PO8: **Individual and Collaborative Team Work:** Function effectively as an individual, and as a member or leader in diverse and multi-disciplinary teams.

PO9: **Communication:** Communicate effectively and inclusively within the engineering community and with society at large — comprehending and writing effective reports and design documentation, and making effective presentations — considering cultural, language, and learning differences.

PO10: **Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects in multi-disciplinary environments.

PO11: **Life-Long Learning:** Recognize the need for, and have the preparation and ability for, independent and life-long learning, adaptability to new and emerging technologies, and critical thinking in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs):

PSO1: Apply principles of Artificial Intelligence, Machine Learning, Deep Learning, Data Analytics and computational intelligence to analyze and solve real-world problems.

PSO2: Design , develop and evaluate intelligent and agentic AI systems using appropriate AI/ML algorithms, models, tools, frameworks and computing platforms.

PSO3: Develop and deploy scalable, autonomous and responsible AI solutions, including agent-based systems, for interdisciplinary applications while considering performance, security, explainability, ethical and societal requirements.

LIST OF ABBREVIATIONS

Abbreviation	Description
BSC	Basic Science Course
ESC	Engineering Science Course
PCC	Program Core Course
PEC	Program Elective Course
MDM	Multidisciplinary Minor
OE	Open Elective - Other than a particular program
VSEC	Vocational and Skill Enhancement Course
AEC	Ability Enhancement Course
ENTR	Entrepreneurship
EC	Economics
MC	Management Courses
IKS	Indian Knowledge System
VEC	Value Education Courses
RM	Research Methodology
CEP	Community Engagement Project
FP	Field Project
PROJ	Project
INT	Internship
OJT	On Job Training
CC	Co-curricular Courses
HSSM	Humanities Social Science and Management
ELC	Experiential Learning Course
B. Tech	Bachelor of Technology
L	Lecture
P	Practical
T	Tutorial
H	Hours
CR	Credits
CIE	Continuous Internal Evaluation
ETE	End Term Evaluation
TW	Term Work
OR	Oral
PR	Project

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Third Year B. Tech. –AIML DEPARTMENT : Semester – V (2024 PATTERN)

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)							Evaluation Scheme					
			L	P	T	H	CR			CIE	ETE	TW	PR	OR	Total
							TH	PR/ Tut	Total						
AMPC508	PCC	Design and Analysis of Algorithms	4	-	-	4	4	-	4	40	60	-	-	-	100
AMPC508P	PCC	Design and Analysis of Algorithms Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
AMPC509	PCC	Neural Network	3	-	-	3	3	-	3	40	60	-	-	-	100
AMPC509P	PCC	Neural Network Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
AMPC510	PCC	Data visualization and Modeling	3	-	-	3	3	-	3	40	60	-	-	-	100
AMPC510P	PCC	Data visualization and Modeling Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
AMPE501	PEC	Program Elective Course - I *	3	-	-	3	3	-	3	40	60	-	-		100
ALOE503	OE	Open Elective - III #	2	-	-	2	-	2	2	-	-	50	-	50	200
AMMD503	MDM	IoT with Artificial Intelligence	-	2	-	2	-	2	2	-	-	-	-	50	50
AMIN504	ELC - INT	Internship - IV	4 Weeks				-	2	2	-	-	25	-	-	25
Total			**15**	**8**	**-**	**24**	**14**	**7**	**22**	**160**	**240**	**75**	**100**	**125**	**700**

Third Year B. Tech. –AIML DEPARTMENT : Semester – V (2024 PATTERN)

* - Select any one course from the given Program Elective Courses		
Course Code	**Course Type**	**Program Elective-I**
AMPE501A	PEC	Computer Vision
AMPE501B		Cloud Computing
AMPE501C		Intelligent System

# - Select any one course from the given Open Elective Courses		
Course Code	**Course Type**	**Open Elective - III**
ALOE503A	OEC	Data Analytics
ALOE503B		Green Building
ALOE503C		Electric Mobility
ALOE503D		Introduction to Stock Market
ALOE503E		Patent Law for Engineers and Scientist

BoS Chairman

Director

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Third Year B. Tech. - AIML DEPARTMENT SEMISTER VI (2024 PATTERN)

Department of Artificial Intelligence and Machine Learning															
Semester VI															
Course Code	**Course Type**	**Course Name**	**Teaching Scheme (Hrs/Week)**							**Evaluation Scheme**					
			L	**P**	**T**	**H**	**CR**			**CIE**	**ETE**	**TW**	**PR**	**OR**	**Total**
							TH	**PR/Tut**	**Total**						
AMPC611	PCC	Machine Learning	4	-	-	4	4	-	4	40	60	-	-	-	100
AMPC612	PCC	Data Mining and Warehousing	3	-	-	3	3	-	3	40	60	-	-	-	100
AMPC612P	PCC	Data Mining and Warehousing Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
AMPE602	PEC	Program Elective Course - II *	2		-	2	2	1	2	40	60	-	-	-	100
AMPE602P	PEC	Program Elective Course - II Lab	-	2	-	2	-	1	1	-	-	-	50	-	50
AMPE603	PEC	Program Elective Course - III *	3	-	-	3	3	1	3	40	60	-	-		100
AMPE603P	PEC	Program Elective Course - III * Lab	-	2	-	2	-	1	1	-	-	-	-	25	25
AMMD604	MDM	Natural Language Processing	3	-	-	3	3	-	3	40	60	-	-	-	100
AMVS605P	VSEC	Machine Learning and NLP Lab	-	4	-	4	-	2	2	-	-	25	50	-	75
AMIN605	ELC - INT	Internship - V	4 Weeks				-	2	2	-	-	25	-	-	25
Total			**15**	**8**	**-**	**23**	**14**	**7**	**22**	**200**	**300**	**50**	**100**	**50**	**700**

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Third Year B. Tech. - AIML DEPARTMENT SEMISTER VI (2024 PATTERN)

* - Select any one course from the given Program Elective Courses		
Course Code	**Course Type**	**Program Elective-II**
AMPE602A	PEC	Web Technology
AMPE602AP		Web Technology Lab
AMPE602B		Text and Speech Analysis
AMPE602BP		Text and Speech Analysis Lab
AMPE602C		Edge Computing
AMPE602CP		Edge Computing Lab

* - Select any one course from the given Program Elective Courses		
Course Code	**Course Type**	**Program Elective-III**
AMPE603A	PEC	Business Intelligence
AMPE603AP		Business Intelligence Lab
AMPE603B		Distributed Computing
AMPE603BP		Distributed Computing Lab
AMPE603C		Explainable AI
AMPE603CP		Explainable AI Lab

BoS Chairman

Director

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2	AMPC509	Neural Network	
3	AMPC510	Data visualization and Modeling	
4	AMPE501	Program Elective Course - I *	
5	ALOE503	Open Elective - III #	
6	AMMD503	IoT with Artificial Intelligence	
Third Year B. Tech.: Semester – VI (2024 Pattern)			
7	AMPC611	Machine Learning	
8	AMPC612	Data Mining and Warehousing	
9	AMPE602	Program Elective Course - II *	
10	AMPE603	Program Elective Course - III *	
11	AMMD604	Natural Language Processing	
12	AMVS605	Machine Learning and NLP Lab	

SYLLABUS
SEMESTER - IV

Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PCC : Design and Analysis of Algorithms								**Code: AMPC508**	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	-	-	04	40	60	-	-	-	100

Prerequisites:

Data Structure

Course Objectives:

- To develop students' problem-solving skills using mathematical and algorithmic concepts.
- To enable students to design and apply efficient algorithms for solving computational problems.
- To analyze the time and space complexity of algorithms and explore their real-world applications.

Course Outcomes: After completion of this course, students will be able to -

CO1	Design a solution for a complex problem using suitable mathematical techniques.
CO2	Validate the correctness of algorithms by using loop invariant and inductive proofs.
CO3	Apply different problem-solving strategies to solve computational problems.
CO4	Compare the algorithms with respect to time and space complexity.
CO5	Identify P, NP, and NP Completeness of a problem.
CO6	Analyze the worst case run time performance of algorithms using asymptotic notations and amortized analysis.

Course Contents:

Unit	**Description**	**Duration**
1.	**Problem solving and Algorithmic Analysis:** Asymptotic notations, lower bound and upper bound: Best case, worst case, average case analysis, classification of time complexities (linear, logarithmic etc), Performance analysis of basic programming constructs. Recurrences: Formulation and solving recurrence, Equations using Master Theorem, Proving correctness of algorithms -Loop Invariant, Empirical studies to validate hypotheses about runtime measures.	9
2.	**Divide and Conquer Strategy:** Problem subdivision – Divide and Conquer: Binary search, Quick sort, Merge sort, Integer Arithmetic. Greedy Strategy : Principle, control abstraction, time analysis of control abstraction, knapsack problem, Job scheduling algorithm, Huffman code generation algorithm, Single Source Shortest Path Dijkstra's, Bellman-Ford .	8
3.	**Dynamic Programming Strategy :** Dynamic Programming: Principle, control abstraction, time analysis of control abstraction, binomial coefficients, 0/1 knapsack, All Pair Shortest Path - Floyd-Warshall, OBST, Chain Matrix Multiplication, Sum of Subset.	8
4.	**Backtracking Strategy:** Principle, control abstraction, time analysis of control abstraction, 8-queen problem, graph coloring problem, sum of subsets problem.	9

	Branch and Bound Strategy : Principle, control abstraction, time analysis of control abstraction, strategies – FIFO, LIFOand LC approaches, knapsack problem, Branch and Bound using Assignment Problem or TSP .	
5.	**Complexity Theory:** Classification of Problem-P, NP, NPC, NP-Hard , Polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P-class problems, NP-class of problems, Polynomial problem reduction NP complete problems- vertex cover, Maximum Clique and 3-SAT and NP hard problem - Hamiltonian cycle, Amortized Analysis.	9
6.	**Approximate Algorithm: Traveling Salesman Problem.** **Randomized Algorithm:** Min-Cut Algorithm. **Parallel and Concurrent Algorithms:** Quick Sort, Parallel Divide-and-Conquer Algorithms for Bubble Sort. **Introduction to Linear Programming:** Linear Programming, Linear Optimization problems. **String Matching-** Introduction, The Naive string matching algorithm, The Rabin-Karp algorithm.	9
	TOTAL	**52 Hrs.**

Text Books:

1. Thomas H Cormen and Charles E.L, Leiserson, "Introduction to Algorithms", The MIT Press; 4th edition, April 5,
2022, ISBN-13: 978-0262046305
2. Jon Kleinberg, Eva Tardos, "Algorithm Design", Pearson, 2nd edition, 2013, ISBN-13: 978-1292023946.
3. Horowitz, Sahani, " Computer Algorithms", Universities Press. 2nd Edition, 2008, ISBN -13:978-8173716119

Reference Books:

1. Brian Christian , Tom Griffiths, "Algorithms to Live By: The Computer Science of Human Decisions", 1st edition, October 2017, ISBN-10:0143191616
2. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, 2nd edition, 2011, ISBN 978-81-203-1131-2

E-Resources:

1. https://academic.oup.com/comjnl/article/65/10/2709/6334046
2. Design and Analysis of Algorithm course on NPTEL : https://nptel.ac.in/courses/106106131

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Program: B. Tech. (AI & ML)								**Semester:** V	
Course: Design and Analysis of Algorithms Lab								**Code:** AMPC508P	
Teaching Scheme (Hrs/week)					**Evaluation Scheme (Marks)**				
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	**02**	**-**	**01**	**-**	**-**	**-**	**25**	**-**	**25**

Prerequisites:

- Basic knowledge of programming and problem-solving.
- Familiarity with data structures such as arrays, stacks, queues, trees, and graphs.

Course Objectives:

- To develop students' practical skills in designing and implementing algorithms for computational problems.
- To enable students to apply algorithmic techniques such as divide and conquer, greedy, dynamic programming, backtracking, and graph algorithms.
- To develop students' ability to analyze algorithm efficiency and apply suitable algorithms to real-world problems**.**

Course Outcomes: After completion of this course, students will be able to -

- Implement fundamental algorithms for solving computational problems using appropriate programming techniques.
- Apply divide and conquer, greedy, and dynamic programming techniques to solve optimization and computational problems.
- Implement graph algorithms for problems such as shortest path, graph coloring, and vertex cover.
- Analyze the time and space complexity of algorithms and select suitable algorithms based on problem requirements.
- Apply backtracking and approximation techniques to solve complex computational problems.
- Develop algorithmic solutions for real-world problems such as password security, job assignment, club assignment, and resource optimization.

List of Assignments: Any 8

1	Implement large integer multiplication using binary strings.
2	Implement the Bellman-Ford algorithm for shortest path computation.
3	Generate Huffman codes based on character frequencies.
4	Solve the graph coloring problem for frequency assignment.
5	Implement the club assignment problem for cost optimization.
6	Solve the 0/1 Knapsack problem using dynamic programming.
7	Implement the job assignment problem for minimum cost allocation.
8	Develop a strong password checker and suggestion system
9	Implement an approximate solution for the vertex cover problem
10	Implement parallel Quick Sort the divide and conquer approach

Reference Books:

1. Brian Christian , Tom Griffiths, "Algorithms to Live By: The Computer Science of Human Decisions", 1stedition, October 2017, ISBN-10:0143191616
2. 2. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, 2nd edition, 2011, ISBN 978-81-203-1131-2

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PCC:Neural Network								**Code:** AMPC509	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Programming and Problem solving .Data Structures and Algorithms, Knowledge Representation and Reasoning

Course Objectives:

- To develop students' understanding of Artificial Intelligence, Artificial Neural Networks, and pattern recognition techniques.
- To enable students to apply feedforward, feedback, competitive learning, and Self-Organizing Map (SOM) algorithms.
- To provide students with practical knowledge of deep learning models such as CNN, RNN, and LSTM for real-world applications.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the fundamentals of AI, ANN, and activation functions.
CO2	Apply learning paradigms and pattern recognition techniques to AI problems.
CO3	Analyze Feedforward Neural Networks and backpropagation learning.
CO4	Explain the architecture and applications of Feedback Neural Networks.
CO5	Analyze Competitive Learning Networks and Self-Organizing Maps (SOM).
CO6	Apply Deep Learning models (CNN, RNN, and LSTM) for intelligent applications.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction** **Fundamentals of AI**: Definition and History of AI, Types of AI (Narrow AI, General AI, Super AI), Applications of AI, AI vs Machine Learning vs Deep Learning, Risk of AI **Fundamentals of ANN:** Introduction to ANN, History of Neural Network, Structure and working of Biological Neural Network, Topology of neural network architecture, Features, Characteristics, Types, Activation functions.	7
2.	**Learning Task** Trends in Computing, Data and Patterns, Pattern Recognition Tasks, Pattern Recognition Problem, Learning Tasks: **Descriptive Tasks:** Clustering and Association Analysis, **Predictive Tasks:** Regression and Classification, Learning Paradigms: Supervised Learning, Unsupervised Learning, Reinforcement Learning	7
3.	**Feedforward Network** Multilayer Perceptrons (MLPs), Neural Network Architectures, Feed Forward Neural Networks, Representation Power of MLPs, Learning in Feed Forward Neural Networks, Sigmoid Neurons, Error Backpropagation Algorithm, Gradient Descent (GD), Momentum-based Gradient Descent, Stochastic Gradient Descent	6

	(SGD), Learning Factors and Performance Issues, Applications of Feed Forward Neural Networks.	
4.	**Feedback Neural Network** Architecture of Feedback Neural Networks, Pattern Storage Networks, Simulated Annealing, Applications of Feedback Neural Networks	6
5.	**Competitive Learning Network** Components of Competitive Learning, Self-Organizing Maps (SOM), Pattern Clustering Networks, Feature Mapping Networks, Applications of SOM,	7
6.	**Deep Learning Neural Networks** Architectures of Deep Learning Networks, Structure of Deep Neural Networks (Input, Hidden, and Output Layers), Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM) Networks, Traditional Machine Learning vs. Deep Learning, Applications of Deep Learning Networks.	7
	TOTAL	**39 Hrs.**

Text Books:

1.Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson,
2 Artificial Neural Networks by B YegnaNarayana, PHI.
3. Introduction to Artificial Neural Systems, J M Zurada, West Publishing Company.

Reference Books:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Neural Networks, Fuzzy logic and Genetic Algorithms , S. Raj sekaran, VijayalakshmiPari
3. Artificial Neural Networks : An Introduction –Kevin.L.Priddy,PaulE.Keller

E-Resources:

https://cs.calvin.edu/courses/cs/344/kvlinden/resources/AIMA-3rd-edition.pdf
https://www.cin.ufpe.br/~tfl2/artificial-intelligence-modern-approach.9780131038059.25368.pdf

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PCC:Neural Network Lab								**Code:** AMPC509P	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	**02**	-	**01**	-	-	-	-	**50**	**50**

Prerequisites:

- Basic knowledge of Python programming.
- Understanding of basic mathematics, statistics, and machine learning concepts.

Course Objectives:

- To develop students' practical understanding of neural network concepts and learning algorithms.
- To enable students to implement perceptron, backpropagation, MLP, and competitive learning models using Python.
- To provide hands-on experience with neural network training, optimization, clustering, and visualization.

Course Outcomes: After completion of this course, students will be able to -

- Implement basic neural network models and activation functions using Python.
- Apply learning algorithms such as backpropagation, gradient descent, momentum, and competitive learning.
- Develop and evaluate neural network models for classification, clustering, and feature mapping.

List of Experiments: Any 8

1.	Write a program to scheme a few activation functions that are used in neural networks
2.	Write a program to show back propagation network for XOR function with binary input and output
3.	Write a program for producing back propagation feed forward network
4.	Write a program to demonstrate ART
5.	Write a program to demonstrate the perceptron learning law with its decision region using python. Give the output in graphical form
6.	Write a Python program to implement a Multilayer Perceptron for binary or multi-class classification.
7.	Write a Python program to implement and compare Gradient Descent (GD) and Stochastic Gradient Descent (SGD) for minimizing a loss function.
8.	Write a Python program to implement Momentum-Based Gradient Descent and compare it with standard Gradient Descent.
9.	Write a Python program to implement a Self-Organizing Map for clustering and feature mapping.
10.	Write a Python program to implement a Competitive Learning Network for clustering data points.

References:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Neural Networks, Fuzzy logic and Genetic Algorithms , S. Raj sekaran, VijayalakshmiPari

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: V**		
Course:PCC: Data Visualization and Modeling							**Code:** AMPC510		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Statistics ,Database Management System

Course Objectives:

- To develop students' understanding of data visualization, preprocessing, and modeling techniques.
- To enable students to analyze data and identify meaningful patterns, trends, and relationships.
- To provide practical skills in developing, interpreting, and communicating data-driven models and insights.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply fundamental concepts of data visualization and modeling.
CO2	Analyze datasets using preprocessing and exploratory analysis techniques.
CO3	Create effective visual representations for data interpretation.
CO4	Analyze patterns and relationships using visualization tools.
CO5	Evaluate suitable modeling techniques for data-driven problems.
CO6	Develop data models and communicate insights for decision-making.

Course Contents:

Unit	Description	Duration (Hrs.)
1.	**Introduction to Data Modeling:** Role of Data Modeling in Business Analytics, Structured and Unstructured Data, Excel and Open-Source Spreadsheet Tools (LibreOffice Calc, Google Sheets), Principles of Good Data Modeling, Types of Data Models: Descriptive, Predictive, and Prescriptive	07
2.	**Business Modeling with Excel and Open-Source Tools** **Introduction to Business Modeling :** Concept and importance of business modeling, Types of business models, Role of data in business decision-making **Financial and Forecasting Models:** Concepts of revenue, cost, and profit analysis, Break-even analysis, Introduction to forecasting models, Trend analysis, Business forecasting techniques, Applications of forecasting in business	08
3.	**Data Visualization Principles and Tools** **Introduction to Data Visualization** Importance of data visualization in business, Principles of effective visualization, Choosing the right chart **Charts and Visualizations:** Basic charts (Bar, Line, Pie, Scatter), Advanced charts (Waterfall, Box Plot, Radar, Funnel, Heatmap) **Dashboards and Visualization Tools:** KPIs and Metrics, Dashboard design (Layout, Filters, Slicers, Drill-down), Introduction to Power BI, Tableau Public, Apache Superset, and Metabase.	08

4.	**Business Intelligence and Data Visualization** Connecting Data Sources (Excel, SQL, and Web Data), Data Cleaning and Preparation, Creating Reports and Dashboards, Measures, Calculated Columns, and DAX (Power BI), Dashboard Publishing and Sharing, Business Applications: Sales Dashboard, Financial Performance Analysis, Customer Segmentation	07
5.	**Data Aggregation and Analysis** Data Aggregation and Grouping, Group By Operations and Data Summarization, Pivot Tables and Cross Tabulation, Introduction to Time Series Data, Date and Time Analysis, Resampling and Frequency Conversion, Moving Window Analysis	07
6.	**Dashboard Development, Data Modeling, and Ethics** Introduction to Streamlit, Overview of Power BI and Tableau, Introduction to Data Modeling and ER Diagrams, Data Ethics and Privacy in Business Analytics	08
	TOTAL	**39 Hrs.**

Text Books:

1. Chun-houh Chen, Wolfgang Härdle, Antony Unwin, "Handbook of Data Visualization", pringer
2. Ben Fry, "Visualizing Data", O'Reilly Media
3. Clous O.Wilke, "Fundamentals of Data Visualization - A Primer on Making Informative and Compelling Figures", O'Reilly Media, Inc.
4. Kieran Healy, "Data Visualization - A Practical Introduction"

Reference Books:

1. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061
2. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publication, 2012, ISBN: 0-07-120413-X
3. Winston, Wayne L & S. Albright,"Data Analysis and Decision Making"South-Western College Publishing Latest

E-Resources:

1. An Introduction to Statistical Learning by Gareth James
https://www.ime.unicamp.br/~dias/Intoduction%20to%20Statistical%20Learning.pdf
2.Python Data Science Handbook by Jake VanderPlas
https://tanthiamhuat.files.wordpress.com/2018/04/pythondatasciencehandbook.pdf

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)						**Semester: V**			
Course: PCC:Data Visualization and Modeling Lab						**Code:** AMPC510P			
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	**02**	**-**	**01**	**-**	**-**	**-**	**-**	**50**	**50**

Prerequisites:

- Basic knowledge of Python programming and data handling
- Familiarity with basic statistics and data analysis

Course Objectives:

- To develop students' practical skills in data cleaning, analysis, visualization, and modeling.
- To enable students to use Python, Excel, and visualization tools for analyzing real-world datasets.
- To develop students' ability to create meaningful visualizations, dashboards, and data models.

Course Outcomes: After completion of this course, students will be able to -

- Perform data loading, cleaning, transformation, and aggregation using suitable tools.
- Create and interpret charts, dashboards, and visualizations to derive data insights.
- Design basic data models and apply analytical techniques to solve real-world problems.

List of Experiments:

1.	Load, clean, transform, and analyze sales data from CSV, Excel, and JSON files.
2.	Retrieve weather data using a web API and analyze and visualize weather patterns.
3.	Clean and prepare customer churn data by handling missing values, duplicates, outliers, and feature transformation.
4.	Analyze stock market data using time-series visualization, moving averages, and forecasting techniques. smoothing models to forecast future stock prices.
5.	Perform data wrangling on real estate data using filtering, encoding, aggregation, and outlier handling. average sale prices by neighborhood or property type.
6.	Visualize air quality trends and pollutant relationships using Matplotlib.
7.	Aggregate and visualize retail sales data to compare regional and product performance
8.	Analyze business sales, cost, profit, and break-even using Excel or LibreOffice Calc.
9	Develop an interactive sales dashboard with KPIs, charts, filters, and data insights using Stream lit.
10	Design a customer-product data model using an ER diagram and identify basic data privacy and security measures.

References:

1. Gelman, Andrew, and Jennifer Hill, "Data Analysis Using Regression and Multilevel/Hierarchical Models", 1st edition, Cambridge, UK: Cambridge University Press, 2006, ISBN: 9780521867061
2. David Dietrich, Barry Hiller, "Data Science and Big Data Analytics", EMC education services, Wiley publication, 2012, ISBN: 0-07-120413-X

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PROGRAM ELECTIVE - I

(Select any one course from the given Program Elective Courses)

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: V**		
Course: PEC: Program Elective Course - I :Computer Vision							**Code:** AMPE501A		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

- Basic Python Programming
- Fundamentals of Machine Learning
- Basic Mathematics for AI
- Introduction to Deep Learning

Course Objectives:

- To develop students' understanding of computer vision and image processing techniques.
- To enable students to apply feature extraction, segmentation, object detection, and deep learning methods.
- To provide practical exposure to modern computer vision applications, including Vision Transformers and Generative AI.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply image preprocessing and enhancement techniques.
CO2	Implement feature extraction and segmentation algorithms.
CO3	Develop deep learning models for computer vision applications.
CO4	Build object detection and video analytics systems.
CO5	Analyze advanced computer vision architectures and emerging AI technologies.
CO6	Design intelligent real-world AI vision applications.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Fundamentals of Computer Vision and Image Processing:** Introduction to Computer Vision, applications, image representation, image digitization, sampling and resolution, digital image types, RGB and HSV color spaces, histogram equalization, image filtering, smoothing, sharpening, morphological operations, OpenCV basics.	7
2.	**Feature Extraction and Mid-Level Vision:** Edge detection using Sobel and Canny, Hough Transform, RANSAC, feature extraction using SIFT, ORB, HoG descriptors, feature matching techniques, pedestrian detection using SVM, contour analysis and semantic information extraction.	6
3.	**Image Segmentation and Deep Learning for Vision:** Semantic and instance segmentation, K-Means and Mean-Shift clustering, Vision Transformers basics, CNN architecture, transfer learning, MobileNet, XceptionNet, segmentation architectures including SAM, Detectron, SOLO, CondInst, segmentation metrics (IoU, Pixel Accuracy).	7
4.	**Image Classification and Object Detection:** Pattern recognition methods, image classification using CNNs, evaluation metrics (Accuracy, Precision, Recall, F1-Score, ROC-AUC), object detection using YOLOv8, SSD and	6

	Faster R-CNN, object localization, multi-label classification, mAP evaluation metrics, skin detection and industrial inspection applications.	
5.	**Object Tracking and Semantic Understanding:** Motion detection, Mean-Shift tracking, Kalman Filters, DeepSORT, SiamFC, scene labeling, semantic hierarchy, visual bag of words, semantic image understanding, patch classification in medical images and intelligent surveillance systems.	6
6.	**Edge AI and Emerging Trends in Computer Vision:** Edge devices for vision (ESP32-CAM, Raspberry Pi, NVIDIA Jetson, Google Coral), OpenVINO, CUDA, multimodal AI, OCR using Tesseract and EasyOCR, LayoutLM, Vision-Language Models, autonomous vision systems, ethical AI in vision, real-world industrial and healthcare applications.	7
	TOTAL	**39 Hrs.**

Text Books:

1.Digital Image Processing – Rafael C. Gonzalez & Richard E. Woods
2. Computer Vision: Algorithms and Applications – Richard Szeliski
3. Learning OpenCV – Gary Bradski & Adrian Kaehler

Reference Books:

- IBM Quantum Experience (Qiskit tutorials)
- Coursera / edX Quantum Computing Courses
- Microsoft Quantum Development Kit Documentation

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: V**		
Course: PEC: Program Elective Course – I: Cloud Computing							**Code:** AMPE501B		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Basics of Computer Networks, Operating Systems

Course Objectives:

- To develop students' understanding of cloud computing concepts and technologies.
- To enable students to understand key issues, challenges, and services in cloud computing.
- To provide an understanding of cloud computing as a next-generation computing paradigm.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explore the fundamentals of cloud
CO2	Illustrate cloud-enabling technology
CO3	Discuss cloud services types and providers
CO4	Discuss data storage in the cloud
CO5	Explore cloud security mechanisms
CO6	Examine common standards in cloud computing

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Fundamentals of Cloud Computing** **Understanding Cloud Computing:** Origin and Influences of History, definitions, technology innovations; Cloud Computing terminologies, Applications, benefits and limitations, risk and challenges; Roles and Boundaries, Cloud characteristics, Cloud Delivery Models, Deployment Models	6
2.	**Common Enabling Technology** **Hardware and Infrastructure:** Clients- mobile, thin, thick; Security- data leakage, offloading work, logging, forensics, development, auditing; Network-basic public Internet and accelerated Internet; Services- Identity, Integration, Mapping, Payments, Search. **Cloud Enabling Technology:** Broadband Networks and Internet Architecture, Data Center Technology, Virtualization Technology, Web Technology, Multitenant Technology, Containerization	7
3.	**Cloud Architecture:** Layered Cloud Architecture Design, NIST Cloud Computing Reference Architecture **Cloud Service Types:** Software as a Service, Platform as a Service, Infrastructure as a Service,	6

	Database as a Service, Monitoring as a Service, Communication as a service.**Cloud Service Providers:** Google- Google App Engine, EMC-Technologies, VMware Acquisition, Microsoft- Azure Services Platform; Amazon- Amazon Elastic Compute Cloud (EC2), Amazon Simple DB, Amazon Simple Storage Service (S3).	
4.	**Cloud File System:** GFS and HDFS, Big Table, HBase and Dynamo **Cloud data stores:** Datastore and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers, Creating Cloud Storage Systems, Virtual Storage Containers, Challenges.	6
5.	**Cloud Security** **Cloud Security:** Basic Terms and Concepts-Confidentiality, Integrity, Authenticity, availability, Threat, Vulnerability, Risk, Security Control, Security Mechanisms, and Security Policies. **Cloud Security Mechanism:** Encryption, Hashing, Digital Signature, Public Key Infrastructure (PKI), Identity and Access Management (IAM), Single Sign-On (SSO)	7
6.	**Cloud Technologies and Advancements** **Cloud Technologies:** Overview of Hadoop, MapReduce, Virtual Box, Google App Engine, Programming Environment for Google App Engine **Advanced levels of cloud:**Open Stack, Federation in the Cloud, Four Levels of Federation, Federated Services and Applications, Future of Federation.	7
	TOTAL	**39 Hrs.**

Text Books:
1. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Pearson May 2013, ISBN: 9780133387568. 2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hil, 2009.
Reference Books:
1. Thomas Erl, Zaigham Mahmood and Ricardo Puttini 2. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra
E-Resources:
Preview: Cloud computing | SWAYAM nevonprojects.comextracurriculard-computing

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)								**Semester: V**	
Course: PEC: Program Elective Course – I: Intelligent system								**Code: AMPE501C**	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Basic knowledge of programming, mathematics, artificial intelligence, and machine learning concepts.

Course Objectives:

- To develop students' understanding of intelligent systems, their architectures, and applications.
- To enable students to apply knowledge representation, reasoning, and machine learning techniques for real-world problem-solving.
- To provide practical exposure to AI-based systems and emerging technologies such as autonomous agents, expert systems, and Generative AI.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the fundamental concepts, architecture, and components of intelligent systems.
CO2	Apply knowledge representation and reasoning techniques to solve AI problems.
CO3	Develop intelligent systems using machine learning and decision-making algorithms.
CO4	Design and implement intelligent agents and expert systems for real-world applications.
CO5	Evaluate the performance of intelligent systems using appropriate AI techniques and metrics
CO6	Analyze and develop AI-driven intelligent solutions for applications in healthcare, robotics, finance, and smart systems.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Intelligent Systems** Introduction to Intelligent Systems: Definition, characteristics, components, intelligent agents, problem-solving approaches, search strategies, knowledge-based systems, applications of intelligent systems, and AI foundations.	7
2.	**Knowledge Representation and Reasoning** Knowledge representation techniques, propositional and predicate logic, semantic networks, frames, ontologies, rule-based systems, inference mechanisms, uncertainty handling, and reasoning under uncertainty.	6
3.	**Machine Learning for Intelligent Systems** Supervised, unsupervised, and reinforcement learning, decision trees, Bayesian learning, neural networks, feature engineering, model evaluation, and intelligent decision-making systems.	7
4.	**Intelligent Agents and Expert Systems** Types of intelligent agents, agent architectures, multi-agent systems, expert systems, knowledge acquisition, inference engines, fuzzy logic, and applications of expert systems.	6
5.	**Deep Learning and Emerging Intelligent Technologies** Deep learning fundamentals, Convolutional Neural Networks (CNNs), Recurrent	7

	Neural Networks (RNNs), Transformers, Generative AI, Explainable AI (XAI), and ethical issues in intelligent systems.	
6.	**Applications of Intelligent Systems** Intelligent healthcare, smart cities, robotics, autonomous vehicles, finance, cybersecurity, recommendation systems, industrial automation, and case studies on real-world intelligent system development and deployment.	6
	TOTAL	**39 Hrs.**

Text Books:

- Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems, 3rd Edition, Pearson Education, 2011.
- Deepak Khemani, A First Course in Artificial Intelligence, McGraw-Hill Education, 2017.
- Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, 3rd Edition, McGraw-Hill Education, 2009.
- George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th Edition, Pearson, 2009.

Reference Books:

- Ivan Bratko, Prolog Programming for Artificial Intelligence, 4th Edition, Addison-Wesley, 2012.
- Ethem Alpaydin, Introduction to Machine Learning, 4th Edition, MIT Press, 2020.
- Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
- Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, MIT Press, 2016.

E-Resources:

1. Stanford University – CS221: Artificial Intelligence: https://stanford-cs221.github.io/
2. edX – Artificial Intelligence Programs https://edx.org/learn/artificial-intelligence

OPEN ELECTIVE - III

(Select any one course from the given Open Elective Courses)

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)								**Semester:** V	
Course: Open Elective – III (Data Analytics)								**Code:** ALOE503A	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	-	-	50	50	-	100

Prerequisites:

Basic knowledge of Mathematics and Statistics, Fundamentals of Computer Science

Course Objectives:

1. To introduce the types and applications of data analytics across domains.
2. To apply descriptive statistics and visualization techniques to summarize data.
3. To apply inferential statistics and hypothesis testing for decision-making.
4. To analyze relationships in data using correlation, regression, and ANOVA.
5. To build predictive models using classification and clustering techniques.
6. To familiarize students with prescriptive analytics and Big Data concepts.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the types of data analytics and their applications across domains.
CO2	Apply descriptive statistics and visualization techniques to summarize data.
CO3	Analyze data using inferential statistics and hypothesis testing methods.
CO4	Apply correlation, regression, and ANOVA techniques for data-driven decisions.
CO5	Design predictive models using classification and clustering approaches.
CO6	Evaluate prescriptive analytics approaches and Big Data platforms for applications.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Data Analytics:** Types of analytics — descriptive, diagnostic, predictive, and prescriptive; Analytics vs. reporting; Key applications across domains: business, healthcare, finance, and marketing; Overview of analytics tools landscape: Excel, Python, R, and Power BI (comparative overview); KPIs and metrics for decision-making.	04
2.	**Descriptive Analytics:** Frequency distributions, outliers; Measures of central tendency and dispersion; Interquartile range; Skewness and kurtosis; Normal distribution and z-scores; Data visualization principles: bar chart, histogram, box plot, scatter plot, and heat map.	05
3.	**Inferential Statistics:** Population vs. sample, random sampling; Sampling distribution, standard error; Hypothesis testing: null and alternate hypothesis, z-test, t-test; One-tailed and two-tailed tests; Confidence intervals and level of confidence; Type I and Type II errors.	05
4.	**Correlation, Regression & ANOVA:** Correlation and scatter plots; Simple linear regression, least squares method;	04

	Multiple regression; Coefficient of determination (R^2); One-way and two-way ANOVA; Chi-square test of independence.	
5.	**Predictive Analytics:** Introduction to predictive modeling; Classification techniques: logistic regression, decision trees; Clustering: k-means; Model evaluation: accuracy, confusion matrix; Time series analysis basics: moving averages, trend analysis.	04
6.	**Prescriptive & Big Data Analytics:** Prescriptive analytics: optimization and simulation for decision-making; Introduction to Big Data: the 5 V's, sources of big data; Overview of the Big Data ecosystem: Hadoop, Spark (conceptual only); Applications: business analytics, web analytics, and social media analytics.	04
	TOTAL	**26**

Term Work:

Sr. No.	Title	Proposed Tutorial Activities
1	Introduction to Data Analytics	Identify descriptive, diagnostic, predictive, and prescriptive analytics using real-world case studies. Compare Excel, Python, R, and Power BI for analytics tasks.
2	Descriptive Statistics – I	Calculate mean, median, mode, range, variance, and standard deviation using a given dataset in Excel/Python.
3	Descriptive Statistics – II	Detect outliers using IQR and visualize distributions using histograms and box plots.
4	Data Visualization	Create bar charts, scatter plots, heat maps, and box plots. Interpret insights from visualizations.
5	Sampling & Probability	Perform random sampling, calculate standard error, and differentiate between population and sample using datasets.
6	Hypothesis Testing	Perform z-test and t-test for given scenarios and interpret Type I and Type II errors.
7	Correlation & Regression	Calculate correlation coefficients, build simple linear regression models, and interpret R^2 values.
8	ANOVA & Chi-Square	Perform one-way ANOVA and Chi-square tests using statistical software and interpret results.
9	Predictive Analytics	Build basic classification models (Logistic Regression/Decision Tree) and perform K-Means clustering using Python.
10	Model Evaluation	Evaluate predictive models using confusion matrix and accuracy metrics.

11	Time Series Analytics	Apply moving averages and identify trends in time-series datasets.
12	Big Data & Prescriptive Analytics	Explore Hadoop and Spark concepts through case studies and discuss optimization-based decision-making.

Text Books:

1. Anil Maheshwari, "Data Analytics", McGraw Hill Education
2. Robert S. Witte and John S. Witte, "Statistics", Wiley Publications
3. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley India

Reference Books:

1. Seema Acharya and Subhashini Chellappan, "Big Data and Analytics", Wiley India
2. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press

E-Resources:

1. NPTEL Course on "Introduction to Data Analytics" (IIT Madras Track)
   Link: nptel.ac.in
2. NPTEL Course on "Data Analytics with Python" (IIT Roorkee Track)
   Link: https://nptel.ac.in/courses/106107220
3. NPTEL Course on "Business Intelligence & Analytics" (IIT Madras Track)
   Link: https://onlinecourses.nptel.ac.in/noc25_cs09/preview
4. NPTEL Course on "Business Analytics for Management Decision" (IIT Kharagpur Track)
   Link: https://nptel.ac.in/courses/110105089
5. Coursera: "Google Data Analytics Professional Certificate" Link: coursera.org
6. edX: "Data Science: Statistics and Machine Learning" by Harvard University
   Link: edx.org

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)								**Semester:** V	
Course: Open Elective – III (Green Building)								**Code:** ALOE503B	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	-	-	50	50	-	100

Prerequisites:

Basic environmental engineering, building materials & construction, engineering chemistry/ environmental science, basic knowledge of energy and sustainability concepts

Course Objectives:

1. To equip students with the principles of sustainable building design, resource-efficient construction, and green building practices.
2. To provide students with knowledge of energy-efficient technologies, water and waste management, sustainable materials, and green building rating systems.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the concepts, principles, benefits, and environmental impacts associated with green buildings and sustainable development.
CO2	Assess building orientation, climate-responsive planning, landscaping, green roofs, and green walls for improving environmental performance.
CO3	Evaluate building energy consumption and recommend energy-efficient strategies, HVAC optimization, renewable energy systems, and conservation measures.
CO4	Design suitable water conservation, rainwater harvesting, greywater recycling, waste management, and sustainable drainage solutions for buildings.
CO5	Select appropriate sustainable building materials and assess indoor environmental quality based on thermal comfort, indoor air quality, lighting, and acoustics.
CO6	Compare major green building rating systems such as IGBC, GRIHA, and LEED and apply their principles to assess building sustainability.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Green Buildings:** Definition, concept, and need of green buildings, Sustainable development principles, Environmental impacts of conventional buildings, Benefits of green buildings.	05
2.	**Sustainable Planning & Architecture:** Sustainable planning, Orientation and climate-responsive design, Landscape planning, Green roofs and walls.	05
3.	**Energy Efficiency in Buildings:** Energy consumption in buildings, Energy-efficient building design, HVAC optimization, Renewable energy systems (solar, wind), Energy audit and conservation techniques.	04
4.	**Water & Waste Management:** Water conservation techniques, Rainwater harvesting systems, Greywater recycling, Waste management in buildings, Sustainable drainage systems.	04

5.	**Sustainable Materials & Indoor Environmental Quality:** Eco-friendly building materials, Low embodied energy materials, Recycled and locally available materials, Indoor air quality (IAQ), Thermal comfort, lighting, and acoustics.	04
6.	**Green Building Rating Systems & Regulations:** Overview of rating systems: Indian Green Building Council (IGBC) Green Rating for Integrated Habitat Assessment (GRIHA) Leadership in Energy and Environmental Design (LEED)	04
	TOTAL	**26**

Teamwork : (Any 10)

1. Study any IGBC/GRIHA certified building and identify the sustainable features adopted.
2. Study how sustainable development principles have been implemented in any residential, commercial, or institutional building.
3. Study a construction project and identify its environmental impacts. Suggest green alternatives to reduce these impacts.
4. Analyze building designed using passive architectural principles.
5. Study the site planning of a green campus, township, or commercial complex.
6. Study an existing building incorporating green roofs or vertical gardens.
7. Study an energy-efficient building and identify passive design strategies adopted.
8. Study a building utilizing renewable energy systems and evaluate their benefits.
9. Analyze an energy audit report (or published case study) and summarize the recommended energy-saving measures.
10. Study water conservation measures implemented in any green building.
11. Study a residential or institutional building with rainwater harvesting and grey water reuse systems.
12. Study the waste management practices of a smart city, residential township, or institutional campus.
13. Study a building that has extensively used sustainable building materials.
14. Perform a literature review on the life cycle assessment of one construction material.
15. Study an office, hospital, educational building, or green building focusing on indoor environmental quality improvements.
16. Compare two certified buildings, each evaluated under different rating systems (e.g., IGBC vs LEED or GRIHA vs IGBC).
17. Study the certification journey of an IGBC or GRIHA certified building.

Text Books:

1. K.S. Jagadeesh, "Alternative Building Materials and Technologies", New Age International.
2. C.J. Kibert, "Sustainable Construction: Green Building Design and Delivery", Wiley.
3. Charles J. Kibert, "Green Buildings: Principles and Practices", Island Press.

Environmental Legislations & Standards:

Indian Regulations

1. Environment (Protection) Act, 1986
2. Energy Conservation Act, 2001
3. National Building Code (NBC) of India
4. Eco-Niwas Samhita (Energy Conservation Building Code – Residential)

Standards & Guidelines

1. Energy Conservation Building Code (ECBC)
2. GRIHA & IGBC rating guidelines
3. LEED certification standards
4. Bureau of Energy Efficiency (BEE) norms

Reference Books:

1. O.H. Koenigsberger, "Manual of Tropical Housing and Building", Orient BlackSwan
2. G.Z. Brown and Mark DeKay, "Sun, Wind & Light", Wiley
3. Laurie Baker, "Building with Earth", Centre for Science and Environment
4. Indian Green Building Council, "IGBC Manuals and Guidelines", CII – Indian Green Building Council

E-Resources:

1. Indian Green Building Council - https://igbc.in
2. Green Rating for Integrated Habitat Assessment - https://grihaindia.org
3. U.S. Green Building Council - https://usgbc.org
4. NPTEL Green Building courses - https://nptel.ac.in
5. Ministry of Environment, Forest and Climate Change - https://moef.gov.in

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)								**Semester:** V	
Course: Open Elective – III (Electrical Mobility)								**Code:** ALOE503C	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	-	-	50	50	-	100

Prerequisites:

Basic Electrical and Electronics Engineering.

Course Objectives:

1. To apply fundamental principles of electric mobility to interpret EV architectures, components and applications.
2. To utilize energy storage and battery management concepts to evaluate battery performance, charging, and safety.
3. To implement basic concepts of EV powertrains, electric drives, regenerative braking, and charging infrastructure.
4. To integrate smart charging, vehicle-to-grid, IoT, and emerging technologies for sustainable electric mobility.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the concepts, architecture, and applications of Electric and Hybrid Electric Vehicles.
CO2	Identify the suitable energy storage systems used in electric vehicles.
CO3	Illustrate battery charging methods, battery management systems, and SoC estimation techniques.
CO4	Interpret hybrid powertrain configurations, operating modes, and regenerative braking.
CO5	Demonstrate the use of electric drives, charging levels, charging standards, and EV charging equipment.
CO6	Describe EV charging technologies and grid integration concepts such as G2V, V2G, V2H, V2B, and V2V.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Electric Mobility:** Need for electric mobility, evolution of EVs, advantages and challenges, environmental and economic aspects, EV vs conventional vehicles, types of EVs: BEV, HEV, PHEV and fuel-cell vehicles, basic EV architecture and major components.	04
2.	**Energy Storage Systems:** Energy storage requirements, battery terminology and specifications, Li-ion batteries and their types, basic battery characteristics, battery alternatives: solid-state, Aluminium-air, fuel cell and supercapacitor, battery–supercapacitor hybrid system, selection of energy storage system.	04
3.	**Battery Charging and Management:** EV charging basics, AC and DC charging, charging methods and levels, charging time and factors affecting charging, Battery Management System (BMS),	05

	functions of BMS, State of Charge (SoC), State of Health (SoH), State of Power (SoP), cell balancing, battery thermal management and safety.	
4.	**EV Powertrain and Electric Drives:** EV powertrain architecture, energy flow in EVs, vehicle performance and basic tractive effort, electric motors used in EVs: BLDC and PMSM, motor selection, basic drive control, regenerative braking and its benefits.	04
5.	**EV Charging Infrastructure:** EV charging infrastructure, charging levels, AC/DC chargers, EVSE, charging connectors and standards: CCS, CHAdeMO, SAE J1772, Bharat AC/DC, basic charging station components, installation and safety considerations.	04
6.	**Smart and Emerging Electric Mobility:** Grid-to-Vehicle (G2V), Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Vehicle-to-Building (V2B), Vehicle-to-Vehicle (V2V), smart charging, wireless charging, battery swapping, energy management, IoT and digital technologies in EVs, future trends and challenges.	05
	TOTAL	**26**

Teamwork :

1. Study the architecture of an Electric Vehicle (EV) and identify the functions of major components such as battery, BMS, motor, inverter, charger, controller and sensors.
2. Compare 3–5 EVs available in India based on battery capacity, motor power, driving range, charging time, efficiency, cost and other key specifications.
3. Study and compare different energy storage technologies such as Li-ion batteries, solid-state batteries, fuel cells and supercapacitors based on energy density, charging time, life, cost, safety and applications.
4. Visit an EV charging station and study the charger type, AC/DC charging, charging level, connector/standard, power rating, and charging time and safety provisions.
5. Prepare a basic layout of an EV charging station showing charging points, power supply, protection system, parking area, cable routing, safety provisions and user facilities.
6. Study smart EV charging and Vehicle-to-Grid (V2G) concepts, including G2V, V2G, V2H and V2B, and identify their applications in smart grids and buildings.
7. Collect and analyze EV performance or charging data using Excel/Python/MATLAB and study parameters such as battery capacity, range, charging time and energy consumption.
8. Design a conceptual IoT-based EV monitoring system showing sensors, communication network, cloud platform and user interface for monitoring SoC, temperature, charging status and energy consumption.
9. Study regenerative braking in EVs and prepare an energy-flow diagram. Analyze energy recovery under different braking conditions using numerical calculations or simulation.
10. Study an emerging EV technology such as battery swapping, wireless charging, solid-state batteries, autonomous EVs, solar charging or second-life batteries and evaluate its technical, economic and environmental benefits.

Text Books:

1. James Larminie and John Lowry, "Electric Vehicle", John Wiley & Sons, 2012.
2. Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE International.
3. K. T. Chau, "Energy Systems for Electric and Hybrid Vehicles", The Institution of Engineering and Technology.

4. D. A. J. Rand, R. Woods, and R. M. Dell, "Batteries for Electric Vehicles", Research Studies Press Ltd., New York, John Wiley & Sons.
5. "Electric & Hybrid Vehicles – Design Fundamentals", CRC Press.

Reference Books:

1. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.
2. Junwei Lu and Jahangir Hossain et al. (Eds.), "Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library.
3. Tom Denton, "Automobile Electrical and Electronic Systems", SAE International Publications.
4. C. Mi, M. A. Masrur, and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
5. Mark Warner, "The Electric Vehicle Conversion Handbook", HP Books, 2011.

E-Resources:

1. https://www.theiet.org/resources/books/transport/vehicle2grid.cfm
2. https://www.sae.org/publications/books/content/pt-143.set/
3. http://nptel.ac.in/courses/108103009/

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (Mechanical Engineering)								**Semester:** V	
Course: Open Elective – III (Introduction to Stock Market)								**Code:** ALOE503D	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	-	-	50	50	-	100

Prerequisites:

- Basic knowledge of economics and financial systems.
- Familiarity with percentage calculations and simple mathematics.
- Interest in investing and financial markets.

Course Objectives:

1. To understand the structure and functioning of financial and stock markets along with investor psychology.
2. To apply candlestick patterns and indicators for identifying market trends.
3. To understand the fundamentals of option trading and option pricing concepts.
4. To develop short-term and long-term investment strategies using fundamental and technical analysis.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the functioning of financial markets using fundamental analysis
CO2	Analyze stock price movements using candlestick patterns for trading decisions.
CO3	Analyze stock price movements using technical indicators for trading decisions.
CO4	Describe the concepts of derivatives and option trading.
CO5	Apply the strategies for option trading.
CO6	Apply investment strategies based on market analysis.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Fundamental Analysis and Investor Psychology:** Introduction to Financial Markets, Primary and Secondary Markets, Market Participants, Stock Exchanges, SEBI and Regulatory Framework, Investment vs Trading, Understanding Business Models, Reading Financial Statements (Balance Sheet, Profit & Loss Account, Cash Flow Statement), Fundamental Ratios (EPS, PE Ratio, PB Ratio, ROE, ROCE, Debt-Equity Ratio), Sector Analysis, Economic Indicators, Investor Psychology, Market Emotions (Fear & Greed), Behavioral Biases, Risk Management Principles.	06
2.	**Technical Analysis using Candlestick Charts:** Introduction to Technical Analysis, Dow Theory, Support and Resistance, Trend Analysis, Price Action Concepts Candlestick Anatomy: Single Candlestick Patterns (Doji, Hammer, Shooting Star, Marubozu, Spinning Top), Double Candlestick Patterns (Bullish & Bearish Engulfing, Harami, Piercing Pattern, Dark Cloud Cover), Triple Candlestick Patterns (Morning Star, Evening Star, Three White Soldiers, Three Black Crows),	04

	Gap Analysis, Trend Reversal and Continuation Patterns.	
3.	**Technical Analysis using Indicators:** Technical Indicators : Moving Averages (SMA, EMA), MACD, RSI, Stochastic Oscillator, Bollinger Bands, VWAP, ADX, ATR, Volume Analysis, Fibonacci Retracement, Pivot Points, Trend Confirmation, Indicator-Based Trading Strategies, Combining Multiple Indicators, Entry and Exit Rules, Backtesting Concepts.	04
4.	**Introduction to Derivatives and FNO:** Introduction to Derivatives, Futures and Options, Types of Options (Call and Put), Option Terminology (Strike Price, Expiry, Premium, Lot Size, Open Interest), Intrinsic and Time Value, ITM, ATM, OTM Options, Option Chain Analysis, Greeks (Delta, Gamma, Theta, Vega, Rho - Basic Concepts), Option Pricing Factors, Option Expiry and Settlement Process.	04
5.	**Introduction to Option Trading Strategies:** Option Buying vs Option Selling, Risk and Reward Analysis, Long Call, Long Put, Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread, Bull Put Spread, Bear Call Spread, Iron Condor (Basic Concept), Straddle and Strangle (Introduction), Position Sizing, Stop Loss Techniques, Capital Management, Risk Management in Options Trading.	04
6.	**Short-Term and Long-Term Trading & Investment Strategies:** Swing Trading, Positional Trading, Intraday Trading (Overview), Momentum Trading, Breakout Trading, Trend Following Strategies, Portfolio Building, Value Investing, Growth Investing, Dividend Investing, SIP in Equity, Asset Allocation, Diversification, Trading Plan Development, Trading Journal, Performance Evaluation, Common Mistakes Made by Traders and Investors, Ethics in Financial Markets.	04
	Total	**26**

Term Work:

Perform Any 10:

Sr No	Title	Proposed Activities
1	Stock Market Basics & Trading Platform	Introduction to NSE & BSE, SEBI, Demat & Trading Accounts, Market Participants, Creating a Paper Trading Account.
2	Fundamental Analysis – I	Reading Financial Statements, EPS, PE Ratio, Book Value, Market Capitalization, Sector Analysis
3	Fundamental Analysis – II & Investor Psychology	Company Comparison, Economic Indicators, Market Cycles, Fear & Greed, Trading Discipline
4	Candlestick Analysis – I	Candlestick Anatomy, Doji, Hammer, Shooting Star, Marubozu, Trend Identification
5	Candlestick Analysis – II	Bullish/Bearish Engulfing, Morning Star, Evening Star, Support & Resistance using Charts
6	Technical Indicators – I	SMA, EMA, Volume Analysis, Trend Identification

		using TradingView
7	Technical Indicators – II	RSI, MACD, Bollinger Bands, VWAP, Indicator-based Entry & Exit
8	Option Trading Fundamentals	Call & Put Options, Strike Price, Premium, Expiry, Option Chain Analysis
9	Option Buying Strategies	Long Call, Long Put, Break-even Calculation, Risk & Reward Analysis
10	Option Selling Strategies	Covered Call, Cash Secured Put, Bull Call Spread, Bear Put Spread
11	Short-term Trading Strategies	Intraday (Concept), Swing Trading, Breakout Trading, Risk Management
12	Long-term Investment Strategies	Value Investing, Growth Investing, Dividend Investing, Portfolio Diversification

Students should spend most of the session on:

- Live chart analysis using TradingView or similar platforms.
- Analyzing real companies using NSE/BSE financial data.
- Paper trading (no real money involved).
- Maintaining a trading journal.
- Presenting and reviewing trading decisions.

Reference Books:

1. John J. Murphy, "Technical Analysis of the Financial Markets", Pearson.
2. Benjamin Graham, "The Intelligent Investor", Harper Business.
3. Martin J. Pring, "Technical Analysis Explained", McGraw-Hill.
4. Sheldon Natenberg, "Option Volatility and Pricing", McGraw-Hill.
5. Aswath Damodaran, "Investment Valuation", Wiley.
6. Alexander Elder, "Trading for a Living", Wiley.

E-Resources:

1. National Stock Exchange (NSE) Learning Portal – https://www.nseindia.com ….. learn tab
2. Bombay Stock Exchange (BSE) Investor Education – https://www.bseindia.com
3. SEBI Investor Education – https://investor.sebi.gov.in
4. NISM (National Institute of Securities Markets) – https://www.nism.ac.in
5. Zerodha Varsity – https://zerodha.com/varsity
6. Investopedia – https://www.investopedia.com

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)								**Semester:** V	
Course: Open Elective – III (Patent Law for Engineers and Scientists)								**Code:** ALOE503E	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	-	-	50	50	-	100

Prerequisites:

Basic understanding of engineering/scientific concepts and technological innovation, Basic skills in technical reading, documentation, and report writing.

Course Objectives:

1. To understand the importance of Intellectual Property Rights (IPR) and patents.
2. To identify patentable and non-patentable inventions based on patentability criteria.
3. To conduct prior-art and patent searches using public patent databases.
4. To draft a basic patent specification, including claims and abstract.
5. To understand and apply the complete patent filing, examination, and granting process in India.
6. To analyze engineering case studies involving patents, innovation, and commercialization.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply the provisions of the Indian Patent Law to engineering inventions.
CO2	Perform prior-art and patent searches using standard patent databases.
CO3	Analyze the patentability, filing, examination, and grant process under the Indian Patent Act.
CO4	Evaluate patent infringement, licensing, technology transfer, and commercialization issues.
CO5	Draft a patent specification, including claims and abstract, in compliance with patent law.
CO6	Develop a patent application for an innovative engineering solution following legal and procedural requirements.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Intellectual Property Rights and Patents:** Introduction to Intellectual Property Rights (IPR), significance of IPR in engineering, innovation and entrepreneurship, types of IPR, concept and objectives of patents, patentability criteria (novelty, inventive step and industrial applicability), patentable and non-patentable inventions under the Indian Patent Act, 1970, patents versus research publications and products, role of patents in technology commercialization and startup ecosystem. **Case Study:** Patentability analysis of a simple engineering innovation.	05
2.	**Indian Patent Law and Prior-Art Search:** Overview of the Indian Patent Act, 1970 and its amendments, objectives and scope of patent law, rights and duties of inventors, overview of WIPO, Patent Cooperation Treaty (PCT) and international patent systems, prior-art search techniques, patent classification systems, patent search using Google Patents, InPASS, Espacenet, and WIPO PATENTSCOPE novelty assessment and patent landscape analysis.	04

	Case Study: Prior-art search and novelty analysis of an engineering invention.	
3.	**Patent Drafting:** Structure and components of a patent specification including title, field of invention, background, prior art, problem statement, objectives, summary of invention, brief description of drawings, detailed description, claims, abstract, and drawings. Principles of claim drafting, dependent and independent claims, patent drafting guidelines, common drafting errors, and patent documentation for engineering innovations. **Case Study:** Drafting of a patent specification for a smart engineering product.	05
4.	**Patent Filing, Examination and Grant:** Patent filing procedure in India, provisional and complete specification, online filing process, statutory forms, publication of patent application, request for examination, First Examination Report (FER), response to objections, hearing process, patent grant, renewal, restoration, opposition, and maintenance of patents under the Indian Patent Act. **Case Study:** Patent filing and grant timeline of an Indian engineering patent.	04
5.	**Patent Commercialization and Legal Issues:** Patent ownership, licensing, assignment, technology transfer, patent valuation, startup and university patents, patent infringement, remedies and dispute resolution, freedom-to-operate (FTO), patent analytics, commercialization strategies, and ethical issues in patent protection. **Case Study:** Commercialization of a patented engineering innovation.	04
6.	**Emerging Technologies and Patent Case Studies:** Patents in Artificial Intelligence, Machine Learning, Internet of Things (IoT), Robotics, Semiconductor Technology, Biotechnology, Software, Green Technologies, and Industry 4.0, AI-generated inventions, recent developments in patent law, international patent trends, patent portfolio management, and innovation-driven entrepreneurship. **Case Study:** Analysis of landmark patent disputes such as Apple vs Samsung or an Indian engineering innovation, along with preparation of a basic patent draft for an engineering solution.	04
	Total	**26**

Term Work:

Students shall complete the following practical, activity-oriented assignments based on a selected engineering innovation/project:

1. Identify suitable IP protection for an engineering innovation and assess basic patentability criteria.
2. Conduct patent searches using Google Patents, IP India, WIPO PATENTSCOPE and Espacenet and analyze the novelty of the selected innovation.

3. Identify a copyrightable work such as software, technical content or digital work and prepare/undertake the copyright registration process.
4. Develop a product/start-up brand, conduct trademark search, identify the appropriate class and prepare a basic trademark application.
5. Identify protectable visual features of an engineering product, conduct design search and prepare a basic design registration application.
6. Prepare a basic patent specification including title, background, objectives, description, drawings, abstract and claims for an engineering innovation.
7. Prepare a mock provisional/complete patent application and study the filing, publication, examination, FER, response and grant process in India.
8. Study the PCT route and prepare a mock PCT application based on the selected engineering invention.
9. Analyze patents in a selected emerging technology area and identify major patent holders, technology trends and basic FTO considerations.
10. Develop an IP portfolio for the selected innovation covering patent, copyright, trademark/design and propose a basic commercialization strategy.

Text Books:

1. P. Narayanan, "Patent Law", Eastern Law House.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw-Hill.
3. N. S. Gopalakrishnan and T. G. Agitha, "Principles of Intellectual Property", Eastern Book Company.
4. Government of India, "The Patents Act, 1970 (as amended) and The Patents Rules, 2003 (as amended)", Government of India.

Reference Books:

1. David Pressman, "Patent It Yourself", NOLO Publications.
2. WIPO, "WIPO Intellectual Property Handbook: Policy, Law and Use", World Intellectual Property Organization.
3. Indian Patent Office, "Manual of Patent Office Practice and Procedure", Office of the Controller General of Patents, Designs & Trade Marks (CGPDTM), Government of India.
4. Alexander I. Poltorak and Paul J. Lerner, "Essentials of Intellectual Property", John Wiley & Sons.

E-Resources:

1. **Patent Law for Engineers and Scientists** – NPTEL (IIT Madras): https://nptel.ac.in/courses/110106081
7. **Intellectual Property** – NPTEL (IIT Madras): https://nptel.ac.in/courses/109106137

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)									**Semester: V**
Course: MDM- IOT with Artificial Intelligence									**Code: AMMD503**
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	2	-	02	-	-	-	50	-	50

Course Objectives:

- To develop students' understanding of IoT fundamentals, architectures, and applications.
- To enable students to develop IoT applications using Arduino, Raspberry Pi, sensors, and Python.
- To provide practical exposure to IoT communication, cloud integration, and machine learning applications.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply IoT concepts to interface sensors, actuators, and embedded devices.
CO2	Apply Python programming to develop basic IoT-based applications using Raspberry Pi or Arduino.
CO3	Analyze IoT communication, client-server architecture, and cloud-based data exchange for IoT applications.

List of Experiments:

1.	Study of Raspberry-Pi, Arduino or other microcontroller (History & Elevation).
2.	Write a Program to interface LED/Buzzer with Raspberry-Pi/ Arduino and write a program to turn on LED for 1s after every 2 sec.
3.	Understanding and connectivity of Raspberry-Pi / Arduino with camera. Write an application to capture and store the image.
4.	Write a program on the Raspberry-pi board / Arduino to upload temperature data to from Thing speak cloud.
5.	To interface an LDR sensor with Raspberry Pi using Python for ambient light detection.
6.	Create a simple web interface for the Raspberry-pi board / Arduino to control the connected LEDs remotely through the interface.
7.	Write a server application to be deployed on the Raspberry-Pi / Arduino. Write client applications to get services from the server application.
8.	Develop an IoT dashboard using ThingSpeak for real-time sensor monitoring and data visualization.
9.	Implement a Machine Learning–based IoT application for sensor data classification or prediction.
10.	Real-life AIoT Mini Project (Home Automation, Healthcare, Smart Agriculture, Smart City, Robotics, Security System, Image Processing, Communication System, etc.).

Text Books:

1. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547.
2. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.

Reference Books:

1. Vijay Madisetti and Arshdeep Bahga, ―Internet of Things (A Hands-on-Approach)‖, 1stEdition, VPT, 2014.
2. Elizabeth Gootman et. al, ―Designing Connected Products‖, Shroff Publisher/O'Reilly Publisher, 2012

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester:** V	
Course: Internship – IV								**Code:** MEIN504	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	-	-	02	-	-	25	-	-	25

Preamble:

Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.

Course Objectives:

1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry.
2. Learn to implement the technical knowledge in real industrial situations.

Course Outcomes: After completion of this course, students will be able to -

CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.

Internship Requirements

1. **Internship Duration:** It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW).
2. **Internship Opportunities:** Students can explore various opportunities for internships at:
    a. Industries
    b. Research labs or organizations
    c. Collegiate clubs
    d. In-house research projects
    e. Online internships
3. **Support and Assistance:** Students can seek assistance for securing internships from:
    a. The Training and Placement cell, along with departmental coordinators
    b. Department or institute faculty members
    c. Personal contacts
    d. Directly connecting with industries or organizations
4. **Request Letter:** Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.

SYLLABUS
SEMESTER - VI

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)							**Semester: VI**		
Course: PCC:Machine Learning							**Code:** AMPC611		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
04	**-**	**-**	**04**	**40**	**60**	**-**	-	-	100

Prerequisites:

Data Science, Data Modeling and Visualization

Course Objectives:

- To develop students' understanding of machine learning paradigms, models, and algorithms.
- To enable students to apply regression, classification, clustering, and ensemble techniques to real-world problems.
- To provide practical exposure to reinforcement learning and its algorithms for intelligent decision-making.

Course Outcomes: After completion of this course, students will be able to -

CO1	Describe and compare different models of machine learning
CO2	Design ML models to make predictions by using linear, non-linear and logistic regression techniques
CO3	Implement classification models for two class problems and multiclass problems
CO4	Implement clustering models for unlabeled data
CO5	Integrate multiple machine learning algorithms in the form of ensemble learning
CO6	Apply reinforcement learning and its algorithms for different applications

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Machine Learning** **Introduction:** What is Machine Learning, Definitions and Real-life applications, Comparison of Machine learning with traditional programming, ML vs AI vs Data Science. **Learning Paradigms:** Learning Tasks- Descriptive and Predictive Tasks, Supervised, Unsupervised, Semi-supervised and Reinforcement Learnings. **Models of Machine learning:** Geometric model, Probabilistic Models, Logical Models, Grouping and grading models, Parametric and non-parametric models. **Feature Transformation:** Dimensionality reduction techniques- PCA and LDA	8
2.	**Regression** **Introduction-** Regression, Need of Regression, Difference between Regression and Correlation, **Types of Regression:** Univariate vs. Multivariate, Linear vs. Nonlinear, Simple Linear vs. Multiple Linear Regression, Bias-Variance tradeoff, Overfitting and Underfitting. **Regression Techniques -** Polynomial Regression, Stepwise Regression, Decision Tree Regression, Random Forest Regression, Support Vector Regression, Ridge Regression, Lasso Regression, Elastic Net Regression, Bayesian Linear Regression. **Evaluation Metrics:** Mean Squared Error (MSE), Mean Absolute Error (MAE), Root Mean Squared Error (RMSE),R-	8

	squared ,Adjusted R-squared	
3.	**Classification** **Introduction:** Need of Classification, Types of Classification (Binary and Multiclass),Binary-vs-Multiclass Classification, Balanced and Imbalanced **Classification Problems.** Binary Classification: Linear Classification model, Performance Evaluation- Confusion Matrix, Accuracy, Precision, Recall, F measures. Multiclass Classification: One-vs-One and One-vs-All classification techniques, Performance Evaluation- Confusion Matrix, Per Class Precision, Per Class Recall **Classification Algorithms:** K Nearest Neighbor, Linear Support Vector Machines (SVM) Introduction, Soft Margin SVM, Kernel functions– Radial Basis Kernel, Gaussian, Polynomial, Sigmoid.	9
4.	**Clustering** **Introduction:** What is clustering, Need of Clustering, Types of Clustering Hierarchical clustering algorithms /connectivity-based clustering): Agglomerative Hierarchical Clustering (AHC) algorithm, Divisive Hierarchical Clustering (DHC) algorithm. Centroid-based clustering algorithms / Partitioning clustering algorithms: K-Means clustering algorithm, Advantages and disadvantages of K-Means clustering algorithm, Elbow method, The Silhouette method, K-Medoids, K-Prototype. Density-based clustering algorithms: DBSCAN algorithm, how it works, Advantages and disadvantages of DBSCAN.	9
5.	**Ensemble Learning** Ensemble Learning: Introduction to Ensemble Learning, Need of Ensemble Learning, Homogeneous and Heterogeneous ensemble methods, Advantages and Limitations of Ensemble methods, Applications of Ensemble Learning. Basic Ensemble Learning Techniques: Voting Ensemble, Types of Voting: Max Voting, Averaging, Weighted Average. Advanced Ensemble Learning Techniques: Bagging: Bootstrapping, Aggregation.Boosting: Adaptive Boosting (AdaBoost), Gradient Boosting, XGBoost .Stacking: Variance Reduction, Blending, Random Forest Ensemble, Advantages of Random Forest	9
6.	**Reinforcement Learning** Reinforcement learning: What is Reinforcement Learning? Need for Reinforcement Learning, Supervised vs Unsupervised vs Reinforcement Learning, Types of Reinforcement, Elements of Reinforcement Learning, Real time applications of Reinforcement learning. Markov's Decision Process: Markov property, Markov chain/process, Markov reward process (MRP), Markov decision process (MDP), Return, Policy, Value functions, Bellman equation Q Learning: Introduction of Q-Learning, Important terms in Q learning, Q table, Q functions, Q learning algorithm.	9
	TOTAL	**52 Hrs.**

Text Books:
1. Ethem Alpaydin, "Introduction to Machine Learning", Publisher: The MIT Press,2014 2. Peter Flach: "Machine Learning: The Art and Science of Algorithms that Make Sense of

Data", Cambridge University Press, Edition 2012
Reference Books:
1. Ian H Witten, Eibe Frank, Mark A Hall, "Data Mining, Practical Machine Learning Tools and Techniques", Elsevier, 3rd Edition 2. Jiawei Han, Micheline Kamber, and Jian Pie, "Data Mining: Concepts and Techniques", Elsevier Publishers Third Edition, ISBN: 9780123814791, 9780123814807
E-Resources:
1. https://timeseriesreasoning.com/ **2. Reinforcement Learning:** **https://www.cs.toronto.edu/~urtasun/courses/CSC411_Fall16/19_rl.pdf**

Back to the Course Structure

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PCC:Data Mining and Warehousing								**Code:** AMPC612	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Course Objectives:

- To develop students' understanding of data warehousing, data mining, and data preprocessing techniques.
- To enable students to apply association rule mining, classification, and clustering techniques to large datasets.
- To provide practical exposure to data mining applications and emerging business trends.

Course Outcomes: After completion of this course, students will be able to -

CO1	Ability to understand the various kinds of tools.
CO2	Apply suitable pre-processing and visualization techniques for data analysis
CO3	Apply frequent pattern and association rule mining techniques for data analysis & Study Warehouse with design and Components
CO4	Apply frequent pattern and association rule mining techniques for data analysis
CO5	Apply appropriate classification and clustering techniques for data analysis
CO6	Design a Data warehouse system and perform business analysis with OLAP tools.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Data Warehouse** **Introduction** to Decision Support System, Need for data warehousing, Operational & informational data, Data Warehouse definition and characteristics, Data Warehouse Architecture. **Warehouse Design**: The Process of Data Warehouse Design, A Three-Tier Data Warehouse Architecture, Conceptual modelling of data warehouse, Differences between operational database and data warehouse, Data warehouse implementation, Data marts. **Components** of data warehouse, Need for data warehousing, Trends in data warehousing	7
2.	**Data Warehouse Components** **Architectural components:** ETL Process, Data Preprocessing: Why Preprocess Data? Data Life Cycle, Data Cleaning Techniques, Data Integration and Transformation, Data Reduction strategies overview, **Discretization** and Concept Hierarchy Generation for numerical data techniques binning, histogram analysis, For categorical data techniques concept hierarchies, Significant role of metadata, Data warehouse applications and usage	6
3.	**INTRODUCTION TO DATA MINING** **Definition of data mining-** Data Mining Techniques, Issues applications, Data Objects and attribute types-knowledge discovery Process, Data Mining Functionalities, Classification of Data Mining Systems, Statistical description of data,	6

	Data Preprocessing Cleaning, Integration, Reduction, Transformation and discretization. **Data Visualization**, Data similarity and dissimilarity measures. Data Mining Task Primitives, Mining Frequent Patterns, Associations, Market Basket Analysis, Apriori Algorithm, Association rules from frequent item set, Text Mining and Web Mining.	
4.	**Classification and Prediction** **Introduction**, Classification by Decision Tree Induction, Attribute selection measures, Bayesian Classification , Bayes Theorem ,Naïve Bayesian Classification, Rule-Based Classification, If then rules for classification **Classification** by Back propagation, Support Vector Machines. Mining Data Mining-frequent Pattern Analysis: Frequent Patterns, Associations and Correlations, Mining Methods, Pattern Evaluation Method, Pattern Mining in Multilevel, Multi-Dimensional Space – Constraint Based Frequent Pattern Mining, Classification using Frequent Patterns.	7
5.	**Cluster Analysis and Business Intelligence** **Introduction to Cluster Analysis-**Types, Categorization of Major Clustering Methods **Clustering techniques: -** Partitioning (k-means, k-means++, Mini-Batch k-means, k-medoids), Hierarchical (Agglomerative and Divisive), Density based (DBSCAN), Grid Based Methods, Outlier analysis-outlier detection methods **Business Intelligence:** Introduction to Data, Information, and Knowledge, Design and implementation aspect of OLTP, Introduction to Business Intelligence and Business Models, BI Definitions & Concepts, Business Applications of BI, Role of DW in BI, BI system components, Components of Data Warehouse Architectures.	6
6.	**OLAP in Data Warehouse** A Multidimensional Data Model, Schemas for Multidimensional Databases: Stars, Snowflakes, and Fact Constellations Measures, Concept Hierarchies, OLAP Operations in the Multidimensional Data Model, Need for OLAP, OLAP tools, Types-ROLAP, MOLAP, HOLAP	7
	TOTAL	**39 Hrs.**

Text Books:

1. Data Mining Concepts and Techniques by Han, Kamber, Morgan Kaufmann , MK publication.
2. Data Mining: Concepts and Techniques by Margaret Dunham, Morgan Kaufmann Publication.

Reference Books:

1. The Data Warehouse Lifecycle Toolkit by Ralph Kimball, John Wiley
2. A Managerial Approach (2nd Ed,) Turba. N, Sharda, Delen, King.Wiley Publication

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PCC:Data Mining and Warehousing Lab								**Code:** AMPC612P	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	25	-	25

Course Objectives:

- To develop students' understanding of data warehousing, data mining, and data preprocessing techniques.
- To enable students to apply association rule mining, classification, and clustering techniques to large datasets.
- To provide practical exposure to data mining applications and emerging business trends.

Course Outcomes: After completion of this course, students will be able to -

- Implement data preprocessing, data warehousing, ETL, and OLAP operations using suitable tools.
- Apply association, classification, regression, and clustering techniques to analyze datasets.
- Use data mining and visualization techniques to discover patterns and derive meaningful insights from real-world data.

List of Experiments:

1. Design a simple data warehouse and explore datasets using WEKA.
2. Perform data cleaning, integration, transformation, and reduction on a dataset.
3. Generate association rules using WEKA and analyze frequent itemsets.
4. Apply the Naïve Bayes algorithm to classify a dataset and evaluate its performance.
5. Perform roll-up, drill-down, slice, and dice operations on a multidimensional dataset.
6. Implement regression on a suitable dataset and analyze the prediction results.
7. Apply K-Means clustering to the Iris dataset and interpret the resulting clusters.
8. Perform data extraction, transformation, and loading using an ETL tool.
9. Implement the Apriori algorithm to discover frequent item sets and association rules.
10. Perform basic text mining on a dataset and extract meaningful patterns.

References:

1. Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining: Concepts and Techniques*, Morgan Kaufmann.
2. Ralph Kimball and Margy Ross, *The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling*, Wiley.

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PROGRAM ELECTIVE - II

(Select any one course from the given Program Elective Courses)

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: V**		
Course: PEC: Program Elective-II: Web Technology							**Code:** AMPE602A		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	40	60	-	-	-	100

Prerequisites:

Database Management Systems, Computer Network

Course Objectives:

- To develop students' understanding of web essentials, markup languages, and web technologies.
- To enable students to apply client-side and server-side technologies for web development.
- To provide practical exposure to web services and modern web development frameworks.

Course Outcomes: After completion of this course, students will be able to -

CO1	Implement and analyze behavior of web pages using HTML and CSS
CO2	Apply the client side technologies for web development
CO3	Analyze the concepts of Servlet and JSP
CO4	Analyze the Web services and frameworks
CO5	Apply the server side technologies for web development
CO6	Create the effective web applications for business functionalities using latest web development platforms

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Web Essentials and Mark-up language- HTML** The Internet, basic internet protocols, the World Wide Web, HTTP Request message, HTTP response message, web clients, web servers.HTML: Introduction, history and versions.HTML elements: headings, paragraphs, line break, colors and fonts, links, frames, lists, tables, images and forms, Difference between HTML and HTML5. CSS: Introduction to Style Sheet, CSS features, CSS core syntax, Style sheets and HTML, Style rule cascading and inheritance, text properties. Bootstrap.	5
2.	**Client Side Technologies: JavaScript and DOM** **JavaScript:** Introduction to JavaScript, JavaScript in perspective, basic syntax, variables and data types,statements, operators, literals, functions, objects, arrays, built in objects, JavaScript debuggers. **DOM:**Introduction to Document Object Model, DOM history and levels, intrinsic event handling, modifying element style, the document tree, DOM event handling, jQuery, Overview of Angular JS.	4
3.	**Java Servlets and XML** **Servlet:** Servlet life cycle, parameter data, sessions, cookies, URL rewriting, other Servlet capabilities, data storage, Servlets concurrency, databases (MySQL) and Java Servlets. **XML:** XML documents and vocabularies, XML declaration, XML	4

	Namespaces, DOM based XML processing, transforming XML documents, DTD: Schema, elements, attributes. **AJAX:** Introduction, Working of AJAX.	
4.	**JSP and Web Services** **JSP**: Introduction to Java Server Pages, JSP and Servlets, running JSP applications, Basic JSP, JavaBeans classes and JSP, Support for the Model-View-Controller paradigm, JSP related technologies. **Web Services**: Web Service concepts, Writing a Java Web Service, Writing a Java web service client, Describing Web Services: WSDL, Communicating Object data: SOAP. Struts: Overview, architecture, configuration, actions, interceptors, result types, validations, localization, exception handling, annotations.	5
5.	**Server Side Scripting Languages** **PHP:** Introduction to PHP, uses of PHP, general syntactic characteristics, Primitives, operations and expressions, output, control statements, arrays, functions, pattern matching, form handling, files,cookies, session tracking, using MySQL with PHP, WAP and WML. **Introduction to ASP.NET:**Overview of the .NET Framework, Overview of C#, Introduction to ASP.NET, ASP.NET Controls, Web Services. Overview of Node JS.	4
6.	**Ruby and Rails** **Introduction to Ruby**: Origins & uses of Ruby, scalar types and their operations, simple input and output, control statements, fundamentals of arrays, hashes, methods, classes, code blocks and iterators, pattern matching. **Introduction to Rails:** Overview of Rails, Document Requests, Processing Forms, Rails Applications and Databases, Layouts, Rails with Ajax. Introduction to EJB.	4
	TOTAL	**26 Hrs.**

Text Books:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035

Reference Books:

1. H.M. Deitel, P.J. Deitel and A.B. Goldberg, "Internet & World Wide Web How To Program", Third Edition, Pearson Education, 2006, ISBN 978-0131752429.

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Program: B. Tech. (AI & ML)								**Semester: V**	
Course: PEC:Program Elective-II :Web Technology Lab								**Code:** AMPE602AP	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	-	50	50

Prerequisites:

- Fundamentals of any programming language, preferably C/C++ or Java.
- Basic understanding of databases and SQL.

Course Objectives:

- Learn the fundamentals of web technologies and understand how websites and web applications work.
- Develop webpages using HTML, CSS, Bootstrap, JavaScript and DOM.
- Understand client-side and server-side programming concepts used in web applications..

Course Outcomes: After completion of this course, students will be able to -

CO1	Create and design structured webpages using HTML, CSS and Bootstrap.
CO2	Develop interactive webpages using JavaScript and DOM.
CO3	Build dynamic web applications using Servlets, JSP and PHP.

Course Contents:

1. Create a basic HTML webpage using headings, paragraphs, links, lists, tables, images, and formatting elements.
2. Design a Student Registration Form using HTML form elements such as text boxes, radio buttons, checkboxes, dropdown lists, and buttons.
3. Apply CSS styling to a webpage using inline, internal, and external CSS, including text, background, font, and border properties.
4. Create a responsive webpage using Bootstrap with containers, rows, columns, buttons, cards, and navigation bar.
5. Write JavaScript programs to demonstrate variables, data types, operators, conditional statements, loops, functions, and arrays.
6. Develop a JavaScript form validation program to validate student/user details such as name, email, mobile number, and password.
7. Create an interactive webpage using JavaScript and DOM to modify HTML elements, styles, images, and text using different events.
8. Create an XML document for storing student/product information and validate it using DTD.
9. Develop a simple Java Servlet/JSP application to accept form data and display the submitted information using sessions or cookies.
10. Develop a simple database-driven web application using PHP and MySQL to perform basic operations such as insert, display, update, and delete.

References:

1. Jeffrey C. Jackson, *Web Technologies: A Computer Science Perspective*, Pearson.

2. Robert W. Sebesta, *Programming the World Wide Web*, Pearson.

Program: B. Tech. (AI & ML)								**Semester: VI**	
Course: PEC:Program Elective II :Text and Speech Analysis								**Code:** AMPE602B	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	40	60	-	-	-	100

Prerequisites:

Programming and Problem solving, Data Structures and Algorithms

Course Objectives:

- To develop students' understanding of Natural Language Processing (NLP) and Speech Processing fundamentals.
- To enable students to apply machine learning and deep learning techniques to NLP and speech applications.
- To provide practical exposure to NLP and speech systems, including chatbots, text summarization, speech recognition, and multimodal AI..

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply fundamental NLP techniques for text preprocessing and feature extraction, and represent textual data using Bag of Words, N-Grams, and TF-IDF models.
CO2	Analyze text data using word embeddings and deep learning models such as RNNs and Transformers for classification and language understanding tasks.
CO3	Design and evaluate question-answering systems and conversational agents using information retrieval, language models, and dialogue management techniques.
CO4	Explain and implement the components of text-to-speech systems, including text processing, prosody generation, and modern neural TTS approaches.
CO5	Apply speech processing techniques for automatic speech recognition using acoustic modeling, feature extraction, and deep learning-based ASR frameworks.
CO6	Analyze advanced NLP and speech AI applications, including emotion recognition, multimodal systems, ethical considerations, and real-world industry solutions.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Natural Language Basics** Foundations of NLP, language syntax, and structure,Text preprocessing: tokenization, stemming, lemmatization, and stop-word removal,Feature engineering: Bag of Words, N-Grams, and TF-IDF models,Text Normalization ,Basic Sentiment Analysis ,Introduction to NLP Libraries	4
2.	**Text Classification and Embeddings** Vector semantics and Word Embeddings (Word2Vec, GloVe, FastText), Deep learning concepts: Recurrent Neural Networks (RNNs) and Transformers, Overviews of Text Summarization and Topic Modeling,Sequence-to-Sequence Learning ,Prompt Engineering and Large Language Models (LLMs) ,Evaluation of NLP Models	5

3.	**Question Answering and Dialogue Systems** Information retrieval (IR) and knowledge-based Question Answering (QA),Classic QA models and Language Models for QA.,Chatbot architectures, design of dialogue systems, and evaluation metrics,Conversational AI Frameworks ,Evaluation of QA and Dialogue Systems ,Responsible Conversational AI .	4
4.	**Text-to-Speech (TTS) Synthesis** Text normalization and Letter-to-Sound (LTS) conversion., Prosody generation and system evaluation., Signal processing methods: Concatenative and parametric approaches., Deep learning-based TTS (e.g., WaveNet and Tacotron),Advanced Text Processing for TTS ,Applications of TTS in virtual assistants, accessibility, e-learning, and customer support, Challenges in TTS: pronunciation ambiguity, emotional speech, and low-resource languages.	4
5.	**Automatic Speech Recognition (ASR)** Acoustic modeling and feature extraction (MFCC).,Hidden Markov Models (HMM) and Gaussian Mixture Models (GMM),Deep learning in ASR (HMM-DNN) and evaluating Word Error Rate (WER),Applications of ASR: Voice Assistants, Voice Search, Transcription Systems, Smart Devices, and Accessibility Tools, Challenges in ASR: Accents, Background Noise, Code-mixed Speech, and Low-resource Languages	5
6.	**Advanced Applications and Case Studies** Speech Emotion Recognition and Audio Mining, Multimodal systems (combining text, speech, and visual cues), Industry case studies, ethics in voice AI, and advanced open-source NLP pipelines, Model Evaluation and Performance Analysis for NLP and Speech Applications, Future Trends: Generative AI, Large Language Models (LLMs), Multimodal AI, and Edge AI for Speech Applications .	4
	TOTAL	**26 Hrs.**

Text Books:

1.Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third edition, Pearson, 2003, ISBN :10: 0136042597
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education(India), 2013,ISBN : 978-1-25-902998-1
3. Elaine Rich, Kevin Knight and Nair, "Artificial Intelligence", TMH, ISBN-978-0-07-008770-

Reference Books:

1. Nilsson Nils J , "Artificial Intelligence: A new Synthesis", Morgan Kaufmann Publishers Inc. San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley Publishing Company, ISBN: 0-201-53377
3. Andries P. Engelbrecht-Computational Intelligence: An Introduction, 2nd Edition-Wiley India ISBN: 978-0-470-51250-0

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: VI**	
Course: PEC:Program Elective II :Text and Speech Analysis Lab								**Code:** AMPE602BP	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	-	50	50

Prerequisites:

Programming and Problem solving , Data Structures and Algorithms

Course Objectives:

- To introduce the fundamental concepts and applications of Natural Language Processing and Speech Processing.
- To teach text preprocessing, normalization, and feature extraction techniques such as tokenization, stemming, N-grams, and TF-IDF.
- To explain word embeddings, text classification, question answering, dialogue systems, and conversational AI...

Course Outcomes: After completion of this course, students will be able to -

CO1	Preprocess and normalize text data using fundamental NLP techniques.
CO2	Represent and extract features from text using N-grams, TF-IDF, and word embeddings.
CO3	Build basic NLP applications such as sentiment analysis, text classification, and question answering.

List of Experiments:

1. Perform text preprocessing using tokenization, stop-word removal, stemming, and lemmatization.
2. Implement Text Normalization by converting text to lowercase and removing punctuation, numbers, and unwanted characters.
3. Generate Bag of Words and N-Gram representations for a given collection of text documents.
4. Implement TF-IDF feature extraction and identify important words from a set of documents.
5. Perform Sentiment Analysis on sample text using a suitable NLP library and classify the text as positive, negative, or neutral.
6. Generate Word Embeddings using Word2Vec or a pre-trained embedding model and find similar words.
7. Build a simple Text Classification model to classify text into predefined categories such as spam/ham or positive/negative.
8. Develop a simple Question Answering system that retrieves an answer from a given text/document.
9. Develop a basic Text-to-Speech application that converts input text into spoken audio using a suitable Python library.
10. Develop a basic Speech-to-Text application that converts recorded or live speech into text and evaluate the output using basic accuracy/WER concepts.

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML Engineering)									**Semester: VI**
Course: PEC:Program Elective II :Edge Computing									**Code:** AMPE602C
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
02	-	-	02	40	60	-	-	-	100

Prerequisites:

Basic knowledge of Computer Networks, Cloud Computing, IoT, Operating Systems, and Programming Fundamentals to understand Edge Computing concepts effectively

Course Objectives:

- To develop students' understanding of Edge Computing architecture, technologies, and applications.
- To enable students to apply data processing, resource management, communication, and virtualization techniques in Edge environments.
- To provide practical exposure to Edge security, privacy, Edge AI, and emerging industrial applications.
- To provide practical exposure to Edge security, privacy, Edge AI, and emerging industrial applications.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the concepts, architecture, and benefits of Edge Computing.
CO2	Design Edge Computing solutions using suitable hardware, platforms, and communication protocols.
CO3	Develop Edge-enabled applications for real-time data processing and analytics.
CO4	Apply security and privacy mechanisms to protect Edge Computing systems.
CO5	Deploy AI and machine learning models on Edge devices for intelligent applications.
CO6	Analyze real-world Edge Computing applications and emerging technologies.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Unit I: Introduction to edge computing** Evolution of Computing ,Distributed Computing Fundamentals ,Cloud, Fog, Mist, and Edge Computing ,Comparison of Cloud, Fog, Mist, and Edge Computing , Need and Motivation for Edge Computing ,Characteristics, Features, Advantages, and Limitations Edge Computing Architecture , Components of Edge Computing , Edge Computing Deployment Models , Edge Data Processing and Data Flow , Edge Intelligence (AI at the Edge) – Introduction , Role of IoT in Edge Computing	5
2.	**Edge Computing Infrastructure** Edge Computing Architecture ,Edge Devices and IoT Gateways ,Embedded Systems (Raspberry Pi, Jetson Nano, Arduino) ,Operating Systems for Edge Devices ,Virtualization and Containerization (VMs, Docker, Docker Compose) ,Container Orchestration (Kubernetes, K3s, MicroK8s) ,Edge Platforms (AWS Greengrass, Azure IoT Edge, Edge Foundry) Communication Technologies (Wi-Fi, BLE, ZigBee, LoRa WAN, 5G) Communication Protocols (MQTT, CoAP, HTTP/HTTPS, WebSocket, AMQP) ,Data Management at the Edge	4

3.	**Unit III: Data Processing at the Edge** Data Processing at the Edge ,Data Collection and Pre-processing , Data Filtering and Aggregation , Data Cleaning and Feature Extraction, Stream Data Processing Event-Driven Data Processing, Edge Analytics, Real-Time Data Processing Edge Storage Systems, Data Caching and Buffering, Distributed Storage at the Edge, Data Synchronization, Resource Management, CPU, Memory, and Storage Optimization, Task Scheduling and Load Balancing, Workload Offloading Strategies , Computation Offloading, Resource Allocation Techniques.	5
4.	**Unit IV: Security and Privacy at the Edge** Security Challenges in Edge Computing ,Threat Model and Attack Surface in Edge Environments ,Authentication and Authorization Mechanisms, Identity and Access Management (IAM), Encryption Techniques for Edge Computing, Data Privacy and Secure Communication, Secure Data Storage and Key Management Common Security Threats · Intrusion Detection and Prevention Systems (IDS/IPS), Blockchain in Edge Computing, Trust Management and Secure Device Management, Secure Boot and Trusted Execution Environment (TEE) Lightweight Security.	4
5.	**Unit V: Edge AI and Machine Learning** Introduction to Edge AI Artificial Intelligence, Machine Learning, and Deep Learning Fundamentals ,Machine Learning on Edge Devices, TinyML Fundamentals, AI Model Optimization (Quantization, Pruning, Knowledge Distillation) , Model Compression Techniques, Inference on Edge Devices Hardware Accelerators for Edge AI (GPU, TPU, NPU), Computer Vision at the Edge, Natural Language Processing (NLP) at the Edge , Edge AI Frameworks (TensorFlow Lite, TensorFlow Lite Micro, PyTorch Mobile, ONNX Runtime),Edge AI Applications.	4
6.	**Unit VI: Applications and Future Trends** Smart Cities, Industrial IoT (Ilott) and Industry 4.0, Healthcare Applications of Edge Computing, Smart Agriculture and Precision Farming, Autonomous Vehicles and Intelligent Transportation Systems, Robotics and Edge-Enabled Automation, Edge Computing in Retail and Supply Chain Management, Performance Evaluation of Edge Systems, Quality of Service (QoS) and Performance Metrics (Latency, Throughput, Scalability, Reliability), Emerging Trends in Edge Computing (5G/6G Integration, Federated Learning, Digital Twins), Edge Intelligence and AI-Driven Edge Computing	4
	TOTAL	**26 Hrs.**

Text Books:

1. Zaigham Mahmood – *Cloud Computing: Concepts, Technology & Architecture* (Springer, 2018)
2. Pethuru Raj and Anupama C. Raman – *The Internet of Things: Enabling Technologies, Platforms, and Use Cases* (CRC Press, 2017)
3. Qusay F. Hassan – *Internet of Things A to Z: Technologies and Applications* (Wiley-IEEE Press, 2018)

Reference Books:

1. Zaigham Mahmood (Editor) – *Fog Computing: Concepts, Frameworks and Applications* (Springer, 2018)

Reference Books:

1. Weisong Shi, Schahram Dustdar, Jie Cao, and Quan Zhang (Editors) – *Edge Computing: A Primer* (Springer, 2022)
2. Sahil Garg, Rajkumar Buyya, and others (Editors) – *Edge Computing: Models, Technologies and Applications* (Institution of Engineering and Technology (IET), 2020)
3. Zaigham Mahmood (Editor) – *Fog Computing: Concepts, Frameworks and Applications* (Springer, 2018)

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Program: B. Tech. (AI & ML Engineering)							**Semester: VI**		
Course: PEC: Program Elective II :Edge Computing Lab							**Code:** AMPE602CP		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	-	50	50

Prerequisites:

Basic knowledge of Computer Networks, Cloud Computing, IoT

Course Objectives:

- To introduce the fundamental concepts, architecture, characteristics, and applications of Edge Computing.
- To explain edge infrastructure, IoT gateways, edge devices, communication technologies, protocols, virtualization, and containerization.
- To develop understanding of data processing, real-time analytics, storage, resource management, and computation offloading at the edge.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the concepts, architecture, characteristics, and benefits of Edge Computing and compare it with Cloud and Fog Computing.
CO2	Identify and use suitable edge devices, IoT gateways, communication protocols, and containerization technologies for edge applications.
CO3	Apply data processing, filtering, aggregation, storage, and resource management techniques in edge environments.

List of Experiments:

1. Generate sensor data using Python and compare processing data locally at the edge with sending all data to a simulated cloud server.
2. Generate temperature, humidity, or light sensor data using Python and display the collected data at an edge node.
3. Process simulated sensor data and filter unnecessary or abnormal values before sending the data to the cloud.
4. Collect continuous sensor readings and calculate minimum, maximum, average, and moving average values at the edge.
5. Create a simple MQTT publisher and subscriber to send and receive sensor data between an IoT device and an edge node.
6. Develop a Python application that continuously reads sensor data and generates an alert when a predefined threshold is exceeded.
7. Create a small Python web/data-processing application and run it inside a Docker container to understand edge application deployment.
8. Train a simple Machine Learning model and perform prediction locally using a small sample dataset to demonstrate AI inference at the edge.
9. Use a pre-trained lightweight model to classify sample images locally and observe the concept of Edge AI inference.
10. Measure and compare processing time/latency for local edge processing and simulated remote/cloud processing and analyze the results.

Reference Books:

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PROGRAM ELECTIVE - III

(Select any one course from the given Program Elective Courses)

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester: VI**	
Course:PEC: Program Elective III :Business Intelligence								**Code: AMPE603A**	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

DBMS

Course Objectives:

- To develop students' understanding of Business Intelligence concepts, systems, and applications.
- To enable students to apply business analytics and intelligence techniques to real-world business scenarios.
- To provide practical knowledge of mathematical and analytical models used in Business Intelligence.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply conceptual knowledge on how Business Intelligence is used in decision making process .
CO2	Use modelling concepts in Business Intelligence
CO3	Understand and apply the concepts of business reports and analytics with the help of visualization for business performance management.
CO4	Comprehend the model based decision making using prescriptive analytics
CO5	Analyze the role of analytics and intelligence in Business
CO6	Comprehend different Business Intelligence trends and its future impacts

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Decision Making and Business Intelligence** Changing Business Environments, Decision Making & Simon's Decision Making Process, Managerial roles in Decision Making, Information Systems Support for Decision Making, framework for Computerized Decision Support: The Gorry and Scott-Morton Classical Framework, Decision support systems (DSS). Capabilities of DSS, DSS Classification, DSS Components. Business Intelligence (BI), Framework for BI, BI architecture, DSS - BI Connection, Goals of Business Intelligence, Business Intelligence: Tasks and Analysis Formats, BI use cases: Application in Patient Treatment, Application in Higher Education, Application in Logistics	7
2.	**Modeling in BI** Models and Modeling in BI, Model Presentation, Model Building, Model Assessment and Quality of Models, Modeling using Logical Structures: Ontologies & Frames, Modeling using Graph Structures : Business Process Model and Notation (BPMN) & Petri Nets, Modeling using Probabilistic Structures, Modeling Using Analytical Structures. Models and Data: Data Generation, The Role of Time, Data Quality.	7

3.	**Business reporting, Visual analytics and Performance management** What Is a Business Report, Components of Business Reporting Systems, Data and Information Visualization, Types of Charts and Graphs, Visual Analytics, Performance Dashboards, Business Performance Management, Closed Loop BPM Cycle, Performance Measurement, Key Performance Indicators, Balanced Scorecards, The Four Perspectives of BSC. BI Tools: Tableau, Qlik, power BI, Dundas BI, Sisense, Web focus, Oracle BI.	6
4.	**Prescriptive Analytics & Model-Based Decision Making** What are Descriptive analytics, predictive analytics, and prescriptive analytics, Decision Support Systems Modeling, Structure of Mathematical Models for Decision Support, Certainty, Uncertainty, and Risk, Decision Modeling with Spreadsheets, Mathematical Programming Optimization, Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking, Decision Analysis with Decision Tables and Decision Trees, Multi-criteria Decision Making With Pairwise Comparisons.	6
5.	**Role of Analytics and Intelligence in Business** The role of visual and business analytics (BA) in BI and how various forms of BA are supported in practice. ERP and Business Intelligence, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI Applications in Fraud Detection, BI Applications in Retail Industry.	7
6.	**Business Analytics: Emerging Trends and Future Impacts** Emerging Technologies, the critical success factors for implementing a BI strategy, Predicting the Future with the help of Data Analysis, BI Search & Text Analytics – Advanced Visualization – Rich Report, cloud computing and BI, Future beyond Technology. Impacts of Analytics in Organizations, Issues of Legality, Privacy, and Ethics, Location-Based Analytics for Organizations, Analytics Applications for Consumers.	6
	TOTAL	**39 Hrs.**

Text Books:

1. Wilfried Grossmann & Stefanie Rinderle-Ma "Fundamentals of Business Intelligence", Springer, ISBN 978-3-662-46531-8 (eBook) 2. Business Intelligence and Analytics: Systems for Decision Support, 10th edition, ISBN 978-0-13305090-5, by Ramesh Sharda, Dursun Delen, and Efraim Turban, published by Pearson Education © 2014.

Reference Books:

1. Sabharwal, R. and Becerra-Fernandez, I. (2011). Business Intelligence: Practices, Technologies and Management. John Wiley.
2. Turban,E. and Volonino, L.(2011). Information Technology for Management: Improving Strategic and Operational Performance. 8th edn.Wiley.

E-Resources:

1. IBM Skills Network, *BI Foundations with SQL, ETL and Data Warehousing Specialization*, Coursera.
2. BI Foundations with SQL, ETL and Data Warehousing Specialization

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: VI**		
Course: PEC:Program Elective III :Business Intelligence Lab							**Code: AMPE603AP**		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	25	-	25

Prerequisites:

DBMS

Course Objectives:

- To develop students' understanding of Business Intelligence concepts, systems, and applications.
- To enable students to apply business analytics and intelligence techniques to real-world business scenarios.
- To provide practical knowledge of mathematical and analytical models used in Business Intelligence.

Course Outcomes: After completion of this course, students will be able to -

CO1	Apply conceptual knowledge on how Business Intelligence is used in decision making process .
CO2	Use modelling concepts in Business Intelligence
CO3	Understand and apply the concepts of business reports and analytics with the help of visualization for business performance management.

List of Experiments:

1. Comparative Study of Open Source Data Analysis tools
2. Identify Key Performance Indicators (KPI) for any real time case study and present analysis for the same
3. Create, model and analyze Petri nets with a standards-compliant Petri net tool for Producer / Consumer OR Dining Philosophers problem
4. Perform a what-if-analysis on Book Store Scenario using Excel
5. Create following visualizations using Excel
6. a. Combo charts b. Band Chart c. Thermometer Chart d. Gantt Chart e. Waterfall Chart f. Sparklines g.Pivot Charts
7. Create interactive visualizations using any open source tool. (Eg. KNIME, D3.js, Grafana, etc.)
8. Create a dashboard / report using Google Data Studio on YouTube Channel Data / Google Ads Data / Search Console Data
9. Develop a Prescriptive Analytics model using optimization or decision trees to solve a real-world business decision problem.
10. Analyze marketing campaign data to evaluate campaign performance and customer response.
11. Develop a decision tree to select the best business alternative under different conditions.

References:

1. Ramesh Sharda, Dursun Delen and Efraim Turban, *Business Intelligence, Analytics, and Data Science: A Managerial Perspective*, Pearson.
2. Efraim Turban, Ramesh Sharda, Dursun Delen and David King, *Business Intelligence: A Managerial Approach*, Pearson.

Program: B. Tech. (AIML Engineering)									**Semester: VI**
Course: PEC: Program Elective III :Distributed Computing									**Code: AMPE603B**
Teaching Scheme (Hrs./week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Data Structures, Operating Systems

Course Objectives:

- To develop students' understanding of distributed system models, communication, synchronization, and coordination techniques.
- To enable students to apply distributed mutual exclusion, deadlock detection, agreement protocols, and fault-tolerance mechanisms.
- To provide practical understanding of cloud computing models and evaluate distributed systems based on performance, scalability, consistency, and security.

Course Outcomes: After completion of this course, students will be able to -

CO1	Summarize various aspects of distributed computation model and logical time.
CO2	Illustrate election algorithm, global snapshot algorithm and termination detection algorithm.
CO3	Compare token based, non-token based and quorum based mutual exclusion algorithms.
CO4	Recognize the significance of deadlock detection and shared memory in distributed systems.
CO5	Explain the concepts of failure recovery and consensus.
CO6	Illustrate distributed file system architectures.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**FUNDAMENTALS AND ARCHITECTURES –** Introduction: Characteristics and examples of distributed systems, Design goals, Types of distributed systems, Trends in distributed systems, Focus on Resource Sharing, Challenges. Architectures: Architectural styles, middleware and middleware organization, system architectures, Example architectures. Case Study: The World Wide Web	6
2.	**COMMUNICATION AND COORDINATION –** Communication: Introduction, Layered protocols , Types of communication, Inter-process Communication, Remote Procedure Call (RPC), Message oriented communication, Multicast Communication, Network Virtualization: Overlay Network Coordination: Clock Synchronization, Logical Clocks, Mutual Exclusion, Election algorithms, Distributed event matching, Gossip Based coordination Case Study: IBM's Websphere Message-Queuing System	6
3.	**REPLICATION AND FAULT TOLERANCE –** Replication: Reasons for replication, Replica management, Failure masking and replication, Consistency protocols, Catching and replication in web,Fault Tolerance: Introduction, Failure models, Fault systems with arbitrary failures, Reliable client server communication, Reliable group communication, Distributed commit, Recovery, Checkpoints. Case Study: Catching and Replication in Web	7

4.	**DISTRIBUTED FILES AND MULTIMEDIA SYSTEMS –** Distributed File Systems: Introduction, File System Architecture, Sun Network File System, and HDFS. Name Services: Introduction, Name Services and the Domain Name System, Directory Services. Case Study- 1: The Global Name Service, 2. The X.500 Directory Service. Distributed Multimedia Systems: Characteristics of Multimedia Data, Quality of Service Management, Resource management, Stream Adaptation. Case Study: BitTorrent and End System Multicast.	6
5.	**DISTRIBUTED WEB BASED SYSTEM –** Architecture of Traditional Web-Based Systems, Apache Web Server, Web Server Clusters, Communication by Hypertext Transfer Protocol, Synchronization, Web Proxy Caching, Replication for Web Hosting Systems, Replication of Web Applications, Fault Tolerance in distributed web based systems, Security Concerns. Case Study: HyperText Transfer Protocol (HTTP)	7
6.	**SECURITY IN DISTRIBUTED SYSTEMS-** Introduction to Security: Security Threats, Policies, and Mechanisms, Design Issues, Cryptography. Secure Channels: Authentication, Message Integrity and Confidentiality, Secure Group Communication, Access Control: General Issues in Access Control, Firewalls, Secure Mobile Code, Denial of Service (DOS). Security Management: Key Management, Secure Group Management, Authorization Management. Emerging Trends In Distributed Systems: Grid Computing, Service Oriented Architectures (SOA). Case Study: Kerberos.	7
	TOTAL	**39 Hrs.**

Text Books:

1. Maarten van Steen, Andrew S. Tanenbaum, Distributed Systems , PHI, 3rd Edition Version 3.01, ISBN: 978-15-430573-8-6(Printed).
2. Andrew S. Tanenbaum, Maarten van Steen, Distributed Systems Principles and Paradigms, PHI, 2nd Edition, ISBN: 978-0130888938.

Reference Books:

1. George Coulouris, Distributed Systems: Concepts and Design,Pearson, 5th edition, Jean Dollimore, Tim Kindberg, Gordon Blair, ISBN:13: 978-0132143011, ISBN:10: 0132143011.
2. Abhijit Belapurkar, Anirban Chakrabarti, Harigopal Ponnapalli, Niranjan Varadarajan, Srinivas Padmanabhuni, Srikanth Sunderrajan, Distributed System Security: Issues,Processes and solutions, Willey online Library, ISBN: 978-0-470-51988-2.
3. Sunita Mahajan, Seema Shah, Distributed Computing, Oxford University Press, 2nd Edition, ISBN-13: 978-0198093480

E-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs15/preview
2. https://www.distributedsystemscourse.com/

Back to the Course Structure

Program: B. Tech. (AIML Engineering)									**Semester: VI**
Course: PEC: Program Elective III :Distributed Computing Lab									**Code: AMPE603BP**
Teaching Scheme (Hrs./week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	25	-	25

Prerequisites:

Data Structures, Operating Systems

Course Objectives:

- To develop students' understanding of distributed system models, communication, synchronization, and coordination techniques.
- To enable students to apply distributed mutual exclusion, deadlock detection, agreement protocols, and fault-tolerance mechanisms.
- To provide practical understanding of cloud computing models and evaluate distributed systems based on performance, scalability, consistency, and security.

Course Outcomes: After completion of this course, students will be able to -

CO1	Summarize various aspects of distributed computation model and logical time.
CO2	Illustrate election algorithm, global snapshot algorithm and termination detection algorithm.
CO3	Compare token based, non-token based and quorum based mutual exclusion algorithms.

List of Experiments:

1. Implement Inter-Process Communication (IPC) between two processes using sockets.
2. Implement a client-server application using TCP/UDP communication.
3. Implement a simple Remote Procedure Call (RPC) application.
4. Implement multicast communication between multiple clients.
5. Demonstrate file replication and consistency in a distributed environment.
6. Implement client-server communication using TCP sockets.
7. Implement message communication between two processes.
8. Demonstrate web proxy caching.
9. Implement basic authentication and access control for a distributed application.
10. Implement a simple fault detection and recovery mechanism.

References:

1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, *Distributed Systems: Concepts and Design*, Pearson.
2. Andrew S. Tanenbaum and Maarten Van Steen, *Distributed Systems: Principles and Paradigms*, Pearson.

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)							**Semester:**		
Course: PEC: Program Elective III : Explainable AI							**Code: AMPE603C**		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	0	-	100

Prerequisites:

Fundamentals of Artificial Intelligence

Course Objectives:

- To develop students' understanding of Explainable AI, interpretability, and transparency in AI models.
- To develop students' understanding of Explainable AI, interpretability, and transparency in AI models.
- To provide practical exposure to fairness, ethics, accountability, and XAI applications in real-world domains.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the concepts, significance, and challenges of Explainable AI.
CO2	Differentiate between interpretable and black-box machine learning models.
CO3	Apply model-agnostic explainability techniques to interpret AI predictions.
CO4	Analyze feature importance and visualize model behavior using XAI methods.
CO5	Evaluate AI models based on fairness, transparency, accountability, and ethics.
CO6	Apply Explainable AI techniques to real-world engineering and industrial applications.

Course Contents:

Unit	**Description**	**Duration (Hrs.)**
1.	**Introduction to Explainable AI** : Artificial Intelligence overview, Machine Learning fundamentals, Need for Explainable AI, Black-box vs White-box models, Interpretability vs Explainability, Transparency, Trustworthy AI, Human-centered AI, Challenges in AI interpretation, Applications of XAI in Engineering.	**7**
2.	**Interpretable Machine Learning Models** : Linear Regression, Logistic Regression, Decision Trees, Rule-based models, Naïve Bayes, K-Nearest Neighbors, Model complexity, Bias-Variance trade-off, Global and Local Interpretability, Evaluation of interpretable models.	**6**
3.	**Model-Agnostic Explainability Techniques** :Local vs Global explanations, Partial Dependence Plots (PDP), Individual Conditional Expectation (ICE), Permutation Feature Importance, SHAP (SHapley Additive Explanations), LIME (Local Interpretable Model-Agnostic Explanations), Anchors, Counterfactual Explanations.	**6**
4.	**Explainability for Deep Learning Models** : Explainability challenges in Deep Learning, Saliency Maps, Gradient-based explanations, Class Activation Maps (CAM), Grad-CAM, Attention mechanisms, Explainability for CNNs and Neural Networks, Explainable Computer Vision and NLP models.	**7**
5.	**Fairness, Ethics and Responsible AI** AI Bias, Fairness Metrics, Explainability vs Fairness, Accountability, Transparency, Privacy-preserving AI, AI Regulations, Responsible AI Frameworks, Risk Assessment, Human-in-the-loop AI, Explainability in Safety-Critical Systems.	**7**

6.	**Industrial Applications of Explainable AI:** Explainable AI in Manufacturing, Predictive Maintenance, Quality Inspection, Autonomous Systems, Healthcare, Finance, Smart Cities, Industrial IoT, Digital Twins, Case Studies, Future Trends in Explainable AI, Generative AI Explainability.	**7**
	Total Hours	**39 Hrs.**

Text Books:

1. Christoph Molnar, *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*, 3rd Edition, 2025.
2. Wojciech Samek, Grégoire Montavon, Andrea Vedaldi, Lars K. Hansen and Klaus-Robert Müller (Eds.), *Explainable AI: Interpreting, Explaining and Visualizing Deep Learning*, Springer.

Reference Books

1. Christoph Molnar, *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*.
2. Marco Ancona et al., *Towards Better Understanding of Gradient-Based Attribution Methods for Deep Neural Networks*, ICLR.
3. R. Guidotti et al., *A Survey of Methods for Explaining Black Box Models*, ACM Computing Surveys.

E-Resources

1. Interpretable Machine Learning – Christoph Molnar
2. SHAP – Explainable AI Documentation

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AIML Engineering)									**Semester:**
Course: PEC: Program Elective III : Explainable AI Lab									**Code: AMPE603CP**
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	02	-	01	-	-	-	25	-	25

Prerequisites:

Fundamentals of Artificial Intelligence

Course Objectives:

- Introduce the fundamental concepts, principles, and importance of Explainable AITo develop students' understanding of Explainable AI, interpretability, and transparency in AI models.
- Familiarize students with interpretable machine learning models and their applications.
- Explain model-agnostic techniques such as SHAP, LIME, PDP, ICE, and counterfactual explanations.

Course Outcomes: After completion of this course, students will be able to -

CO1	Explain the need, principles, and importance of Explainable AI.
CO2	Differentiate between interpretable and black-box machine learning models.
CO3	Apply explainability techniques to deep learning and computer vision models.

List of Experiments:

1. Compare interpretable and black-box models using a classification dataset and analyze their prediction behavior.
2. Visualize Decision Tree decisions and explain how different features contribute to the final prediction.
3. Perform Permutation Feature Importance to identify the most important features in a machine learning model.
4. Generate Partial Dependence Plots (PDP) to study the effect of individual features on model predictions.
5. Apply SHAP Explainability to explain global and individual predictions of a machine learning model.
6. Apply LIME to generate local explanations for individual predictions.
7. Generate Counterfactual Explanations to identify the minimum feature changes required to obtain a different prediction.
8. Apply Grad-CAM to a CNN model to visualize the image regions responsible for classification.
9. Analyze bias and fairness in a machine learning model using simple fairness metrics across different groups.
10. Develop an Explainable AI application that combines a trained ML model with SHAP/LIME visualizations to provide understandable predictions.

References:

1. **Christoph Molnar**, *Interpretable Machine Learning: A Guide for Making Black Box Models Explainable*.
2. **Wojciech Samek et al. (Eds.)**, *Explainable AI: Interpreting, Explaining and Visualizing* .

Program: B. Tech. (AI & ML)	**Semester: VI**
Course: MDM:Natural Language Processing	**Code:** AMMD604

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Teaching Scheme (Hrs/week)				Evaluation Scheme (Marks)					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
03	-	-	03	40	60	-	-	-	100

Prerequisites:

Software Engineering ,Project Management ,Cloud Computing Fundamentals

Course Objectives:

- To develop students' understanding of Natural Language Processing and Natural Language Generation techniques.
- To provide practical knowledge of information retrieval techniques and their applications.
- To enable students to apply text mining techniques for extracting useful information from text data.

Course Outcomes: After completion of this course, students will be able to -

CO1	Understand and analyze the natural language text and model.
CO2	Analyze the natural language syntactically.
CO3	Analyze and study natural language logically.
CO4	Process the natural language text based on relations and knowledge.
CO5	Evaluate the natural language text using models and apply modeling techniques for automatic document separation and text mining.
CO6	Apply information retrieval techniques.

Course Contents:

Unit	Description	Duration (Hrs.)
1.	**Introduction to NLP** Overview: Origins and challenges of NLP- Language and GrammarProcessing Indian Languages- NLP Applications Information Retrieval. Language Modelling: Various Grammar- based Language. Models-Statistical Language Model.	6
2.	**Word Level Analysis and Syntactic Analysis** **Word Level Analysis:** Regular Expressions- Finite-State Automata-Morphological Parsing-Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. **Syntactic Analysis:** Context-free Grammar-Constituency- Parsing-Probabilistic Parsing,	7
3.	**Semantic Analysis** Introduction, Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation Discourse Processing: Introduction, Cohesion, Reference Resolution, Discourse Coherence and Structure.	6
4.	**Text Processing: Relations and Knowledge** Extracting Relations from Text: From Word Sequences to Dependency Paths: Introduction, Subsequence Kernels for Relation Extraction, A Dependency-Path Kernel for Relation Extraction and Experimental Evaluation. Mining Diagnostic Text Reports by Learning to Annotate Knowledge Roles: Introduction, Domain Knowledge and Knowledge Roles, Frame Semantics and Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations.	7

5.	**Document Processing and Text Mining** Automatic Document Separation: A Combination of Probabilistic Classification and Finite-State Sequence Modelling: Introduction, Related Work, Data Preparation, Document Separation as a Sequence Mapping Problem, Results. Evolving Explanatory Novel Patterns for Semantically Based Text Mining: Related Work, A Semantically Guided Model for Effective Text Mining	7
6.	**Information retrieval and lexical resources** Information Retrieval: Design features of Information Retrieval Systems Classical, non-classical, Alternative Models of Information Retrieval – valuation Lexical Resources: World Net-Frame NetStemmers-POS Tagger-Research Corpora. Model: Introduction to iSTART	6
	TOTAL	**39 Hrs.**

Text Books:

1. U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008. 2. Anne Kao and Stephen R. Poteet (Eds), "Natural LanguageProcessing and Text Mining", Springer-Verlag London Limited 2007.

Reference Books:

1. Allen James, Natural Language Understanding, Pearson India, 2nd Edition ISBN: 9788131708958, 8131708950 2. James H. Martin, Daniel Jurafsky, Speech and Language Processing Pearson 1stAddition, ISBN 9789332518414 3. Hobson Lane, Cole Howard, Hannes Hapke. 2019. Natural Language Processing in Action. Live Book

E-Resources:

1. **https://onlinecourses.nptel.ac.in/noc20_cs87/preview**
2. **https://onlinecourses.nptel.ac.in/noc19_cs56/preview**

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DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)							**Semester: VI**		
Course:VESC: Machine Learning and NLP Lab							**Code:** AMVS605		
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	**04**	**-**	**02**	**-**	**-**	**25**	**-**	**50**	**75**

Prerequisite:

- Basic knowledge of Python programming and data handling.
- Familiarity with basic statistics, probability, and machine learning concepts.

Course Objectives:

- To develop students' practical skills in data preprocessing, machine learning, and NLP techniques.
- To enable students to implement and evaluate classification, regression, text processing, and information retrieval models.
- To provide hands-on experience in solving real-world problems using machine learning and NLP tools.

Course Outcomes: After completion of this course, students will be able to -

- Implement and evaluate machine learning models for regression and classification problems.
- Perform data preprocessing, feature analysis, and visualization on real-world datasets.
- To enable students to apply machine learning and NLP tools to solve real-world problems through hands-on implementation.

List of Experiments: Solve any 8

Group A

1.	Access an open source dataset "Titanic". Apply pre-processing techniques on the raw dataset.
2.	Write a program to recognize a document is positive or negative based on polarity words using suitable classification method.
3.	Uber Fare Prediction: Preprocess the Uber dataset, analyze outliers an correlations, and compare Linear, Ridge, and Lasso Regression models.
4.	Implement Random Forest Classifier model to predict the safety of the car. Datasetlink: https://www.kaggle.com/datasets/elikplim/car-evaluation-data-set Semantic Role Labelling, Learning to Annotate Cases with Knowledge Roles and Evaluations.
5.	Download Abalone Dataset from Kaggle: a) Predict the number of rings either as a continuous value or as a classification problem. b) Predict the age of abalone from physical measurements using linear regression

Group B

6	Perform text preprocessing by implementing tokenization, stop-word removal, stemming, and lemmatization on a given text corpus.
7	Implement word-level analysis using regular expressions, morphological analysis, spelling correction, and Part-of-Speech (POS) tagging.
8	Perform syntactic analysis by implementing Context-Free Grammar (CFG) and parsing techniques to generate parse trees for given sentences.

9	Implement semantic analysis using WordNet to perform lexical semantics, word sense disambiguation, and named entity recognition.
10	Develop an Information Retrieval system using TF-IDF and cosine similarity to retrieve relevant documents based on user queries.

References:

1. Tom M. Mitchell, *Machine Learning*, McGraw-Hill Education.
2. Daniel Jurafsky and James H. Martin, *Speech and Language Processing*, Pearson.
3. Peter Harrington, *Machine Learning in Action*, Manning Publications.

Back to the Course Structure

DEPARTMENT OF ARTIFICIAL INTELLEGENCE AND MACHINE LEARNING

Program: B. Tech. (AI & ML)								**Semester:** V	
Course: Internship – V								**Code:** AMN605	
Teaching Scheme (Hrs/week)				**Evaluation Scheme (Marks)**					
Lecture	**Practical**	**Tutorial**	**Credit**	**CIE**	**ETE**	**TW**	**OR**	**PR**	**Total**
-	-	-	02	-	-	25	-	-	25

Preamble:

Internships serve as vital educational and career development experiences, offering practical exposure in a specific field. Employers seek individuals who possess the necessary skills and an understanding of industry environments, practices, and cultures. This internship is designed as a structured, short-term, supervised training program, often centered on specific tasks or projects with clear timelines. The primary goal is to immerse technical students in an industrial setting, providing experiences that cannot be replicated in the classroom. This exposure aims to develop competent professionals who understand the social, economic, and administrative factors influencing the operations of industrial organizations.

Course Objectives:

1. Exposure to students to the industrial environment, which cannot be provided in the classroom and hence creating deployable professionals for the industry.
2. Learn to implement the technical knowledge in real industrial situations.

Course Outcomes: After completion of this course, students will be able to -

CO1	Gain exposure to industry practices and understand how academic concepts are applied in professional settings.
CO2	Develop and demonstrate effective communication and teamwork skills within a work environment.
CO3	Improve your problem-solving and time management skills by working in real-world industry settings.

Internship Requirements

1. **Internship Duration:** It is mandatory for all students to undergo an internship after every semester during vacations for the duration of 3 to 5 weeks. Internships completed during this period will be considered for the assessment of Term Work (TW).
2. **Internship Opportunities:** Students can explore various opportunities for internships at:
    f. Industries
    g. Research labs or organizations
    h. Collegiate clubs
    i. In-house research projects
    j. Online internships
3. **Support and Assistance:** Students can seek assistance for securing internships from:
    e. The Training and Placement cell, along with departmental coordinators
    f. Department or institute faculty members
    g. Personal contacts
    h. Directly connecting with industries or organizations
4. **Request Letter:** Once an industry, research organization, or collegiate club is identified, students must obtain a request letter from the concerned department or placement office. This letter, in the standard format must be duly signed by the authority, should be addressed to the HR manager or relevant authority.

5. **Confirmation Letter:** Students must submit the confirmation letter from the industry, research organization, or collegiate club to the Internship Coordinator and the Head of Department (HOD) office.
6. **Joining Report:** Upon commencing the internship, students must submit the joining report, joining letter, or a copy of the confirmation email to the Internship Coordinator and the HOD office.
7. **Faculty Mentor:** A faculty member will be assigned as a mentor to a group of students. The mentor will be responsible for monitoring, evaluating, and assessing student internship activities. The faculty mentor is also required to visit the internship location and submit formal feedback to the Internship Coordinator.
8. **Faculty Visits:** Faculty members are advised to visit the internship site once or twice during the internship period to monitor progress.
9. **Progress Report:** Students must submit progress report fortnightly to their faculty guide and the final internship report to the Internship Coordinator and department office.
10. **Evaluation Report:** After the completion of the internship, the mentor, along with the assessment panel members, should submit the evaluation report of the students to the department office and the Internship Coordinator.
11. **Internship Certificate:** Students must receive the Internship Certificate from the industry and submit it to the Internship Coordinator and department office.
12. **Presentation and Assessment:** Students are required to give a presentation on their internship work as part of the term work. The internship diary and report will also be verified and assessed.