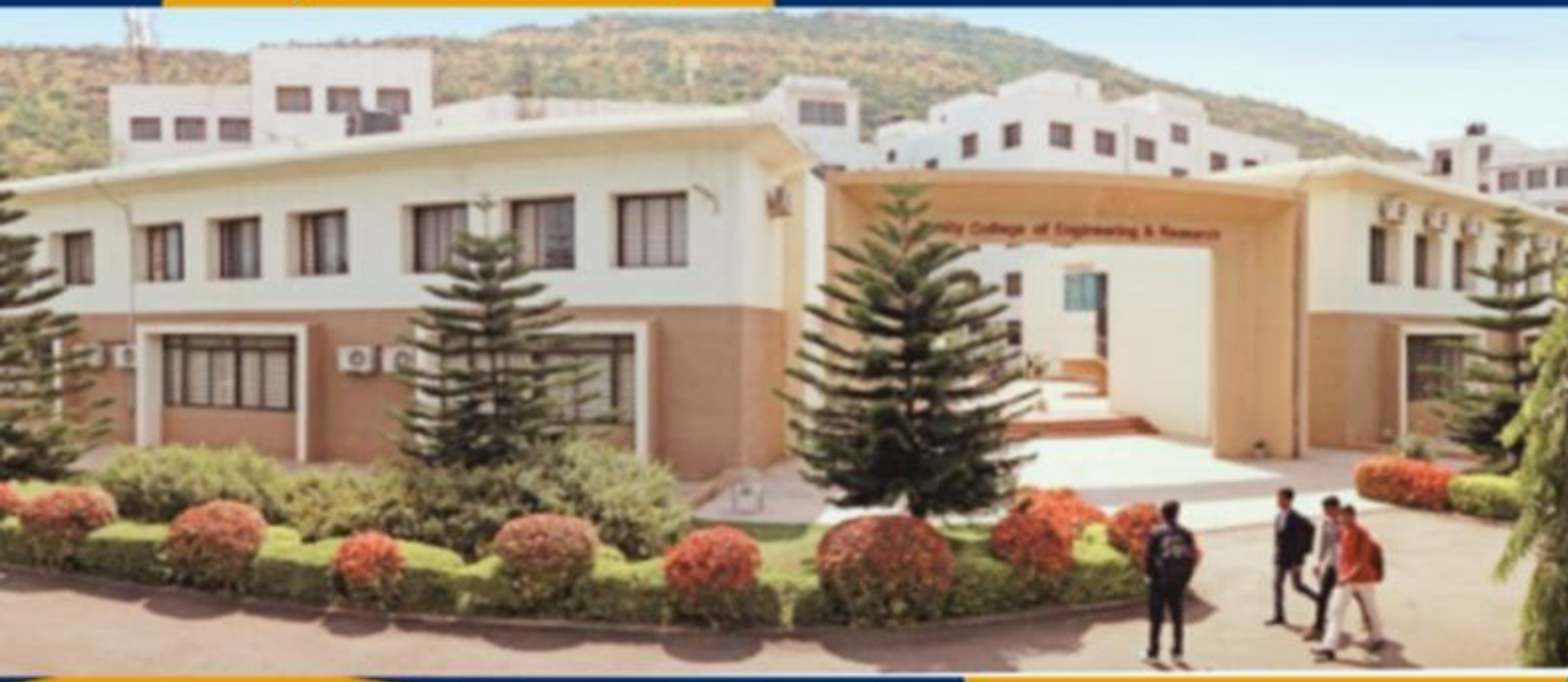
K J's EDUCATIONAL INSTITUTES

Trinity College of Engineering and Research, Pune

An Autonomous Institute Affiliated to Savitribai Phule Pune University
Approved by AICTE & Government of Maharashtra

First year- Master of Technology in Computer Engineering (M.Tech Computer Engg.)

The journey of a thousand miles begins with one step



Curriculum & Syllabi [W.e.f.A.Y.2025-26]

K J's EDUCATIONAL INSTITUTES

Trinity College of Engineering and Research,Pune

An Autonomous Institute Affiliated to Savitribai Phule Pune University
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VISION AND MISSION

To be a premier knowledge center for socio-economic development

To provide education that combines rigorous academics with joy of discovery through sustained efforts and dynamic strategies in building innovative, participatory, problem based learning practices and research that leads to capacity building of students

K J's EDUCATIONAL INSTITUTES

Trinity College of Engineering & Research, Pune, Maharashtra, India

Accredited NAAC Grade 'A+'

Approved by AICTE, Government of Maharashtra & Affiliated to Savitribai Phule Pune University, Pune, Maharashtra, India

Department of Computer Engineering

National Education Policy (NEP)2020 Complaint Curriculum

M. Tech. (2025 Pattern)

(With effect from 2025-26)

NEP 2020 Compliant Curriculum Structure

M. Tech. (Computer Engineering)

2025 Pattern

Syllabus structure: Semester I

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CIE	End Sem	Practical	Oral	Total	Theory	Practical	Total
Semester I												
MCCM2501	Major Core Course	Mathematical Foundation for Data science	4	-	50	50	-	-	100	4	-	4
MCCM2502	Major Core Course	Design and Analysis of Advance Algorithms	4	-	50	50	-	-	100	4	-	4
MCCM2503	Major Core Course	Modern Machine Learning Approaches	3	-	50	50	-	-	100	3	-	3
MCCM2504	Major Core Course	Lab Practice -I	-	4	-	-	-	50	50	-	2	2
MECM2521	Major Elective Course	Elective I	4	-	50	50	-	-	100	4	-	4
HSMM2561	Humanities social science and Management **(Mandatory Course)**	Human Rights	1	-	-	50	-	-	50	1	-	1
ELM2541	Experiential learning	Research Methodology	4	-	50	50	-	-	100	4	-	4
Total			20	4	250	300	-	50	600	20	2	22

List of Elective I Courses:

MECM2521A	Distributed Computing
MECM2521B	Speech Processing
MECM2521C	Business Intelligence
MECM2521D	Internet of Things

NEP 2020 Compliant Curriculum Structure

M. Tech. (Computer Engineering)

2025 Pattern

Syllabus structure: Semester II

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits	
			Theory	Practical	CIE	End Sem	Practical	Oral	Total	Theory	Practical	Total
Semester II												
MCCM2505	Major Core Course	Digital Forensics	4	-	50	50	-	-	100	4	-	4
MCCM2506	Major Core Course	Next Generation Networks	4	-	50	50	-	-	100	4	-	4
MCCM2507	Major Core Course	Deep Learning	3	-	50	50	-	-	100	3	-	3
MCCM2508	Major Core Courses	Lab Practice -II	-	4	-	-	-	50	50	-	2	2
MECM2523	Major Elective Course	Elective –II	4	-	50	50	-	-	100	4	-	4
HSSMM2562	Humanities social science and Management (Mandatory Course)	Universal Human values	1	-	-	50	-	-	50	1	-	1
ELM2542	Experiential learning	Seminar-I	-	8	50	-	-	50	100	-	4	4
Total			**16**	**12**	**250**	**250**	**00**	**100**	**600**	**16**	**6**	**22**

List of Elective II Courses:

MECM2523A	Cloud and Edge Technology
MECM2523B	Generative Artificial Intelligence
MECM2523C	Computer Vision
MECM2523D	Social Media Analysis

NEP 2020 Compliant Curriculum Structure

M. Tech. (Computer Engineering)

2025 Pattern

Syllabus structure: Semester III

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CIE	End Sem	Practical	Oral/ Presentation	Total	Theory	Practical	Total
Semester III												
MCCM2509	Major Core Course	Scalable Data Science	4	-	50	50	-	-	100	4	-	4
OEM2551	Open Elective I	MOOC 1*	4	-	-	100	-	-	100	4	-	4
MCM2543	Mandatory Course	Cyber Security	4	-	50	50	-	-	100	4	-	4
VSECM2563	Vocational and Skill Enhancement Course **(Mandatory Course)**	Skill Development I	-	4	-	-	-	50	50	-	2	2
RPM2544	Experiential learning	Research Project-I	-	16	100	-	-	100	200	-	8	8
Total			**12**	**20**	**200**	**200**		**150**	**550**	**12**	**10**	**22**

* Any Multidisciplinary / Course

NEP 2020 Compliant Curriculum Structure

M. Tech. (Computer Engineering)

2025 Pattern

Syllabus structure: Semester IV

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme					Credits		
			Theory	Practical	CIE	End Sem	Practical	Oral/ Presentation	Total	Theory	Practical	Total
Semester IV												
VEM2545	Value Education **(Mandatory Course)**	Indian Constitution	2	-	-	50	-	-	50	2	-	2
VSECM2546	Vocational and Skill Enhancement Course **(Mandatory Course)**	Skill Development II	-	4	-	-	-	50	50	-	2	2
ELM247	Experiential learning	Seminar II	-	12	50	-	-	50	100	-	6	6
RPM2548	Research Project	Research Project II	-	24	100	-	-	100	200	-	12	12
Total			2	40	150	50	00	200	400	02	20	22

Preface

Trinity College of Engineering and Research, Pune proudly marks a new milestone as it attains **autonomous status** starting from the academic year **2025–26**. This achievement reflects our sustained commitment to academic excellence and innovation.

Autonomy empowers us to design and deliver an outcome-based, future-focused curriculum aligned with the vision of the National Education Policy (NEP) 2020). This empowers us to offer greater academic flexibility, encourage interdisciplinary learning, and remain agile in meeting the dynamic needs of our students and the industry.

As we embark on this transformative journey, our commitment to fostering **innovation, integrity, and holistic development** remains steadfast.

- Hon. Shri. Kalyan Jadhav
Founder President, KJEI, Pune

The introduction of the National Education Policy (NEP) 2020 has initiated a significant shift in India's educational approach, aiming to align learning with the evolving demands of the 21st century. In response to this forward-looking vision, our institution has taken active steps to implement the core principles of NEP, which emphasizes well-rounded, interdisciplinary, and student-centric learning.

The M-Tech curriculum (2025 pattern) has been thoughtfully developed to provide a strong knowledge in subjects such as Digital Forensic, Deep Learning and Cyber Security, Modern Machine learning approaches and Next Generation Networks per the industry requirement. It also incorporates Human Values and Human rights.

This document outlines key academic elements such as the credit structure, course content, evaluation methods, and useful academic guidelines, helping both students and faculty make effective use of the curriculum.

We sincerely appreciate the dedicated efforts of all subject experts, curriculum developers, and faculty members who collaborated to design this innovative, learner-centered syllabus. We are confident that it will empower our M-Tech students to build a strong academic as per the industry requirement and equip them to thrive in today's rapidly evolving global environment.

Dr. A. B. Auti
Director-TCOER, Pune

Program Outcomes (POs)

PO1	**Engineering Knowledge**	Apply the knowledge of mathematics, science, Engineering fundamentals and an Engineering specialization to the solution of complex Engineering problems.
PO2	**Problem Analysis**	Identify, formulate, review research literature and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and Engineering sciences.
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**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern Tool Usage**	Create, select, and apply appropriate techniques, resources, and modern Engineering and IT tools including prediction and modelling to complex Engineering activities with an understanding of the imitations.
PO6	**The Engineer and The World**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practices.
PO7	**Ethics**	Apply ethical principles and committee professional ethics and responsibilities and norms of Engineering practice.
PO8	**Individual and Collaborative Team Work**	Function effectively as an individual and as a member or leader in diverse teams and in multidisciplinary settings.
PO9	**Communication Skills**	Communicate effectively on complex Engineering activities with the Engineering community and with society at large such as being able to comprehend and write effective reports and design documentation, Make effective presentations and give and receive clear instructions.
PO10	**Project Management and Finance**	Demonstrate knowledge and understanding of Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary Environments.
PO11	**Life long Learning**	Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Abbreviations

AEC	Ability Enhancement Course
BSC	Basic Science Course
CCC	Co-Curricular Courses
CIE	Continuous Internal Evaluation
CEP	Common Engineering Project
CO	Course Outcome
ELC	Experiential Learning Courses
ESC	Engineering Science Course
FP	Field Project
IKS	Indian Knowledge System
INT	Internship
MDM	Multidisciplinary Minor
NEP	National Education Policy
OE	Open Elective
OJT	On Job Training
PCC	Program Core Course
PEC	Programme Elective Course
PO	Program Outcomes
PR	Practical
PRJ	Project
PSO	Program Specific Outcome
RM	Research Methodology
TH	Theory
TU	Tutorials
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
ESE	End Semester Exam

Examination Scheme

Theory Examination:

The theory examination shall be conducted in two different parts

1. Continuous Internal Evaluation (CIE)
2. End Semester Examination (ESE)

Continuous Internal Evaluation (CIE)

Continuous Internal Evaluation (CIE) shall carry 50 marks and will be based on all Units of course syllabus. It will be scheduled and conducted at institute level.

The (CIE**)** scheme for a theory subject of 50 marks is detailed below:

Sr.	Parameters	Marks	Coverage of Units
1.	Unit Test 1	10 Marks	Unit 1 & Unit 2 (20 marks converted into 10 Marks)
2.	Unit Test 2	10 Marks	Unit 3 & Unit 4 (20 marks converted into 10 Marks)
3.	Problem Solving / Quize /	10 Marks	Unit 5 (10 Marks)
4.	Assignment / Presentation / Case Study / (Based on All Unit 1 to 5)	20 Marks	Unit 1 to 5 (20 Marks)

End Semester Examination (ESE)

End Semester Examination (ESE) is a 50 marks written theory examination based on all units of course syllabus scheduled by TCOER at the end of the semester.

Practical Examination:

The practical examination shall be conducted in two different parts

1. Continuous Internal Evaluation (CIE)
2. End Semester Examination (ESE)

Continuous Internal Evaluation (CIE)

Cotenuous Internal Evaluation (CIE) for Lab shall carry 50 marks and will be based on Assignments in the course syllabus. It will be scheduled and conducted at institute level. The CIE Scheme for Lab evaluation is as follows:

Sr.	Parameters	Marks
1.	Performance	10 Marks
2.	Evaluation	10 Marks
3.	Understanding	10 Marks
4.	Attendance	10 Marks
5	Oral	10 Marks

K J's EDUCATIONAL INSTITUTES

Trinity College of Engineering & Research, Pune, Maharashtra, India

National Education Policy (NEP) Compliant Curriculum

Semester I

M. Tech. Computer Engineering (2025 Pattern)

https://www.kjei.edu.in/tcoer

Trinity College of Engineering and Research, Pune
M. Tech of Computer Engineering (2025 Course)
MCCM2501: Mathematical Foundation for Data science

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

- Develop a strong foundation in probability theory.
- Understand the theoretical basis of statistical models.
- Solve real-world data science problems using statistical reasoning
- Connect statistical theory with computational tools.

Course Outcomes:

After completion of the course, students should be able to

- CO1: Analyze vector spaces and determine bases
- CO2: Summarize and describe datasets using statistical measures
- CO3: Calculate probabilities and use conditional rules
- CO4: Understand the principles behind statistical inference
- CO5: Use linear algebra for regression and dimensionality reduction

Course Contents

Unit I	Linear Algebra and Calculus	08 Hours

Vectors and vector operations Vector spaces and subspaces, Matrices: types, operations, and properties, Systems of linear equations, The Matrix Eigenvalue Problem, Determining Eigenvalues and Eigenvectors, Introduction to determinants, Linear independence, basis, and dimension, Rank and nullity. Understanding of calculus: concept of function and derivative, Multivariate calculus: concept, Partial Derivatives, chain rule, the Jacobian and the Hessian

Unit II	Data Analysis & Probability Theory	08 Hours

Data Representation, Average, Spread, Experiments, Outcomes, Events, Probability, Permutations and Combinations, Random Variables, Probability Distributions, Mean and Variance of a Distribution, Binomial, Poisson, and Hyper geometric Distributions, Normal Distribution, Distributions of Several Random Variables.

Unit III	Statistical Inference I	08 Hours

Types of Statistical Inference, Descriptive Statistics, Inferential Statistics, Importance of Statistical Inference in Machine Learning, Descriptive Statistics, Measures of Central Tendency: Mean, Median, Mode, Midrange, Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Coefficient of variation: Moments, Skewness, Kurtosis, one sample hypothesis testing, hypothesis, Testing of Hypothesis, Binomial distribution and normal distribution, Chi-Square Tests, t- test, ANOVA. Pearson Correlation.

Unit IV	Statistical Inference II	08 Hours

Measure of Relationship: Covariance, Karl Pearson's Coefficient of Correlation, Measures of Position: Percentile, Z-score, Quartiles, Bayes' Theorem, Bayes Classifier, Bayesian network, Probabilistic models with hidden variables.

Unit V	Regression Model	08 Hours

Introduction, types of regression. Simple regression- Types, Making predictions, Cost function, Gradient descent, Training, Model evaluation. Multivariable regression: Growing complexity, Normalization, making predictions, initialize weights, Cost function, Simplifying with matrices, Bias term, Model evaluation

Books:

Text:

1. **Linear Algebra and Its Applications** – *David C. Lay, Steven R. Lay, and Judi J. McDonald*
2. **The Art of Statistics: How to Learn from Data** – *David Spiegelhalter*
3. **Matrix Analysis and Applied Linear Algebra** – *Carl D. Meyer*
4. **Introduction to Probability** – *Dimitri P. Bertsekas and John N. Tsitsiklis*

References:

1. D. C. Montgomery and G.C. Runger, "Applied Statistics and Probability for Engineers", 5th edition, John Wiley & Sons, (2009).
2. Robert H. Shumway and David S. Stoffer, "Time Series Analysis and Its Applications with R Examples", Third edition, Springer Texts in Statistics, (2006).

Trinity College of Engineering and Research, Pune
M. Tech of Computer Engineering (2025 Course)
MCCM2502: Design and Analysis of advance algorithms

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	04	CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

- Understand advanced algorithms and data structures.
- Analyze computational complexity
- Develop parallel and distributed computing skills
- Explore computational models and theoretical foundations

Course Outcomes:

On completion of the course, student will be able to–

- CO1: Analyze and compare time/space complexities
- CO2: Design efficient solutions using classical techniques
- CO3: Apply advanced data structures in optimization and graph algorithms
- CO4: Understand flow theory applications in networks and scheduling
- CO5: Design and evaluate approximation solutions for NP-hard problems

Course Contents

Unit I	Unit 1: Algorithm Analysis and Design Techniques	08 Hours

Asymptotic notations and recurrence relations (M. Tech Theorem), Divide and conquer, Greedy algorithms, Dynamic programming. Segment trees and Binary Indexed Trees (Fenwick Trees), performance analysis-space complexity, time complexity, asymptotic notation- big (O) notation, omega notation, theta notation and little (o) notation, recurrences, probabilistic analysis, disjoint set operations, union and find algorithms.

Unit II	Unit 2: Graph Algorithms – Advanced Concepts	08 Hours

Network flow algorithms (Ford-Fulkerson, Edmonds-Karp, Dinic's), Bipartite matching, Minimum-cost flow, Graph coloring and tree decomposition

Unit III	Unit 3: Approximation and Randomized Algorithms	08 Hours

Approximation algorithms and performance guarantees, Greedy and LP-based approximation, Randomized algorithms (Las Vegas, Monte Carlo), Probabilistic analysis

Unit IV	Unit 4: Online and Streaming Algorithms	08 Hours

Online algorithms and competitive analysis, Paging and caching algorithms (e.g., LRU, LFU), Stream processing: Count-Min sketch, Hyper Log Log, Sliding window algorithms

Unit V	Unit 5: Parameterized, Parallel, and Quantum Algorithms	08 Hours

Parameterized and Advanced Complexity: Fixed-parameter tractability (FPT), kernelization, W-hierarchy, ETH and fine-grained complexity

Parallel and Distributed Algorithms: PRAM models, parallel prefix sums, MapReduce algorithms, Consensus and leader election,

Quantum Algorithms: Qubits and basic gates, Grover's and Shor's algorithms, Complexity classes (BQP)

Books:

Text:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms,” ISBN: 978-0-262-04630-5, 4th edition MIT press, 2022.
2. Parag HimanshuDave, HimanshuBhalchandra Dave, “Design and Analysis of Algorithms,” Pearson Education, ISBN 81-7758-595-92, 2nd edition, 2013.

References

3. Rajeev Motwani and Prabhakar Raghavan, “Randomized Algorithms,” Cambridge University Press, ISBN: 978-0-521-61390-3, 1st edition, 2004.
4. Gilles Brassard, Paul Bratley, “Fundamentals of Algorithmics,” PHI, ISBN 978-81-203-1131-2. 163.
5. Michael T. Goodrich, Roberto Tamassia, “Algorithm Design: Foundations, Analysis and Internet Examples,” Wiley, ISBN 978-81-265-0986-7, 1st edition 2006.

Trinity College of Engineering and Research, Pune
M. Tech of Computer Engineering (2025 Course)
MCCM2503: Modern Machine Learning Approaches

Teaching Scheme:	Credit	Examination Scheme:
TH: 03 Hours/Week	03	CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

- To understand the basic concepts, state-of-the art techniques of machine learning.
- To apply different concepts for the machine learning problems.
- To apply and analyze different supervised and unsupervised learning approaches as per the suitability of the problem.
- To understand and evaluate machine learning methods to use them.
- To design solutions of problems using different machine learning approaches

Course Outcomes:

After completion of the course, students should be able to

- CO1: Apply different feature extraction, classification, regression, algorithms and modeling.
- CO2: Evaluate the performance of an algorithm and comparison of different learning techniques.
- CO3: Understand unsupervised methods and their applications
- CO4: Optimize the algorithms effectively
- CO5: Apply techniques using different case studies

Course Contents

Unit I	Principles of Pattern Recognition and Parametric Methods	08 Hours

Introduction: Pattern Representation, Concept of Pattern Recognition, Bayes' Decision Theory, Maximum-Likelihood and Bayesian Parameter Estimation, Error Probabilities, Learning of Patterns, Modeling, Regression.

Parametric Methods: Gaussian Parameter Estimation, Maximum Likelihood Estimation, Bias and Variance, Bayes' Estimator, Bayesian Estimation, Parametric Classification, Regression, Naive Bayes, Hidden Markov Models, Support Vector Machines, Decision Trees.

Unit II	Dimensionality Reduction and Probabilistic Inference in ML	08 Hours

Kernel methods, Basic kernels, Types of Kernel, Properties of kernels, Pattern analysis using Eigen decomposition, Principal Component Analysis, Hidden Markov Models, Markov Decision Processes, Nonparametric techniques for density estimation, Parzen-window method

Unit III	Foundations and Variants of Convolutional Neural Networks	08 Hours

Convolutional Neural Networks: The operation, pooling layers, fully connected layers, Convolution and Pooling as an infinitely strong prior, Variants of the basic functions, efficient algorithms, Random or Unsupervised Features, Neuroscientific Basis for Convolutional Networks. Applications

Unit IV	Advanced Recurrent Neural Network Architectures	08 Hours

Recurrent Neural Networks: Types of RNN, Encoder-Decoder Sequence to sequence architecture,

Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and other Gated RNNs, Optimization for Long Term Dependencies, Applications

Unit V	**Ensemble Methods and Applied Machine Learning**	**08 Hours**

Advanced Machine Learning Techniques: Ensemble Learning Methods, Support Vector Machines (SVM),Dimensionality Reduction Techniques, Introduction to Deep Learning, Use Cases and Applications Fraud detection, sentiment analysis, computer vision, medical diagnosis case studies and applications only

Books :

Text:

1. Peter Flach, Machine Learning: The Art and Science of Algorithms that make sense of data, Cambridge University Press, 1st Edition, 2012, ISBN No.: 978-1-316-50611-0
2. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2nd edition, 2013, 978-0-262-01243-0
3. Kevin Murphy, Machine Learning: a Probabilistic Approach, MIT Press, 1st Edition, 2012, ISBN No.: 978-0262-30616-4

Reference :

1. C.M. Bishop, Pattern Recognition and Machine learning, Springer, 1st Edition, 2013, ISBN No.: 978-81-322-0906-5
2. Hastie, Tibshirani, Friedman, Introduction to statistical machine learning with applications in R, Springer, 2nd Edition, 2013, ISBN No.: 978-1-4614-7138-7
3. Tom Mitchell, Machine Learning, McGraw Hill, 1997, 0-07-042807-7
4. Parag Kulkarni, Reinforcement and Systemic Machine learning for Decision Making, Wiley-IEEE Press, 2012, 978-0-470-91999-6
5. M. F. Der, L. K. Saul, S. Savage, and G. M. Voelker (2014). Knock it off: profiling the online storefronts of counterfeit merchandise. In Proceedings of the Twentieth ACM Conference on Knowledge Discovery and Data Mining (KDD-14), pages 1759-1768. New York, NY.
6. J. T. Ma, L. K. Saul, S. Savage, and G. M. Voelker (2011). Learning to detect malicious URLs. ACM Transactions on Intelligent Systems and Technology 2(3), pages 30:1-24.

Trinity College of Engineering and Research, Pune
M. Tech of Computer Engineering (2025 Course)
MCCM2504: Laboratory Proficiency I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hours/Week	02	Oral : 50 Marks

Laboratory Proficiency I (LP I) is companion course of theory courses (core and elective) in Semester I. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements are suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, complexity analysis, results, analysis and conclusions). Softcopy of report /journal and code is to be
Maintained by department/ institute in digital repository.

Suitable platform/framework/language is to be used for completing mini-project/assignments.

Guidelines for Examination

It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.

Suggested List of Laboratory Assignments

A. Research Methodology (Any ONE)

1. Use an academic web search to locate a journal paper which describes a design outcome in your field of interest (i.e. your engineering discipline).You must enter several keywords which relate to your topic. Read the paper and, using your own words, demonstrate your understanding of the paper by:

- Brief Contribution
- Performance metric, data set, comparative analysis and outcomes
- Writing out the major conclusions of the paper;
- Outlining the verification method(s) used to support these conclusions
- Describing the author's reflective comments on the quality of the design (positive and negative).
- The positive and negative environmental impacts;

After reading a published research paper, write down the research question you think the author have addressed in undertaking this research. Do you think the paper adequately supports the conclusions reached in addressing the question?

2. a) Literature Review Quality: Using a Journal paper selected in your engineering discipline of interest, write a 400-word evaluation of the quality of Literature Review. In particular, review the quality and relevance of cited papers, the comments made on those papers contribution to the general field, and any omission of papers which are of major importance in the field.

b) Develop a new research proposal from a published paper: From selected published Journal paper, read the paper. In particular, read the discussion and conclusion section and find Suggestions for further work. Apply one of the question words (How?, Why?, What?, When?) and write one or more research questions arising from this paper. This can be used as guide to help you to develop your own research project proposal

Mathematical Foundation for Data science (Any ONE)	
1.	**Simulate a Markov Chain:** Use linear algebra to represent transitions in a Markov chain and simulate its behavior over time. **Perform Principal Component Analysis (PCA):** Apply PCA to a dataset using linear algebra to reduce dimensionality and extract key features.
2.	**Explore the properties of a specific statistical distribution:** Analyze the properties of a specific statistical distribution (e.g., normal distribution) using linear algebra techniques.
Design and Analysis of Advance Algorithms (Any ONE)	
1.	Implement and benchmark a parallel algorithm (e.g., matrix multiplication, Monte Carlo simulation) on a cluster or supercomputer.
2.	Implement and evaluate a new algorithm (e.g., machine learning algorithm, optimization algorithm, image processing algorithm)
3.	Analyze a large dataset using advanced data analysis techniques (e.g., data mining, statistical modeling, visualization)
Modern Machine Learning Approaches (Any ONE)	
1.	**Suspicious activity detection from CCTVs:** Use machine learning to make the society a safer place. The idea is to have a machine learning algorithm capturing and analyzing the CCTV video all the time and learn from it the normal activities of people like walking, running. so that if any suspicious activity occurs, say robbery, it alerts the authorities in real time about the incident.
2.	**Web Search and Recommendation Engines:** - find recognize input, find relevant searches, predict which results are most relevant to us, return a ranked output - recommend similar products (e.g., Netflix, Amazon,)
3.	**Social Networks and Advertisement:** - data mining of personal information - selecting relevant ads to show

Trinity College of Engineering and Research, Pune
M. Tech of Computer Engineering (2025 Course)
Elective I

MECM2521A: Distributed Computing

Teaching Scheme: TH: 04 Hours/Week	Credits 04	Examination Scheme: CIE: 50 Marks End- Sem : 50 Marks

Course Objectives:

- Explore communication and synchronization mechanisms.
- Analyze distributed algorithms and protocols.
- Apply distributed computing to solve real-world problems.
- Analyze distributed algorithms and protocols

Course Outcomes:

After completion of the course, students should be able to-

- Explain the architecture and components of distributed systems.
- Implement basic distributed algorithms and synchronization techniques.
- Evaluate system performance and reliability.
- Design and analyze scalable distributed applications

Selection of Modules:

Kindly note that modules 1, 2 are compulsory and select any three (03) modules from module number-3 to 7.

Course Contents

Unit No.	Title	Hours
1	**Introduction to Distributed Computing**	08
Introduction: Definition-Relation to Computer System Components – Motivation – Message -Passing Systems versus Shared Memory Systems – Primitives for Distributed Communication – Synchronous versus Asynchronous Executions – Design Issues and Challenges; A Model of Distributed Computations: A Distributed Program – A Model of Distributed Executions – Models of Communication Networks – Global State of a Distributed System.		
2	**LOGICAL TIME**	08
Logical Time: Physical Clock Synchronization: NTP – A Framework for a System of Logical Clocks – Scalar Time – Vector Time; Message Ordering and Group Communication: Message Ordering Paradigms – Asynchronous Execution with Synchronous Communication – Synchronous Program Order on Asynchronous System – Group Communication – Causal Order – Total Order;		
3	**DISTRIBUTED MUTEX AND DEADLOCK**	08
Logical Time: Physical Clock Synchronization: NTP – A Framework for a System of Logical Clocks – Scalar Time – Vector Time; Message Ordering and Group Communication: Message Ordering Paradigms – Asynchronous Execution with Synchronous Communication – Synchronous Program Order on Asynchronous System – Group Communication – Causal Order – Total Order; Global State and Snapshot Recording Algorithms: Introduction – System Model and Definitions – Snapshot Algorithms for FIFO Channels		
4	**CONSENSUS AND RECOVERY**	08
Consensus and Agreement Algorithms: Problem Definition – Overview of Results – Agreement in a Failure-Free System(Synchronous and Asynchronous) – Agreement in Synchronous Systems with Failures; Checkpointing and Rollback Recovery: Introduction – Background and Definitions – Issues in Failure Recovery – Checkpoint-based Recovery – Coordinated Checkpointing Algorithm – – Algorithm for Asynchronous Checkpointing and Recovery		

5	CLOUD COMPUTING	08

Definition of Cloud Computing – Characteristics of Cloud – Cloud Deployment Models – Cloud Service Models – Driving Factors and Challenges of Cloud – Virtualization – Load Balancing – Scalability and Elasticity – Replication – Monitoring – Cloud Services and Platforms: Compute Services – Storage Services – Application Services

Books :

Text:

1. Distributed OS by Pradeep K. Sinha (PHI)
2. Tanenbaum S.: Distributed Operating Systems, Pearson Education
3. Tanenbaum S. Maarten V.S.: Distributed Systems Principles and Paradigms, (Pearson Education)
4. George Coulouris, Jean Dollimore. Tim Kindberg: Distributed Systems concepts and design.

References:

1. "Introduction to Algorithms" by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein.
2. "Computer Algorithms: Introduction to Design and Analysis" by Sara Baase and Allen Van Gelder
3. "High Performance Computing: Paradigm and Infrastructure" by Laurence T. Yang and Minyi Guo.

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective I
MECM2521B: Speech Processing

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE : 50 Marks End-Sem : 50 Marks

Course Objectives:

- Understand the fundamentals of speech production and perception
- Analyze the characteristics of speech signals
- Explore signal processing techniques for speech analysis
- Implement and evaluate speech processing systems

Course Outcomes:

On completion of the course the student should be able to-

- CO1: Understand production of speech.
- CO2: Analyze time domain models for speech signals.
- CO3: Analyze linear predictive coding techniques.
- CO4: Illustrate the homomorphic speech processing.
- CO5: Analyze the speech enhancement techniques.

Course Contents

Unit I	Fundamentals of Digital Speech Processing	08

Anatomy and Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

Unit II	Time Domain Models for Speech Processing	08

Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech Vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

Unit III	Linear Predictive Coding (LPC) Analysis	08

Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, 74 (R-2019) urbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.

Unit IV	Homomorphic Speech Processing	08

Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder.

Unit V	Speech Enhancement	08

Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach: spectral subtraction, Applications of Speech Processing: Speech recognition systems, Text-to-Speech system and Speaker recognition systems: speaker verification systems, speaker identification systems.

Books :

Text:

1. L.R. Rabiner and S. W. Schafer, Digital Processing of Speech Signals, Pearson Education, 2008.

2. Human & Machine, Douglas O'Shaughnessy, Speech Communications , 2nd Edition., Wiley India, 2000.

References:

1. Thomas F. Quateri, Discrete Time Speech Signal Processing: Principles and Practice , 1st Edition, PE, 2001.
2. Ben Gold & Nelson Morgan, S peech & Audio Signal Processing , 1st Edition, Wiley, 2011.

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective I
MECM2521C: Business Intelligence

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE: 50 Marks End- Sem: 50 Marks

Course Objectives:

- Explain the Business Intelligence, Analytics and Decision Support system
- List the technologies or Decision making, Automated decision systems
- Explain sentiment analysis techniques
- Illustrate Multi-criteria Decision making systems, predictive modelling technique

Course Outcomes: After completion of the course, students should be able to

- CO1: Explain the concepts, components, and architecture of Business Intelligence systems
- CO2: Analyze and interpret business data using analytical tools and methods
- CO3: Develop interactive dashboards and visualizations
- CO4: Design model for decision making system
- CO5: Develop decision system and expert system

Course Contents

Unit I	An Overview of Business Intelligence,	08

Information Systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems, A Framework for Business Intelligence

Unit II	Decision Making	08

Introduction and Definitions, Phases of the Decision, Making Process, The Intelligence Phase, Design Phase, Choice Phase, Implementation Phase, Decision Support Systems Capabilities, Decision Support Systems Classification, Decision Support Systems Components.

Unit III	Neural Networks and Sentiment Analysis	08

Basic Concepts of Neural Networks, Developing Neural Network-Based Systems, Illuminating the Black Box of ANN with Sensitivity, Support Vector Machines, A Process Based Approach to the Use of SVM, Nearest Neighbor Method for Prediction, Sentiment Analysis Overview, Sentiment Analysis Applications, Sentiment Analysis Process,, Sentiment Analysis, Speech Analytics.

Unit IV	Model-Based Decision Making	08

Decision Support Systems modeling, Structure of mathematical models for decision support, Certainty, Uncertainty, and Risk, Decision modeling with spreadsheets, Mathematical programming optimization, Decision Analysis with Decision Tables and Decision Trees, Multi-Criteria Decision Making With Pairwise Comparisons

Unit V	Automated Decision Systems and Expert Systems	08

Automated Decision Systems, The Artificial Intelligence field, Basic concepts of Expert Systems, Applications of Expert Systems, Structure of Expert Systems, Knowledge Engineering, Development of Expert Systems.

Books:

1. Ramesh Sharda, Dursun Delen, EfraimTurban, J.E.Aronson,Ting-Peng Liang, David King, “Business Intelligence and Analytics: System for Decision Support”, 10th Edition, Pearson Global Edition, 2013
2. Data Analytics: The Ultimate Beginner's Guide to Data Analytics Paperback – 12 November 2017by Edward Mize.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective I
MECM2521D: Internet of Things

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE: 50 Marks End- Sem: 50 Marks

Course Objectives :

- To introduce the fundamental concepts of IoT including its definition, architecture, characteristics, and applications.
- To understand the basics of M2M communication, sensing, and networking, including wireless sensor networks and communication protocols.
- To explore Market Basket Analysis (MBA) techniques and tools using distributed computing frameworks like Map Reduce and Spark.
- To analyze IoT data using cloud platforms and big data tools and explore real-world IoT applications in domains such as smart cities and industrial IoT.

Course Outcomes:

After completion of the course, students should be able to-

- CO1: Explain the fundamental concepts, definitions, characteristics, and designs of IoT systems
- CO2: Describe the technologies enabling M2M communication and IoT networking including sensing, actuation, and protocols.
- CO3: Analyze the requirements for IoT system management and platform development including device integration and application design.
- CO4: Apply Market Basket Analysis techniques for pattern discovery using big data tools like MapReduce and Spark.
- CO5: Evaluate real-world IoT applications and case studies across different domains such as smart homes, smart cities, and industrial IoT.

Course Contents

Unit I	**Introduction & Basic of IoT-**	**08**

Definition, Characteristics, Physical and Logical Designs, challenges, Technological trends in IOT, IoT Examples, M2M

Unit II	**Communication and Networking**	**08**

Introduction to Sensing and Networking: Sensing & actuation, Wireless Senor network, Senor nodes, Communication Protocols, M2M Communication, Networking Hardware, Networking Protocols. The Network Simplex Algorithm - The minimum cost flow problem

Unit III	**IoT System Management**	**08**

Network Operator Requirements, IoT Platform Design Specification– Requirements, Process, Domain Model, Service, IoT Level, Function, Operational view, Device and Component Integration, Application development.

Unit IV	**Market Basket Analysis**	**08**

Market Basket Analysis: MBA Goals, Application Areas for MBA, Market Basket Analysis Using Map Reduce, Spark Solution, POJO Common Friends Solution.

Unit V	**IoT Clouds and Data Analytics and Applications**	**08**

RESTful Web API, Amazon Web Services for IoT, Apache Hadoop, Batch Data Analysis, Chef, Chef Case Studies, Puppet, NETCONF-YANG. Case studies: smart cities, smart home, connected vehicles, Industrial IOT.

Books :

Text book

1. Kamal, R.,"Internet of Things– Architecture and Design Principles," 1st Edition, Mcgraw Hill,2017.
2. Simone Cirani," Internet of Things- Architectures, Protocols and Standards", WILEY,2018.
3. Alessandro Bassi," Enabling Things to Talk- Designing IoT solutions with the IoT Architectural Reference Model", Springer,2013.

Reference Book :

1. Reference Books: 1. D. Patranabis, "Sensor & Transducers", Murthy Prentice Hall India Learning Private Limited, 2nd edition, 2009.
2. Jacob Fraden," Handbook of Modern Sensors", Physics, Designs, and Applications, Fifth Edition, Spinger,2016.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
HSMM2561: Human Rights

Teaching Scheme: TH: 01 Hours/Week	Credit 01	Examination Scheme: End- Sem: 50 Marks

Course Objectives:

- Introduce students to the concept, origin, and significance of human rights.
- Familiarize students with national and international legal frameworks for the protection of human rights.
- Sensitize students to specific human rights issues related to marginalized groups and categories of rights.
- Explore contemporary global challenges to human rights in the context of technology, globalization, and development.
- Encourage analytical thinking, advocacy, and active engagement with real-world human rights issues through institutions, case studies, and discussions.

Course Outcomes:

After completion of the course, students should be able to-

- CO1: Explain the origin, evolution, and significance of human rights in the global context.
- CO2: Describe how national and international legal systems safeguard human rights through constitutional provisions and enforcement mechanisms.
- CO3: Analyze the rights of marginalized groups and the significance of civil, political, economic, social, and cultural rights.
- CO4: Evaluate the impact of globalization, technology, and development on the protection and violation of human rights
- CO5: Examine the roles of judicial bodies, commissions, NGOs, and civic participation in addressing real- world human rights challenges.

Course Contents

Unit I	Foundational Concepts	03

Definition of Human Rights and its importance. Origin and Evolution: The historical development of human rights, including key documents like the Universal Declaration of Human Rights. International Standards: Examining international human rights instruments and their impact.

Unit II	Legal Frameworks	03

National and International Law: How human rights are protected by national constitutions and international treaties. Constitutional Rights: Rights enshrined in the constitution, like freedom of speech, religion, and equality. Enforcement Mechanisms: How human rights are protected and enforced, including judicial remedies and human rights commissions.

Unit III	Human Rights Issues	03

Rights of Specific Groups: Examining the rights of women, children, minorities, indigenous peoples, and other marginalized groups. Economic, Social, and Cultural Rights: Rights to education, health, and an adequate standard of living. Civil and Political Rights: Rights to freedom of speech, assembly, and a fair trial.

Unit IV	Human Rights in the Modern World	08

Human Rights and Globalization: The impact of globalization on human rights. Human Rights and Technology: The role of technology in protecting and violating human rights. Human Rights

and Development: The relationship between human rights and sustainable development.

Unit V	Applied Human Rights: Institutions, Cases, and Civic Engagement	08

The Role of the Judiciary in protecting human rights, National and International Human Rights Commissions: Their powers and functions. Non-Governmental Organizations (NGOs): Their role in promoting and protecting human rights. Case Studies: Analyzing real-world human rights violations and their consequences. Research Projects: Conducting research on specific human rights issues. Debates and Discussions: Engaging in critical discussions about human rights issues.

Books :

Text Books:

1. Shivani Verma –"Human Rights" ,Vayu Education of India
2. Niraj Kumar – "Human Rights in India: Historical, Social and Political Perspectives," Aakar Books
3. Durga Das Basu – "Introduction to the Constitution of India", LexisNexis
4. Bajpai, Asha – "Child Rights in India: Law, Policy, and Practice". Oxford University Press.

Reference Book :

1. Amartya Sen – Development as Freedom – Oxford University Press
2. Jack Donnelly – Universal Human Rights in Theory and Practice – Cornell University Press
3. Rhona K. M. Smith – Textbook on International Human Rights – Oxford University Press.
4. Anuradha Kumar – Encyclopaedia of Human Rights – Anmol Publications

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
RMM2541: Research Methodology

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

1. Introduce the fundamental concepts, definitions, and characteristics of research.
2. Classify and differentiate between various types of research methodologies.
3. Understand and assess different outcomes of research, including publications, patents, and innovations.
4. Teach the application of statistical methods like Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) for research data interpretation.
5. Develop competencies in technical writing, preparation of research reports, theses, scientific papers, and understanding of Intellectual Property Rights (IPR) necessary to protect research outcomes.

Course Outcomes:

After completion of the course, students should be able to

- CO1: Define research and explain its essential characteristics with examples from engineering and science fields.
- CO2: Identify and apply different types of research (basic, applied, qualitative, quantitative, exploratory, descriptive, etc.) to specific problems.
- CO3: Analyze the outcomes of research such as publications, patents, and technological contributions, and understand their societal and industrial impacts.
- CO4: Apply ANOVA and ANCOVA techniques for effective experimental data analysis and interpretation of results.
- CO5: Understand and apply the basics of Intellectual Property Rights (IPR) to safeguard innovative research and prevent unethical practices.

Course Contents

Unit I	Definition and Characteristics of Research:-	08

Research — Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Philosophy and validity of research. Objective of research. Various functions that describe characteristics of research such as systematic, valid, verifiable, empirical and critical approach.

Unit II	Types of Research	08

Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches. Formulating the Research Problem, Literature Review, Developing the objectives, Preparing the research design including sample Design, Sample size.

Unit III	Outcome of Research	08

Relevance, interest, available data, choice of data, Analysis of data, Generalization and interpretation of analysis, Preparation of the Report on conclusions reached, Testing validity of research outcomes, Suggestions and recommendations, identifying future scope.

Unit IV	Analysis of Variance and Covariance	08

Basic principle of Analysis of Variance, ANOVA Technique, Setting up Analysis of Variance Table, short-cut method for oneway ANOVA, Coding method, Two-way ANOVA, ANOVA in Latin-square design, analysis of co-variance (ANCOVA), assumptions in ANCOVA. Academic Ethics: Plagiarism, exposure on anti-plagiarism tools.

Unit V	Technical Writing and IPR-	08

Academic writing, sources of information, assessment of quality of journals and articles, writing scientific report, structure and component of research report, types of report– technical reports

and thesis, SCOPUS Index, citations, search engines beyond google, impact factor, H-Index. IPR: What is IPR?, importance of patents, types of IPR, process of patent.

Books :

Text:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers' Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, Pearson Education.

References:

1. Caroline Whitbeck, "Ethics in Engineering Practice and Research", 2nd Ed., Cambridge University Press; ISBN :978-1-107-66847-8
2. Gordana DODIG-CRNKOVIC, "Scientific Methods in Computer Science", Department of Computer Science Malardalen University, Vasteas, Sweden; ISBN: 91-26-97860-1

Semester II

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
MCCM2505: Digital Forensics

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

- To introduce the principle and concepts of digital forensic.
- To detail about the various investigation procedures like data acquisition and evidence gathering
- To get Knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools

Course Outcomes:

After completion of the course, students should be able to-

- CO1: Understand the principles of network, mobile and cyber forensic science.
- CO2: Illustrate the cyber-crime investigation procedures.
- CO3: Apply the cyber-crime techniques to data acquisition and evidence collection.
- CO4: Apply Admissibility Rules for Electronic Evidence.
- CO5: Analyzing the digital evidences.

Course Contents

Unit I	Basics of Digital Forensics	08

Digital Forensics- Introduction, Objective and Methodology, Rules of Digital Forensics, Good Forensic Practices, Daubert‟s Standards, Principles of Digital Evidence. Overview of types of Computer Forensics – Network Forensics, Mobile Forensics, Social Media Forensics and E-mail Forensics. Services offered by Digital Forensics. First Responder – Role, Toolkit and Do’ and Don’ts

Unit II	Cyber Crime Investigation	08

Introduction to Cyber Crime Investigation, Procedure for Search and seizure of digital evidences in cyber-crime incident- Forensics Investigation Process- Pre search consideration, Acquisition, Duplication & Preservation of evidences , Examination and Analysis of evidences, Storing of Evidences, Documentation and Reporting, Maintaining the Chain of Custody.

Unit III	Data Acquisition and Evidence Gathering	08

Data Acquisition of live system, Shutdown Systems and Remote systems, servers. E-mail Investigations, Password Cracking. Seizing and preserving mobile devices. Methods of data acquisition of evidence from mobile devices. Data Acquisition and Evidence Gathering from Social Media. Performing Data Acquisition of encrypted systems. Challenges and issues in cyber-crime investigation.

Unit IV	Mobile Forensics, Legal Aspects of Digital Forensics	08

Mobile Forensics: mobile forensics techniques, mobile forensics tools. Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008. Recent trends in mobile forensic technique and methods to search and seizure electronic evidence.

Unit V	Analysis of Digital Evidences	08

Search and Seizure of Volatile and Non-volatile Digital Evidence, Imaging and Hashing of Digital Evidences, Introduction to Deleted File Recovery, Steganography and Steg analysis, Data Recovery Tools and Procedures, Duplication and Preservation of Digital Evidences, Recover Internet Usage Data, Recover Swap files/Temporary Files/Cache Files. Software and Hardware tools used in cybercrime investigation – Open Source and Proprietary tools. Importance of Log Analysis in forensic analysis. Understanding Storage Formats for Digital

Evidences – Raw Format, Proprietary Formats, Advanced Forensic Formats.

Books:

Text:

1. Nina Godbole and SunitBelapore; “Cyber Security: Understanding CyberCrimes, Computer Forensics and Legal Perspectives”, Wiley Publications,2011.
2. Bill Nelson, Amelia Phillips and Christopher Steuart; “Guide to Computer Forensics and Investigations” – 3rd Edition, Cengage, 2010 BBS
3. Shon Harris; “All in One CISSP Guide, Exam Guide Sixth Edition”,McGraw Hill, 2013.

References:

1. 1. LNJN National Institute of Criminology and Forensic Science, “A ForensicGuide for Crime Investigators – Standard Operating Procedures” LNJNNICFS, 2016.
2. Anthony Reyes, Jack Wiles; “The Best Damn Cybercrime and DigitalForensic Book”, Syngress, USA, 2007.
3. Cory Altheide and HalanCarvey; “Digital Forensics with Open SourceTools”, Syngress Publication.

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
MCCM2506: Next Generation Networks

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE: 50 Marks End- Sem : 50 Marks

Course Objectives:

- Understand the architecture, protocols, and technologies of modern computer networks.
- Analyze security threats, vulnerabilities, and attacks on computer networks and systems.
- Learn and apply various cybersecurity tools and technologies for protecting networks and data.
- Understand the principles and mechanisms of cryptography and secure communication.

Course Outcomes:

After completion of the course, students should be able to-

- CO1: Describe the layered architecture and protocols of computer networks (e.g., TCP/IP, OSI).
- CO2: Identify and analyze potential network threats, vulnerabilities, and attack vectors.
- CO3: Apply cryptographic algorithms and security protocols to secure data transmission.
- CO4: Implement intrusion detection and prevention techniques using appropriate tools.
- CO5: Evaluate network security policies, risk management strategies, and compliance requirements.
- CO6: Design and deploy secure network architectures using firewalls, VPNs, and security best practices.

Course Contents

Unit I	Introduction and NGN Networks	08 Hours

Introduction, Challenges, The Network Evolution Towards NGN, The Telecom Environment and Corporate Responsibility: NGN Networks: Perspectives and Potentials, Some Possible Scenarios. NGN Functional Architecture, The Proposed NGN Functional Architecture

Unit II	NGN Key Development Areas	08 Hours

Terminal Area, Access Network Area, Backhaul Network Area, Core Transport Network Area, Service Creation Area, Network Control and Management Area, Service Control and Management Area, Advanced Technologies for Network and Service Management

Unit III	NGN Standardizations	08 Hours

ITU and GSI-NGN, ETSI and TISPAN-NGN, ATIS and NGN, CJA and NGN. TMF and NGOSS, NGMN Alliance and NGMN, and 3GPP and LTE/SAE

Unit IV	NGN Key Development Areas	08 Hours

Terminal Area, Access Network Area, Backhaul Network Area, Core Transport Network Area, Service Creation Area, Network Control and Management Area, Service Control and Management Area, Advanced Technologies for Network and Service Management

Unit V	NGN Standardizations	08 Hours

ITU and GSI-NGN, ETSI and TISPAN-NGN, ATIS and NGN, CJA and NGN. TMF and NGOSS, NGMN Alliance and NGMN, and 3GPP and LTE/SAE

Books

Text:

1. "Computer Networking: A Top-Down Approach" By: James F. Kurose and Keith W. Ross
2. "Network Security Essentials: Applications and Standards" By: William Stallings
3. Jingming Li Salina and Pascal Salina, Next Generation Networks: Perspectives and Potentials, John Wiley & Sons Ltd, 2007, ISBN 978-0-470-51649-2.

Reference:

1. Steven Noble, Building Modern Networks: Create and manage cutting-edge networks and services, Packt Publishing, 2017, ISBN 978-1-78646-697-6
2. "Data and Computer Communications" By: William Stallings
3. "Network Security and Cryptography" By: Bernard Menezes

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025Course)
MCCM2507: Deep Learning

Teaching Scheme: TH: 03 Hours/Week	Credit 03	Examination Scheme: CIE: 50 Marks End- Sem : 50 Marks

Course Objectives:

- Understand the theoretical foundations and mathematical principles behind deep learning.
- Learn and implement various types of neural networks, including CNNs, RNNs, and auto encoders.
- Gain hands-on experience using popular deep learning frameworks (e.g., TensorFlow, PyTorch).
- Apply deep learning techniques to real-world problems in vision, language, and time-series data.
- Analyze, tune, and optimize deep learning models for better performance and generalization.

Course Outcomes :

After completion of the course, students should be able to-

- CO1: Explain deep learning architectures and training processes, including gradient descent and backpropagation.
- CO2: Implement feedforward, convolutional, and recurrent neural networks from scratch or using frameworks.
- CO3: Analyze and solve overfitting, vanishing gradients, and other model-related issues.
- CO4: Design and deploy deep learning models for image classification, NLP, and time-series tasks.
- CO5: Evaluate and fine-tune models using performance metrics, regularization, and hyper parameter tuning.

Course Contents

Unit I	**Introduction to Deep Learning**	**08 Hours**

Overview of AI, ML, and DL, Biological and artificial neurons, Mathematical foundations: linear algebra, calculus, probability, Activation functions: Sigmoid, Tanh, ReLU, Leaky ReLU

Unit II	**Feedforward Neural Networks**	**08 Hours**

Perceptron and multilayer perceptron, Loss functions (MSE, cross-entropy), Forward and backward propagation, Optimization: gradient descent, stochastic gradient descent, momentum, Adam, Weight initialization and model evaluation

Unit III	**Convolutional Neural Networks (CNNs)**	**08 Hours**

Convolution, pooling, and padding, CNN architectures: LeNet, AlexNet, VGG, ResNet, Applications in image classification, object detection, Transfer learning and fine-tuning

Unit IV	**Recurrent Neural Networks (RNNs) and Sequence Models**	**08 Hours**

RNN basics and training, Vanishing gradient problem, LSTM and GRU networks, applications in NLP: sentiment analysis, machine translation, Word embeddings: Word2Vec, GloVe

Unit V	Advanced Deep Learning and its Application	08 Hours

Autoencoders and Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Attention mechanisms and Transformers, Deep reinforcement learning. Deep learning using TensorFlow / PyTorch, Model interpretability and explain ability, Real-world applications in healthcare, finance, autonomous systems, Ethical considerations in deep learning.

Books:

Text:

1. Recurrent Neural Networks (RNNs) and Sequence Models
2. RNN basics and training
3. Vanishing gradient problem, LSTM and GRU networks
4. Applications in NLP: sentiment analysis, machine translation
5. Word embeddings: Word2Vec, GloVe

Reference:

1. Richard S. Sutton and Andrew G. Barto, ―Reinforcement Learning: An Introduction‖ by Seth Weidman,
2. Deep Learning from Scratch: Building with Python from First Principles‖O'Reily
3. Francois Duval, ―Deep Learning for Beginners, Practical Guide with Python and Tensorflow‖

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
MCCM2508: Laboratory Proficiency II

Teaching Scheme:	Credit 02	Examination Scheme:
Practical: 04 Hrs/week		Term Work: 25 Marks Practical: 25 Marks

Laboratory Proficiency II (LP II) is companion course of theory courses (core and elective) in Semester II. It is recommended that set of assignments or at least one mini-project/study project per course is to be completed. Set of problem statements is suggested. Course/ Laboratory instructor may frame suitable problem statements. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, complexity analysis, results, analysis, and conclusions). Softcopy of report /journal and code is to be maintained at department/institute in digital repository.

Suitable platform/framework/language is to be used for completing mini- project/assignments.

Guidelines for Examination

It is recommended that examination should be conducted as presentation by student based on one of the mini projects completed and the content understanding of laboratory work.

Suggested List of Laboratory Assignments

1. Digital Forensics (Any One)

1. **Digital Forensics Investigation Workflow**
   1. Objective: Simulate the digital evidence investigation process.
   2. Task: Use a case study to walk through Pre-search, Acquisition, Duplication, Analysis, and Reporting steps.
2. **Social Media and Mobile Device Evidence Collection**
   1. Objective: Use forensic tools to gather evidence from social media or mobile backups.
   2. Tools: Magnet AXIOM (trial), MOBILedit, Cellebrite (if available).
3. **Recover Deleted and Temporary Files**
   1. Objective: Use forensic software to recover deleted files and internet artifacts.
   2. Tools: Recuva, Autopsy.
4. **Study of IT Act 2000 & 2008 Amendment**
   - Objective: Understand and present on digital laws relevant to forensic professionals.
   - Task: Research and summarize cyber laws and forensic admissibility standards

2. Next Generation Networks (Any One)

1. IP Network connectivity and configuration: To identify, analyze and resolve the IP network problem using wire-shark. Perform IP address configuration, use diagnostic tools, troubleshoot the problem.
2. Service Control and Management in Network Systems in Python / Bash scripting Environment: Implement the techniques for controlling and managing network services, like service monitoring, traffic shaping, access control, fault detection and recovery in networks.

3. Deep Learning (Any One)

1. Image Generation using Generative Adversarial Networks (GAN) using Python: Train a GAN to generate and written digits similar to MNIST dataset using Tensor Flow and Keras.
2. Recommender system for Social Network Analysis using Python: Build a asimple friend recommender system Based on highest similarity score. Users are connected in a social graph. Create, analyze, and visualize graph. Use real dataset like, facebook, X, etc.

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective II

MECM2523A: Cloud and Edge Technology

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: CIE: 50 Marks End-Sem : 50 Marks

Course Objectives :

- Understand the architecture, service models, and deployment models of cloud computing.
- Explore the design and challenges of edge and fog computing systems.
- Learn about virtualization, containerization, and resource management in the cloud.
- Analyze the interplay between cloud and edge for latency-sensitive and real-time applications.
- Gain hands-on experience with cloud and edge platforms and tools.

Course Outcomes :

After completion of the course, students should be able to-

- CO1: Explain cloud computing concepts, architectures, and service models (IaaS, PaaS, SaaS).
- CO2: Demonstrate knowledge of edge and fog computing architectures and their roles in modern applications.
- CO3: Apply virtualization and containerization techniques for scalable and efficient computing.
- CO4: Design and analyze solutions that integrate cloud and edge technologies for real-time data processing.
- CO5: Use cloud and edge platforms such as AWS, Microsoft Azure, Google Cloud, and edge frameworks like KubeEdge or EdgeX Foundry.

Course Contents

Unit I	Introduction to Cloud Computing	08

Cloud computing definition, history, and evolution, Service models: IaaS, PaaS, SaaS, Deployment models: public, private, hybrid, and community, loud computing architecture and benefits Key technologies: virtualization, distributed systems

Unit II	Virtualization and Containerization	08

Virtual machines and hypervisors (Xen, KVM, VMware), Containers and Docker architecture,, Kubernetes and container orchestration, Comparison of VMs vs containers, Security and resource isolation

Unit III	Edge and Fog Computing Fundamentals	08

Introduction to edge and fog computing, Edge architecture and components, Fog computing characteristics and architecture, Use cases: smart cities, IoT, autonomous vehicles, Latency, bandwidth, and real-time requirements

Unit IV	Cloud and Edge Integration	08

Cloud-edge collaboration models, Data offloading and computation partitioning, Edge analytics and edge AI, Serverless computing at the edge, Multi-access edge computing (MEC), Load balancing and fault tolerance, Resource allocation in cloud and edge

Unit V	Tools, Platforms, and Case Studies	08

Overview of AWS, Azure, and Google Cloud, Edge frameworks: KubeEdge, EdgeX Foundry, AWS Green grass, Case studies: healthcare, manufacturing, transportation, Emerging trends: cloud-native, AI at the edge, 5G integration

Books :

Text:

1. "Cloud Computing: Concepts, Technology & Architecture" – Thomas Erl
2. "Fog and Edge Computing: Principles and Paradigms" – Rajkumar Buyya, Satish Narayana Srirama
3. "Cloud Computing: Principles and Paradigms" – Rajkumar Buyya, James Broberg, Andrzej Goscinski

Reference:

1. "Architecting the Cloud" – Michael J. Kavis
2. "Edge Computing: Models, Technologies and Applications" – Weisong Shi, Schahram Dustdar
3. "Hands-On Cloud-Native Applications with Java and Quarkus" – Francesco Marchioni
4. Documentation from platforms – AWS, Microsoft Azure, Docker, Kubernetes, KubeEdge

Trinity College Of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective II

MECM2523B: Generative Artificial Intelligence

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: CIE: 50 Marks End- Sem : 50 Marks

Course Objectives:

- To understand the fundamentals of Generative AI models and their applications.
- To explore various architectures like GANs, VAEs, and Transformers.
- To apply Generative AI techniques for text, image, and audio generation.
- To examine real-world applications and emerging trends in Generative AI

Course Outcomes:

After completion of the course, students should be able to-

- CO1: Explain the evolution, types, and ethical considerations of Generative AI models.
- CO2: Analyse the architecture and working principles of Transformers, Large Language Models (LLMs), and multimodal generative models.
- CO3: Implement AI-based text, image, and audio generation techniques using state-of-the-art models.
- CO4: Utilize industry-standard frameworks (Hugging Face, OpenAI APIs, TensorFlow/Keras) to build and fine-tune generative AI models.
- CO5: Evaluate real-world applications, challenges, and emerging trends in Generative AI across different domains.

Course Contents

Unit I	Foundations of Generative Models	08

Introduction to AI-driven content generation, Evolution of generative models: From rule based AI to deep generative models, Types of Generative Models: Autoregressive models, Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs), Diffusion Models, Ethical Considerations in Generative AI: Bias, misinformation, deepfakes, copyright issues.

Unit II	Foundation Models & Architectures	08

Transformers and Self-Attention Mechanism, Large Language Models (LLMs): GPT, BERT, T5, LLaMA, Pre-training vs. Fine-tuning approaches, Multimodal Generative AI: DALL·E, CLIP, Stable Diffusion

Unit III	Generative AI for Text, Image & Audio Generation-	08

Text Generation: Autoregressive models, ChatGPT, summarization, creative writing, Image Generation: StyleGAN, Stable Diffusion, DeepDream, AI Art, Audio Generation: Text to-Speech (TTS), AI Music Composition, Speech Synthesis, Evaluation Metrics: Perplexity, BLEU, FID score, Inception Score

Unit IV	Tools, Frameworks, and Applications	08

Generative AI in Software Development: GitHub Copilot, Code Llama, Frameworks & Libraries: Hugging Face, OpenAI APIs, TensorFlow/Keras for Generative AI, Fine-tuning & Custom Model Development, AI for Content Creation: Deepfake detection, AI-generated movies, virtual influencers

Unit V	Industry Use Cases & Future Trends	08

Generative AI in Healthcare, Finance, and Creative Industries, Synthetic Data Generation & AI for Simulations, Regulations & AI Governance: Transparency, accountability, and ethical AI, Future Trends in Generative AI: Explainable AI, Federated Learning, Edge AI.

Books :

Text:

1. Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play– David Foster, O'Reilly Media, 2nd Edition, 2023.
2. Hands-On Generative AI with Transformers– Utkarsh Sinha, Packt Publishing, 2023.

Reference :

1. Deep Learning for Natural Language Processing– Palash Goyal, Sumit Pandey, Karan Jain, Apress, 2018.
2. GANs in Action: Deep Learning with Generative Adversarial Networks– Jakub Langr, Vladimir Bok, Manning Publications, 2019.
3. Building Machine Learning Powered Applications– Emmanuel Ameisen, O'Reilly Media, 2020.
4. Transformers for Natural Language Processing– Denis Rothman, Packt Publishing, 2022.

Trinity College of engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective II
MECM2523C: Computer Vision

Teaching Scheme: TH: 04 Hours/Week	Credit 04	Examination Scheme: CIE : 50 Marks End-Sem : 50 Marks

Course Objectives:

- To learn basic principles of image formation, image processing algorithms
- To study the core vision tasks of scene understanding and recognition with Applications
- To study the modeling video analysis, video surveillance, object recognition and vision-based control etc.

Course Outcomes:

On completion of the course, student will be able to–

- CO1: To implement fundamental image processing techniques required for computer vision
- CO2: Understand Image formation process
- CO3: To perform various analysis on image to extract features form Images
- CO4: To develop applications using computer vision techniques
- CO5: design the application with respective parameters

Course Contents

Unit I	INTRODUCTION TO COMPUTER VISION	08

Image Processing, Computer Vision and Computer Graphics, Computer Vision Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality.

Unit II	IMAGE REPRESENTATION AND ANALYSIS	08

Image representation, Image processing techniques like color and geometric transforms, Edge-detection Techniques, Filtering, Mathematical operations on image and its applications like convolution, filtering,

Unit III	MOTION ESTIMATION	08

Introduction to motion, Regularization theory, Optical computation, Stereo Vision, Motion estimation, Structure from motion and models, Photo album, Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces

Unit IV	OBJECT RECOGNITION	08

Hough transforms and other simple object recognition methods, Shape correspondence and shape matching, Principal component analysis, Shape priors for recognition

Unit V	APPLICATIONS	08

Application: Surveillance, fore ground background separation, particle filters, Chamfer matching, tracking, and occlusion, combining views from multiple cameras, human gait analysis Application: In vehicle vision system: locating roadway, road markings, identifying road signs, locating pedestrians

Books :

Text:

1. Computer Vision - A modern approach, by D. Forsyth and J. Ponce, Prentice Hall Robot Vision, by B. K. P. Horn, McGraw-Hill.
2. Introductory Techniques for 3D Computer Vision, by E. Trucco and A. Verri, Publisher: Prentice Hall.
3. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Addison Wesley Longman, Inc., 1992. D. H. Ballard, C. M. Brown. Computer Vision. Prentice-Hall, Englewood Cliffs, 1982.

References:

- Richard Szeliski, Computer Vision: Algorithms and Applications (CVAA). Springer, 2010
- Image Processing, Analysis, and Machine Vision. Sonka, Hlavac, and Boyle. Thomson.
- Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012 .
- Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Ed.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
Elective II

MECM2523D: Social Media Analysis

Teaching Scheme:	Credit	Examination Scheme:
TH: 04 Hours/Week	04	CIE:: 50 Marks End-Sem: 50 Marks

Course Objectives:

- To demonstrate foundations of Social Media Analytics.
- To analyze data mining aspects in social networks.
- To solve mining problems by different algorithms.
- To describe network measures for social data.
- To explain behavioral part of web applications for Analysis.
- To analyze the data available on any social media applications.

Course Outcomes:

After completion of the course, students should be able to

- CO1: Discuss the basics of Social Media Analytics.
- CO2: Describe the significance of Data mining in Social media.
- CO3: Interpret the algorithms used for text mining.
- CO4: Apply network measures for social media data.
- CO5: Explain Behavior Analytics techniques used for social media data.

Course Contents

Unit I	**ANALYTICS IN SOCIAL MEDIA AND TYPES OF ANALYTICS TOOLS**	**08**

The foundation for analytics, Social media data sources, Defining social media data, data sources in social media channels, Estimated Data sources and Factual Data Sources, Public and Private data, data gathering in social media analytics.

Unit II	**VISUALIZING SOCIAL NETWORKS**	**08**

Introduction, A Taxonomy of Visualization, The convergence of Visualization, Interaction and Analytics. Data mining in Social Media: Introduction, Motivations for Data mining in Social Media, Data mining methods for Social Media, Related Efforts.

Unit III	**TEXT MINING IN SOCIAL NETWORKS**	**08**

Introduction, Keyword search, Classification Algorithms, Clustering AlgorithmsGreedy lustering, Hierarchical clustering, k-means clustering, Transfer Learning in heterogeneous Networks, Sampling of online social networks, Comparison of different algorithms used for mining, tools for text mining.

Unit IV	**NETWORK MEASURES**	**08**

Centrality: Degree Centrality , Eigenvector Centrality, Katz Centrality , Page Rank, Betweenness Centrality, Closeness Centrality ,Group Centrality ,Transitivity and Reciprocity, Balance and Status, Similarity: Structural Equivalence, Regular Equivalence

Unit V	**BEHAVIOR ANALYTICS**	**08**

Individual Behavior: Individual Behavior Analysis, Individual Behavior Modeling, Individual Behavior Prediction Collective Behavior: Collective Behavior Analysis, Collective Behavior Modeling, Collective Behavior Prediction. Case study on Mining Facebook: Overview, Exploring Facebook's Social Graph API's, Analyzing Social Graph Connections.

Books:

Text:

1. Reza Zafarani Mohammad Ali Abbasi Huan Liu, Social Media Mining, Cambridge University Press,ISBN: 10: 1107018854.
2. Charu C. Aggarwal, Social Network Data Analytics, Springer, ISBN: 978-1-4419-8461-6.

Reference:

1. Marshall Sponder, Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics, McGraw Hill Education, 978-0-07-176829-0.
2. Matthew A. Russell, Mining the Social Web, O'Reilly, 2nd Edition, ISBN:10: 1449367615.
3. Jiawei Han University of Illinois at Urbana-Champaign Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 2nd Edition, ISBN: 13: 978-1-55860-901-3 ISBN: 10: 1-55860- 901-6.
4. Bing Liu, Web Data Mining : Exploring Hyperlinks, Contents and Usage Data, Springer, 2nd Edition, ISBN: 978-3-642-19459-7.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
HSSMM2562: Universal Human Values

Teaching Scheme:	Credit	Examination Scheme:
TH: 01 Hours/Week	01	End-Sem: 50 Marks

Course Objectives:

- To help the students appreciate the essential complementarity between "VALUES and SKILL to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction.

Course Outcomes:

After completion of the course, students should be able to

- CO 1: Construct a conceptual framework for humane society based on relationship and harmony
- CO 2: Develop the competence to work as a team based on relationship in different dimensions of life and society
- CO 3: Analyze the significance of feelings in ensuring justice in human-human relationships
- CO4: Understand and explain the concept of harmony in nature
- CO5: Understand the Humanistic Constitution and the Universal Human Order

Course Contents

Unit I	**Introduction to Value Education**	**08**
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations		
Unit II	**Harmony in the Human Being**	**08**
Understanding Human being as the Co-existence of the Self and the Body, distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.		
Unit III	**Harmony in the Family and Society**	**08**
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Respect – as the Right Evaluation, Other Feelings, Justice in Human-to- Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.		
Unit IV	**Harmony in the Nature/Existence**	**08**
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.		
Unit V	**Implications of the Holistic Understanding – a Look at Professional Ethics**	**08**

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

Books:

Text Book:

1. The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034- 47-1
2. The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Book:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher. Slow is Beautiful - Cecile Andrews

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
ELM2542 : Seminar I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 08 Hrs/week	04	CIE : 50 Marks Presentation : 50 marks

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms and services.

Course Outcomes:

On completion of the course, student will be able–

- CO1: To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,
- CO2: To acquire, articulate, create and convey intended meaning using verbal and non- verbal method of communication.
- CO3: To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across

The student shall have to deliver the seminar I in semester II on a topic approved by guide and authorities. It is recommended to allot guide to the student since the commencement of semester I. The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. It is recommended that seminar shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected or domain of interest.

It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain. Thorough literature study based on the broad identified topic has to be carried out. This practice will eventually lead to convergence of the efforts for the dissertation in Semester III and IV.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research & innovation. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.

Semester III

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
MCCM2509 : Scalable Data Science

Teaching Scheme:	Credit 04	Examination Scheme:
TH: 04 Hours/Week		CIE: 50 Marks End-Sem: 50 Marks

Course Objectives:

- To understand the challenges and architectures for scaling data science workflows.
- To introduce distributed data storage, processing, and machine learning systems.
- To apply data science techniques on big data using tools like Hadoop, Spark, and scalable ML libraries.
- To design and evaluate large-scale data pipelines with fault-tolerance and performance considerations.

Course Outcomes:

After completion of the course, students should be able to

- CO1: Analyze and articulate the scalability requirements of real-world data science problems.
- CO2: Apply distributed storage and processing systems like HDFS, Spark, and Kafka for handling large datasets.
- CO3: Design and implement machine learning workflows using distributed computing platforms.
- CO4: Evaluate and optimize the performance of scalable data science pipelines.
- CO5: Integrate scalable solutions using cloud technologies and orchestration tools for end-to-end data analytics.

Course Contents

Unit I	**Foundations of Scalable Data Science**	**08**

Introduction to Big Data & Scalable Data Science, The need for scalability: Volume, Velocity, Variety, Distributed Computing Fundamentals, Overview of MapReduce Paradigm, Challenges in Scaling Machine Learning

Unit II	**Distributed Data Storage and Processing**	**08**

HDFS and Distributed File Systems, Apache Hadoop Ecosystem Overview, Data formats for scalability: Avro, Parquet, ORC, Batch vs Stream Processing, Introduction to Stream Processing (Apache Kafka, Spark Streaming)

Unit III	**Apache Spark Ecosystem**	**08**

Spark Architecture and Execution Model, RDDs, DataFrames, Datasets: Concepts and Operations, Spark SQL and Catalyst Optimizer, Machine Learning with Spark MLlib Structured Streaming with Spark. Performance tuning and fault tolerance

Unit IV	**Scalable Machine Learning Techniques**	**08**

Parallelized ML Algorithms (SGD, Decision Trees, Clustering), Model Training at Scale (Parameter Servers, Horovod, MLlib), Distributed Hyperparameter Optimization, Feature Engineering at Scale, Distributed learning algorithms (Linear Models, Tree-based models, Clustering)

Unit V	**Workflow Automation and Cloud Scalability**	**08**

Building data pipelines with Apache Airflow and Luigi, Data ingestion and orchestration tools (Kafka, Beam), Cloud-based scalable platforms (AWS EMR, GCP Dataproc, Azure Synapse) ,

End-to-end project architecture: From ingestion to ML inference, Case studies: Scalable recommender systems, Fraud detection at scale

Books:

Textbooks:

1. **"Advanced Analytics with Spark: Patterns for Learning at Scale"** – Sandy Ryza, Uri Laserson, Sean Owen, Josh Wills, O'Reilly.
2. **"Big Data: Principles and Paradigms"** – Rajkumar Buyya, Rodrigo N. Calheiros, Amir Vahid Dastjerdi.

Reference Books

1. "Designing Data-Intensive Applications" – Martin Kleppmann
2. "Spark: The Definitive Guide" – Bill Chambers and Matei Zaharia
3. Apache Spark, Hadoop, and Kafka Documentation
4. Selected IEEE/ACM journal papers on scalable machine learning

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
OEM2551: (MOOC Online)*

Teaching Scheme:	Credit 04	Examination Scheme:
Practical: 04 Hrs/week		Presentation: 100 Marks

Prerequisite Description:

- Individual students can register for MOOC course which include the multi-disciplinary knowledge, tools and techniques to develop and apply it in project.
- Selection of Course: –
  - The selected course should be from NPTEL/ Coursera/ Udemy/any foreign university approved course.
  - The selected course should not be from courses offered in the programme curriculum.
  - Students must take prior approval from Mentor/Project Guide and PG coordinator/MOOC coordinator through the prescribed form given in MOOC Course Approval Form
  - Students must submit proof of course registration done along with MOOC Course Approval Form
  - Certification and grade report is mandatory for the course to be selected
  - Students must complete all assessments related to the selected course as prescribed by the course and guide/ mentor

- **Course Objectives:**
  The course aims to:
  1. To imbibe self-learning.
  2. To prepare students for modern tools and techniques
- **Course Outcomes:**
  Upon successful completion of this course, students will be able to:
  - Apply the technical knowledge in multi-disciplinary project.
  - Explore modern tools and techniques.

Assessment of Course

At the end of course submission, the MOOC report of 10-15 pages in hardcopy is mandatory along with certificate of completion.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
MCM2543: Cyber Security

Teaching Scheme:	Credit 04	Examination Scheme:
TH: 04 Hours/Week		CIE: 50 Marks End-Sem : 50 Marks

Course Objectives:

Upon successful completion of this course, students will be able to:

- Understand the fundamental concepts of cybercrime and cybersecurity
- Identify and analyze common cyber threats and vulnerabilities
- Utilize practical vulnerability scanning and assessment tools
- Develop an awareness of common security assessment methodologies and tools

Course Outcomes:

On completion of the course, student will be able to–

- CO1: **Define and differentiate** fundamental cybersecurity concepts
- CO2: **Identify and explain** the mechanisms and characteristics of major cyberattack types.
- CO3: Implement basic network defense mechanisms.
- CO4: **Perform essential network reconnaissance and vulnerability scanning** using tools.
- CO5: Utilize common web application security testing tools

Course Contents

Unit I	Introduction to Cyber Security	08 Hours

Introduction to Cyber Crime: Definition and Origin of the Word, Cyber Security: Definition, Who are Cyber Criminals, Cyber Crime and Information Security, Cyberspace, Classification of Cybercrimes, Basic Terminologies: Vulnerability, Threat, Exploit, Attack, Active Attacks, Passive Attacks, Types of hackers, How Criminal Plans the Attack, What is hacking , Phases of Hacking.

Unit II	Cyber Attacks	08 Hours

What is malware, Types of malwares: Virus, Worms Trojan, backdoors, Keyloggers and Spyware, Proxy server and Anonymizers, Buffer Overflow, Cyber Defamation, Software Piracy, Computer Sabotage, E-mail Spoofing, Salami Attack, Data Diddling, Forgery, Online Frauds, Email Bombing, Computer Network Intrusion, Password Sniffing, Credit Card Frauds, Identity Theft, Social Engineering and its types, Botnet, Botnet Architecture, Phishing: How does phishing work, DOS and DDOS Attacks, SQL Injection.

Unit III	Introduction to Network Defense	08 Hours

Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Stateless Vs Stateful Firewalls, IDS, IPS, IDS vs IPS, Network Address Translation (NAT), Open Port, Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Intrusion Detection System

Unit IV	Vulnerability Scanning	08 Hours

Overview of vulnerability scanning, Open Port/Service Identification, Banner/Version Check, Traffic-Probe, Vulnerability Probe, Vulnerability Examples, Network Reconnaissance – Nmap, Networks Vulnerability Scanning - Netcat, Network Sniffers and Injection tools – Tcpdump and Wireshark,

Unit V	Web Application Scanning tools	08 Hours

Web Application vulnerabilities scanning tools: Vega Scanner, Nikto, W3af, Application Inspection tools: Zed Attack Proxy, Sqlmap, DVWA, Password Cracking and Brute-Force Tools: John the Ripper, L0phtcrack, Pwdump, OWASP top 10 testing tools.

Books:

Text:

1. Cryptography and Network Security - Principles and Practice | Eighth Edition | By Pearson,2023
2. William Stallings, Computer Security: Principles and Practices, Pearson 6 Ed, ISBN 978-0-13- 335469-0, 2017
3. Nina Godbole, Sunit Belapure, Cyber Security- Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiely India Pvt.Ltd, ISBN- 978-81-265-2179-1, 2011

References:

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd, Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt.Ltd, 2005
2. CK Shyamala et el., Cryptography and Security, Wiley India Pvt. Ltd, ISBN-978-81-265-2285-9. 4.
3. Berouz Forouzan, Cryptography and Network Security,TMH, 2 edition, ISBN -978-00-707-0208- 0.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
VSECM2563: Skill Development I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs/week	02	Oral : 50 Marks

Prerequisites: Basic knowledge of digital image fundamentals, basic MATLAB programming.

Course Objectives:

- To gain hands-on experience in digital image processing using MATLAB.
- To enhance and restore images using spatial and frequency domain techniques.
- To implement edge detection, segmentation, and morphological operations.
- To extract features and apply recognition on processed images.
- To solve real-world imaging problems using MATLAB-based algorithms

Course Outcomes:

On completion of the course, students will be able to–

- CO1: Demonstrate proficiency in MATLAB and its Image Processing Toolbox for basic image operations.
- CO2: Apply spatial and frequency domain filtering techniques for image enhancement.
- CO3: Implement various image segmentation and morphological processing techniques.
- CO4: Extract meaningful features for image analysis and recognition.
- CO5: Design and develop small real-time projects using image processing methods for specialized applications.

Guidelines for Instructor's Manual

The instructor’s manual should briefly cover the university/program background, course objectives, syllabus, lab conduction methods, and assessment criteria. It should provide topic-wise concepts, expected outcomes, and a list of practical assignments using MATLAB. Sample code structures, references, and standard evaluation rubrics should also be included. The goal is to guide consistent lab delivery and help instructors align sessions with defined learning outcomes.

Guidelines for Student's Lab Journal

Students must maintain a handwritten lab journal including a prologue, certificate, index, and structured content for each experiment. Each write-up should cover the title, objective, problem statement, mapped COs, tools used, theory, algorithm/flowchart, MATLAB code, output, and conclusion. Journal should be neat and regularly signed. Printing code is optional to promote ecofriendly practices. A DVD of programs may be maintained in the lab for record-keeping.

Guidelines for Oral Examination

The practical exam should be jointly conducted by internal and external examiners. Problems should reflect real-time concepts like enhancement, segmentation, or filtering. Focus must be on implementation, output, and student understanding. Supplementary questions can be asked for concept clarity. Evaluation should be transparent and based on actual execution.

List of Assignments:- (Perform Any 5 Practical’s)

1. Image I/O and Basic Operations —

Read and display grayscale and color images using MATLAB. Perform basic operations such as resizing, flipping, rotating, and format conversion. Save the modified image in different formats.

• **Objective:** Learn basic image handling in MATLAB.

• **Tasks:**

- Read grayscale and color images.
- Resize, flip (horizontally/vertically), rotate by arbitrary angles.
- Convert between formats (e.g., JPG → PNG → BMP).
- Save the processed image.

2. Image Enhancement in Spatial Domain —
Implement contrast stretching, negative transformation, and histogram equalization on grayscale images. Analyze the effect of these operations visually and through histograms.

• **Objective:** Enhance image contrast and clarity.

• **Tasks:**

- Apply negative transformation.
- Perform contrast stretching.
- Implement histogram equalization.
- Compare histograms (before and after).

• **Deliverables:** Plots of histograms, processed images, analysis.

3. Frequency Domain Filtering —
Apply Discrete Fourier Transform (DFT) to images. Design and implement ideal, Butterworth, and Gaussian low-pass and high-pass filters. Display magnitude and phase spectrum.

• **Objective**: Analyze and filter images in frequency domain.

• **Tasks**:

- Apply DFT and show magnitude & phase spectrum.
- Design and apply:
  - Ideal Low/High-Pass Filter
  - Butterworth Filter
  - Gaussian Filter

• **Deliverables**: Filter masks, filtered outputs, comparison plots.

4. Noise Addition and Smoothing —
Add Gaussian and salt & pepper noise to an image. Apply mean, median, and Gaussian filters for noise removal. Compare results using visual and quantitative metrics (e.g., PSNR).

• Objective: Understand noise effects and smoothing filters.

• Tasks:

- Add Gaussian noise and salt & pepper noise.
- Apply mean, median, and Gaussian filters.
- Calculate and compare PSNR before and after filtering.

• Deliverables: Noisy and denoised images, PSNR values, plots.

5. Edge Detection —
Implement Sobel, Prewitt, Laplacian, and Canny edge detectors. Compare their edge maps on the same image. Evaluate performance in terms of edge continuity and noise sensitivity.

• Objective: Extract edges using different operators.

• Tasks:

- Implement and compare:
  - Sobel
  - Prewitt
  - Laplacian
  - Canny Edge Detection
- Analyze edge continuity and noise sensitivity.

• Deliverables: Edge maps, summary table with visual and analytical comparison.

6. Image Segmentation —
Perform segmentation using global and adaptive thresholding techniques. Implement k-means clustering on color images. Highlight segmented regions and extract object boundaries.

• Objective: Partition images into meaningful regions.

• Tasks:

- Apply global thresholding and Otsu's method.
- Adaptive thresholding (mean, Gaussian).
- K-means clustering on color images.
- Extract object boundaries.

• Deliverables: Segmented outputs, boundary overlays, k-means cluster map.

7. Morphological Operations —
Use dilation, erosion, opening, closing, and morphological gradient operations on binary images. Apply them on text, cell, or fingerprint images to observe structural transformations.

• Objective: Understand shape-based operations.

• Tasks:

- Perform dilation, erosion, opening, closing.
- Morphological gradient.
- Apply on binary/text/fingerprint/cell images.

• Deliverables: Operation-wise results, before-after comparison.

8. Feature Extraction —
Extract texture features using Gray Level Co-occurrence Matrix (GLCM), and shape features using Hu Moments. Apply Local Binary Pattern (LBP) for texture classification.

- Objective: Derive texture and shape features.

- Tasks:

  - Extract texture features using GLCM (contrast, correlation, entropy).
  - Extract Hu Moments.
  - Apply Local Binary Pattern (LBP) for classification.

- Deliverables: Feature tables, classification result, plots.

9. Case Study: Real-Time Image Application —
Choose any one case: a) Enhance and segment a medical image (e.g., MRI, X-ray). b) Satellite image enhancement and classification (e.g., NDVI analysis). Apply multiple techniques from previous experiments and interpret results.

- Objective: Apply integrated image processing to a real-world scenario.

- Options (choose any one):

  - a) **Medical Imaging** (MRI/X-ray): Enhance, segment, analyze.
  - b) **Satellite Image**: NDVI calculation, enhancement, land classification.

- Deliverables: Complete report with steps, code snippets, visuals, and interpretation.

10. Mini Project —
Develop a complete image processing application using MATLAB. Examples: object counting in industrial parts, traffic sign detection, digital watermarking, license plate recognition, etc. Submit project code, report, and output screenshots.

- Objective: Build a real-world image processing system.

- Ideas:

  - Industrial object counting
  - Traffic sign detection
  - License plate recognition
  - Digital watermarking

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
RPM2544: Research Project-I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 16 Hrs/week	08	CIE: 100 Marks Practical: 100 Marks

Course Description:

- The master's degree culminates in a research project of the student's own design. This project is documented by a final research report or dissertation. The student's work is guided by an academic supervisor.
- It also is supported by a variety of key skill programmes. Students are expected to construct a research project that includes original research, deliberate and well considered methodological choices, and shows relevance to significant conversations within the discipline.
- The dissertation should represent the very best research and analysis a student can produce

Course Objectives:

Upon successful completion of this course, students will be able to:

1. demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
2. demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
3. demonstrate expert knowledge in the subject of their research project, such as through a integrated literature survey
4. demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
5. demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
6. demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
7. demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
8. demonstrate an ability to balance description, analysis, and synthesis within their project report
9. demonstrate an ability to reflect on the strengths and weaknesses of their research and methodology, with constructive advice on how they might improve their efforts in future work

Course Outcomes:

After successful completion of the course, learner will be able to:

1. undertake independent research that makes an original contribution to knowledge, or produces a novel synthesis of existing materials relevant to significant conversations in the discipline
2. plan their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value
3. work independently and manage a complex project within strict time constraints
4. comply with relevant ethical, safety, and documentation processes as appropriate to the work
5. select and deploy research methods that are appropriate to the data collection within the project

6. relate their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature
7. balance description, analysis, and synthesis within the context of scholarly writing
8. assemble their rationale, methods, findings, and analysis into a substantial piece of writing that presents a clear thesis and a cohesive evidence-based argument or analysis
9. reflect on the strengths and weaknesses of their research and methodology, understanding how they might improve their efforts in future work

Course Contents

Phase 1: Informal conversations

Students are strongly encouraged to discuss possible project ideas with tutors, fellow students, and other research professionals. All research projects begin with open-ended conversations and scoping exercises. These should be non-committal.

Phase 2: Identify topic

The first formal step in the module involves identifying a preliminary project title and writing an abstract of no more than 100 words. This requires submitting a completed registration form. Writing an abstract for a research proposal or for completed research work is an important transferable skill. Students who do not submit a completed registration form will be assigned a project. The project title is understood to be provisional. Supervisors will be assigned to students after the project title/ abstract forms have been submitted. Supervision: A supervisor is required. The main responsibilities of the supervisor are to assist the student with project management and to advise the student on criteria for assessment. You can expect your supervisor to read and comment on a full draft of your research proposal and of your project.

It is a good idea to discuss a time line for your project with your supervisor, and to establish a definite timetable.

Some key points in our advice to students on compliance:

1. allow at least two weeks between submitting an ethics application and the date of your first data collection
2. your supervisor must approve (and sign!) your ethics application before you submit it at departmental level
3. after your protocols have been approved, append a copy of your ethical approval certificate to the dissertation and project proposal.

Phase 3: Project proposal

The proposal should reflect a student's best effort. At the same time, we recognize research often raises new questions. Some redefinitions of topics and titles is common later in the research process. Students should keep their supervisors up to date on these developments, and they can expect a reasonable amount of adaptation.

Phase 4: Term-1 research

Students are expected to commit substantial time during the term to their research project. Supervisions The principal form of academic input for the research project normally comes through discussions with the designated supervisor. The majority of these meetings should be face-to-face, either in person or via video- or audio-conferencing technology. Students are expected to respect these periods of absence and plan their needs accordingly.

One distinction is crucial:

1. when staff are on leave, they are off work (i.e., not expected to maintain contact with their supervisees or to undertake their duties); however,
2. when staff are working remotely, they are at work (i.e., expected to maintain contact and to be available for normal duties).

3. A student's supervisor is not the only person who may advise on projects and writing. Others include peers and subject experts.

Phase 5: Submit project report

The project report with the specific due date must be submitted to Department

Additional Information

- **Research notebook**: Students are strongly advised to maintain a research notebook, either digital or paper, and to keep this up to date. A research notebook can prove useful should examiners query research methods, research integrity, or research process. • Preventing data loss: Protect yourself against loss of research material and writing by maintaining a system for secure, redundant, up-to-date back-up of research material and writing. Loss cannot be accepted as a reason for failing to meet a deadline. A copy of written notebooks can be stored by supervisors for the duration of the project. Loss of project materials through accidents and theft have occurred in the past; these have had devastating effects on the unprepared. All students are warned to create redundancies to protect their project from similar calamities.
- **Extensions:** This is a long-term research project, and time management is a learning objective. Short-term extensions normally are not considered. Applications for extension must be made through the processes described in the STS Student Handbook. Personal Tutors are the first point of contact on extension requests.
- **Word counts:** Words counted towards the total word count include the main body of the report and supporting footnotes or endnotes. The word count does not include: bibliography, front matter (title page, keywords, abstract, table of contents, acknowledgments), appendix material, supplemental data packages, table and figure legends, or documentation of ethics protocols or approvals. Otherwise, University standard policy on word counts will apply.
- **Re-using coursework from other modules:** Text and ideas in the research proposal may reappear in the dissertation if significantly developed or further elaborated; however, Universities policy on self-plagiarism prevents the same work receiving credit twice. This means rote duplication is not allowed.
- **Citation format:** The style must be clear, explicit, and meaningful. In every instance, it must allow an examiner to locate efficiently and specifically material referred to. As a recommendation, students should use a style frequently used in the literature relevant to their research project. Most journals have style guides in their notes to contributors. Students should discuss options with their supervisors, and they should keep in mind that efficient citation is one element in the criteria for assessment.

Semester IV

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
VEM2545: Indian Constitution

Teaching Scheme:	Credit	Examination Scheme:
Practical: 02 Hrs/week	02	End Sem : 50 Marks

Course Objectives:

- To realize the significance of constitution of India to students from all walks of life and help them to understand the basic concepts of Indian constitution.
- To identify the importance of fundamental rights as well as fundamental duties.
- To understand the functioning of Union, State and Local Governments in Indian federal system.
- To learn procedure and effects of emergency, composition and activities of election commission and amendment procedure.

Course Outcome:

1. CO1: Understand and explain the significance of Indian Constitution as the fundamental law of the land.
2. CO2: Utilize his fundamental rights in proper sense at the same time identifies his responsibilities in national building.
3. CO3: Analyse the Indian political system, the powers and functions of the Union, State and Local Governments in detail
4. CO4: Understand Electoral Process, Emergency provisions and Amendment procedure
5. CO5: Understand the directive principles of state Policy.

Course Contents

Unit I	Introduction to Constitution	06 Hours

Meaning and importance of the Constitution, salient features of Indian Constitution. Preamble of the Constitution. Fundamental rights. Directive principles of state policy and Fundamental duties.

Unit II	Union Government	06 Hours

Union Executive, Union Legislature and Union Judiciary-Supreme Court of India – composition and powers and functions, Union Executive – President, Prime Minister, Union Cabinet.

Unit III	State and Local Governments:	06 Hours

State Executive- Governor, Chief Minister, Council of Ministers. State Legislature-State Legislative Assembly and State Legislative Council. State Judiciary-High court. Local Government-Panchayat Raj system with special reference to 73rd and Urban Local Self Govt. with special reference to 74th Amendment.

Unit IV	Election provisions	06 Hours

Election Commission of India- composition, powers, functions and electoral process. Types of emergency-grounds, procedure, duration, and effects. Amendment of the constitution-meaning, procedure, and limitations.

Unit V	Directive Principles	06 Hours

Directive Principles of State Policy (DPSP's) and its present relevance in Indian society. Fundamental Duties and its Scope and significance in Nation,

Books:

Textbooks:

1. M. V. Pylee, "Introduction to the Constitution of India",4th Edition, Vikas publication, 2005.
2. Durga Das Basu(DD Basu) , "Introduction to the constitution of India", (Student Edition),19th

edition, Prentice-Hall EEE, 2008.

Reference Book:

1. Merunandan, "Multiple Choice Questions on Constitution of India", 2nd Edition, Meraga publication,2007.

Activity:

1. Poster presentation on election provisions in India.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
VSECM2546: Skill Development I

Teaching Scheme:	Credit	Examination Scheme:
Practical: 04 Hrs/week	02	Oral : 50 Marks

Prerequisites:

- Basic knowledge of software engineering and software testing concepts
- Familiarity with programming in Python or Java and using tools like Postman or JIRA

Course Objectives:

- To understand the fundamentals of software testing and structured test processes.
- To gain hands-on experience in writing test cases and performing manual testing.
- To implement automated testing using Selenium WebDriver and PyTest.
- To test REST APIs using Postman and generate automated test reports.
- To use test management tools and interpret QA metrics effectively.

Course Outcomes:

On completion of the course, students will be able to–

- CO1: Write structured and effective manual test cases mapped to functional requirements.
- CO2: Apply test design techniques like BVA, decision tables, and state transition testing.
- CO3: Develop and execute automation test scripts using Selenium and PyTest.
- CO4: Conduct and automate REST API testing using Postman and document it using Swagger.
- 5. CO5: Interpret testing results using defect metrics and manage testing using QA tools.

Guidelines for Instructor's Manual

The instructor's manual should briefly cover the university/program background, course objectives, syllabus, lab conduction methods, and assessment criteria. It should provide topic-wise concepts, expected outcomes, and a list of practical assignments using MATLAB. Sample code structures, references, and standard evaluation rubrics should also be included. The goal is to guide consistent lab delivery and help instructors align sessions with defined learning outcomes.

Guidelines for Student's Lab Journal

Students must maintain a handwritten lab journal including a prologue, certificate, index, and structured content for each experiment. Each write-up should cover the title, objective, problem statement, mapped COs, tools used, theory, algorithm/flowchart, MATLAB code, output, and conclusion. Journal should be neat and regularly signed. Printing code is optional to promote ecofriendly practices. A DVD of programs may be maintained in the lab for record-keeping.

Guidelines for Oral Examination

The practical exam should be jointly conducted by internal and external examiners. Problems should reflect real-time concepts like enhancement, segmentation, or filtering. Focus must be on implementation, output, and student understanding. Supplementary questions can be asked for concept clarity. Evaluation should be transparent and based on actual execution.

List of Assignments:- (Perform Any 5 Practical's)

1. Manual Testing and Test Case Writing —
Write test cases for a login module. Include functional, UI, and negative test scenarios. Prepare a test plan and execution log.

- Objective: Understand basics of manual testing, test documentation.

- Tasks:

  - Write functional, UI, and negative test cases for a login module.
  - Prepare a test plan.
  - Maintain a test execution log (pass/fail status, observations).

- Deliverables: Test cases (Excel/Doc), test plan, execution log.

2. Boundary Value and Equivalence Partitioning —
Design and execute test cases using BVA and EP for a numerical input field (e.g., age, salary). Identify edge and invalid values.

- Objective: Apply BVA and EP techniques for input field validation.

- Tasks:

  - Choose a numeric input (e.g., age 18–60, salary >10K).
  - Design test cases using:
    - **Boundary Value Analysis (BVA)**
    - **Equivalence Partitioning (EP)**
  - Execute and record observations.

- Deliverables: Test design tables, execution logs, analysis.

3. Decision Table and State Transition Testing —
Create a decision table and state diagram for an ATM transaction system. Derive test cases and execute them.

- Objective: Design test cases from formal models.

- Tasks:

  - Create a **decision table** for ATM operations (e.g., PIN check, balance check, withdrawal).
  - Design a **state transition diagram** for ATM system.
  - Derive and execute test cases from both.

- Deliverables: Diagrams, test cases, execution results.

4. Defect Lifecycle and Reporting using JIRA —
Simulate a testing scenario, raise bugs using JIRA, and track their lifecycle. Create dashboards and filters.

- Objective: Practice defect logging and tracking.

- Tasks:

  - Simulate a test scenario with bugs (e.g., login failure, incorrect alert).
  - Report bugs in **JIRA**.
  - Track their lifecycle through statuses (Open → In Progress → Resolved → Closed).

- Create JIRA **dashboards, filters**, and **bug reports**.

• Deliverables: Bug report screenshots, dashboards, filter config.

5. Selenium WebDriver Automation —
Write Selenium scripts in Python/Java for login and search functionalities. Use locators and assertions.

• Objective: Automate UI testing using Selenium.

• Tasks:

- Automate login and search scenarios on a web application.
- Use XPath/CSS selectors.
- Validate results using **assertions**.

• Tools: Python/Java + Selenium

• Deliverables: Scripts, screenshots of test runs, output logs.

6. PyTest Automation Framework —
Develop test cases using PyTest. Use fixtures, test suites, and generate HTML reports.

• Objective: Build unit tests using PyTest.

• Tasks:

- Create test cases using PyTest.
- Use **fixtures**, **parametrize**, and **test suites**.
- Generate **HTML test reports**.

• Deliverables: Python test scripts, report output, config files.

7. Performance Testing using JMeter —
Create a JMeter test plan to simulate 100 virtual users for a login API. Analyze response time and throughput.

• Objective: Evaluate application performance under load.

• Tasks:

- Create a JMeter test plan to simulate **100 virtual users** hitting a login API.
- Record:
  - **Response Time**
  - **Throughput**
  - **Error %
- Analyze with graphs and summaries.

• Deliverables: JMX file, results dashboard, summary report.

8. Testing Metrics and Reporting —
Calculate defect density, test coverage, and test efficiency from simulated data. Present using charts and reports.

- Objective: Interpret testing efficiency and effectiveness.

- Tasks:

  - Use simulated test data to calculate:
    - **Defect Density**
    - **Test Coverage**
    - **Test Efficiency**
  - Present analysis using Excel/Google Sheets.

- Deliverables: Metric sheet with formulas, bar/pie charts, observations.

9. Test Management Tools (TestLink/Zephyr/TestRail) —
Create test cycles, link test cases with requirements, and execute them using one of the test management tools.

- Objective: Manage test lifecycle with test management tools.

- Tasks:

  - Create **requirements**, **test cases**, and **test cycles**.
  - Link test cases to requirements.
  - Execute test cycles and update status.

- Tools: Choose any (TestLink/Zephyr/TestRail)

- Deliverables: Screenshots of test plans, execution reports.

10. Mini Project —
Automated test suite for a real-world application (e.g., e-commerce login, product search, checkout) using Selenium, Postman, and JIRA.

- Objective: Develop an end-to-end automated testing solution.

- Sample **Use Cases**:

  - E-commerce login, product search, cart, checkout.
  - Ticket booking (e.g., train, movie).
  - Admin panel validation.

- **Tools**: Selenium + PyTest + JIRA + Postman (optional API testing)

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
ELM247: Seminar -II

Teaching Scheme:	Credit	Examination Scheme:
Practical: 12 Hrs/week	06	Term Work:50 Marks Practical: 50 Marks

Course Objectives:

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms and services.

Course Outcomes:

On completion of the course, student will be able–

- To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression,
- To acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication.
- To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across

The student shall have to deliver the seminar II in semester IV on a topic approved by guide and authorities. It is recommended to allot guide to the student since the commencement of semester I. The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. It is recommended that seminar shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected or domain of interest.

It is appreciated and strongly recommended that the student will select the domain of his/her dissertation and identify the literature confined to the domain. Thorough literature study based on the broad identified topic has to be carried out. This practice will eventually lead to convergence of the efforts for the dissertation in Semester III and IV.

The relevant literature then be explored as state-of-the-art, exotic, recent technological advancement, future trend, application and research & innovation. Multidisciplinary topics are encouraged. The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. The student will be assessed based on his/her presentation and preparations by the panel of examiners out of them one has to be an external examiner.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.

The continuous assessment of the progress need to be documented unambiguously. For standardization and documentation, follow the guidelines circulated / as in seminar logbook approved by Board of Studies.

Trinity College of Engineering and Research, Pune
M. Tech. of Computer Engineering (2025 Course)
RPM2548: Research Project-II

Teaching Scheme:	Credit	Examination Scheme:
Practical: 24 Hrs/week	12	CIE:100 Marks Oral/Practical: 100 Marks

Course Description:

- The master's degree culminates in a research project of the student's own design. This project is documented by a final research report or dissertation. The student's work is guided by an academic supervisor.
- It also is supported by a variety of key skill programmes. Students are expected to construct a research project that includes original research, deliberate and well considered methodological choices, and shows relevance to significant conversations within the discipline.
- The dissertation should represent the very best research and analysis a student can produce

Course Objectives: Upon successful completion of this course, students will be able to:

- Demonstrate an ability to plan a research project, such as is required in a research proposal prior to the launch of their work
- Demonstrate an ability to comply with ethical, safety, and documentation processes appropriate to their project
- Demonstrate expert knowledge in the subject of their research project, such as through a integrated literature survey
- Demonstrate expert knowledge in the research methods appropriate to generating reliable data for their research questions
- Demonstrate the ability to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
- Demonstrate an ability to relate their original data to existing literature, or to create an novel synthesis of existing materials
- Demonstrate an ability to assemble their findings into a substantial piece of writing that presents a clear thesis and a cohesive, evidence-based argument
- Demonstrate an ability to balance description, analysis, and synthesis within their project report
- Demonstrate an ability to reflect on the strengths and weaknesses of their research and methodology, with constructive advice on how they might improve their efforts in future work

Course Outcomes: After successful completion of the course, learner will be able to:

1. undertake independent research that makes an original contribution to knowledge, or produces a novel synthesis of existing materials relevant to significant conversations in the discipline
2. plan their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value
3. work independently and manage a complex project within strict time constraints
4. comply with relevant ethical, safety, and documentation processes as appropriate to the work
5. select and deploy research methods that are appropriate to the data collection within the project
6. relate their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature
7. balance description, analysis, and synthesis within the context of scholarly writing
8. assemble their rationale, methods, findings, and analysis into a substantial piece of writing that presents a clear thesis and a cohesive evidence-based argument or analysis
9. reflect on the strengths and weaknesses of their research and methodology, understanding how they might improve their efforts in future work.

Course Contents

In Research Project-II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, UML implementations, testing, Results, measuring performance, discussions using data tables per parameter considered for the improvement with existing/known algorithms/systems,

comparative analysis, validation of results and conclusions. The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department /Institute.

The students are expected to validate their study undertaken by publishing it at standard platforms.

The investigations and findings need to be validated appropriately at standard platforms conference and/or peer reviewed journal. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.