Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

Curriculum Structure and Syllabus

Master of Engineering (2025 Pattern) in

M. E. – Information Technology

(With effect from Academic Year 2025-26)

Contents

Nomenclature

AICTE	All India Council for Technical Education
CCE	Comprehensive Continuous Evaluation
ESE	End-Semester Examination
KAP	Knowledge and Attitude Profile
OJT	On Job Training
PCC	Programme Core Course
PEC	Programme Elective Course
PEO	Programme Educational Objectives
PO	Programme Outcomes
PSO	Program Specific Outcomes
WK	Knowledge and Attitude Profile

Master of Engineering in Information Technology - 2025 Pattern

Preface by Chairman, BoS

Dear Students and Teachers,

As the Chairman of the Board of Studies for Information Technology, Savitribai Phule Pune University (SPPU), it is my privilege to present the curriculum for the Master of Information Technology (M.E. IT) program. The world of Information Technology (IT) is evolving at an unprecedented pace, and it is imperative that our academic offerings align with global industry standards and emerging technological trends. This curriculum is designed to equip students with a comprehensive understanding of the foundational and advanced concepts in IT, preparing them to be leaders and innovators in the field.

The M.E. IT curriculum at SPPU has been crafted with a dual focus: imparting both theoretical knowledge and practical skills. It incorporates essential topics such as software engineering and project Management, Applied Machine Learning, Cyber Security, and Generative AI, all of which play a pivotal role in the modern technological landscape. Furthermore, it encourages students to engage with cutting-edge research, fostering an environment of intellectual curiosity and critical thinking.

We understand that the demand for IT professionals is not only about technical proficiency but also the ability to solve real-world problems using Information Technology with effective collaborations by adapting to new challenges. To address this, our curriculum emphasizes hands-on learning through Computational Laboratories, , and soft skill development through Skill based laboratories and Technical Seminar, ensuring that students will be accomplished professionals who can contribute meaningfully to any organization.

The M.E. IT program at SPPU is designed not only to be a comprehensive academic experience but also to serve as a platform for students to push boundaries, foster innovation, and contribute to the ever-expanding world of Information Technology. I appeal you to explore this curriculum, which reflects our commitment to excellence in education and to the development of the professionals who will be the driving force behind the technological innovations of tomorrow.

Dr. Sudeep Thepade

Chairman

Board of Studies – Information Technology

Members of Board of Studies

Dr. Sudeep D. Thepade	Professor, Pimpri Chinchwad college of Engineering, Pune
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Dr. Abhijat Vichare	Consultant and Distinguished Professional Member, ACM

Master of Engineering – Information Technology (2025 Course)

Programme Educational Objectives (PEO)

Program Education Objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Focus	PEO Statements
PEO1	Core competence	To prepare post graduates students to engage with cutting-edge research, fostering an environment of intellectual curiosity and critical thinking to provide effective Information Technology based solutions for engineering and research problems.
PEO2	Breadth	To prepare the post graduates to work as a committed professionals with strong professional ethics and values, sense of responsibilities, understanding of legal, safety, health, societal, cultural and environmental issues.
PEO3	Professionalism	To prepare motivated post graduates with research attitude, lifelong learning, investigative approach, and multidisciplinary thinking to succeed in the career in industry/academia/research
PEO4	Team Building	To prepare post graduates with strong managerial and communication skills to be accomplished professionals who can contribute meaningfully to any organization

Curriculum for Master of Engineering - Information Technology (2025 Pattern)

Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Programme Outcomes (PO)

Program Outcomes are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, attitude and behaviour that students acquire through the program. NBA has defined the following three POs for a graduate of PG Engineering Program:-

PO1	Ability to demonstrate a degree of mastery over the area of specialization (Information Technology) at a level higher than the bachelor's program
PO2	Ability to solve real-world problems using Information Technology with effective collaborations by adapting to new challenges
PO3	Ability to self-reliantly conduct the research-oriented development work to solve practical problems.

Program Specific Outcomes (PSOs)

Program Specific Outcomes (PSOs) are statements that describe the knowledge, skills, and attitudes that graduates of a academic program (Master of Engineering in Computer Engineering) should be able to demonstrate at the time of their graduation.

PSO1	Advanced Computing Solutions: Apply advanced techniques in artificial intelligence, machine learning, cloud computing, and big data analytics to design and optimize computing solutions.
PSO2	Research & System Design: Conduct research, model complex systems, and develop efficient algorithms and architectures for high-performance and secure computing.
PSO3	Professional Readiness: Demonstrate domain expertise, industry-readiness, and the ability to adapt emerging technologies for professional, entrepreneurial, and societal applications.

Master of Engineering (2025 Pattern) – Information Technology

Curriculum Structure - Semester I

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	ESE	Term Work	Practical	Oral	Total	Theory	Practical	Total
PCC-501-ITT	Programme Core Course	Applied Probability and Statistics	4	-	50	50	-	-	-	100	4	-	4
PCC-502-ITT	Programme Core Course	Information Quality and Business Rules	4	-	50	50	-	-	-	100	4	-	4
PCC-503-ITT	Programme Core Course	Applied Machine Learning	4	-	50	50	-	-	-	100	4	-	4
PCC-504-ITT	Programme Core Course	Advance Software Engineering And Project Management	4	-	50	50	-	-	-	100	4	-	4
PCC-505-ITT	Programme Core Course	Computational Laboratory-I	-	4	-	-	25	-	25	50	-	2	2
PEC-521-ITT	Programme Elective Course	Elective I	3	-	50	50	-	-	-	100	3	-	3
PEC-522-ITT	Programme Elective Course	Skill Based Laboratory -I	-	2	-	-	25	-	25	50	-	1	1
Total			**19**	**6**	**250**	**250**	**50**	**-**	**50**	**600**	**19**	**3**	**22**

Elective I - Courses	
PEC-521A-ITT	Data Engineering
PEC-521B-ITT	Speech Processing
PEC-521C-ITT	Blockchain Technology
PEC-521D-ITT	Internet of Things

Master of Engineering (2025 Pattern) – Information Technology

Curriculum Structure - Semester II

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
PCC-551-ITT	Programme Core Course	Deep Learning	4	-	50	50	-	-	-	100	4	-	4
PCC-552-ITT	Programme Core Course	Cyber Security	4	-	50	50	-	-	-	100	4	-	4
PCC-553-ITT	Programme Core Course	Generative AI	4	-	50	50	-	-	-	100	4	-	4
PCC-554-ITT	Programme Core Course	Computational Laboratory-II	-	4	-	-	25	-	25	50	2	-	2
PEC-561-ITT	Programme Elective Course	Elective –II	3	-	50	50	-	-		100	3	-	3
PEC-562-ITT	Programme Elective Course	Elective –III	3	-	50	50	-	-	-	100	3		3
SEM-581-ITT	Seminar	Technical Seminar I	-	4	-	-	25	-	25	50	2	-	2
Total			**18**	**8**	**250**	**250**	**50**	**-**	**50**	**600**	**18**	**4**	**22**

Elective II Courses		Elective III Courses	
PEC-561A-ITT	Cloud and Edge Technology	PEC-562A-ITT	Quantum Computing
PEC-561B-ITT	Social Media Analytics	PEC-562B-ITT	Real-time Operating System
PEC-561C-ITT	Game Theory and Applications	PEC-562C-ITT	Mobile Adhoc Network
PEC-561D-IT	Bio Inspired Computing	PEC-562D-ITT	Enterprise Application Integration And Management

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Curriculum Structure - Semester III

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
RM-601-ITT	Research Methodology	Research Methodology	4	-	50	50	-	-	-	100	4	-	4
OJT-602-ITT	OJT/ Internship	On Job Train-ing/Internship	-	10	-	-	100	-	-	100	-	5	5
SEM-603-ITT	Seminar	Technical Seminar II	-	8	-	-	25	-	25	50	-	4	4
RPR-604-ITT	Research Project	Research Project-I	-	18	-	-	25	-	25	50	-	9	9
Total			**04**	**36**	**50**	**50**	**150**	**-**	**50**	**300**	**04**	**18**	**22**

Curriculum Structure - Semester IV

Course Code	Course Type	Course Name	Teaching Scheme		Examination Scheme						Credits		
			Theory	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Practical	Total
SEM-651-ITT	Seminar	Technical Seminar III	-	8	-	-	50	-	50	100	-	4	4
RPR-652-ITT	Research Project	Research Project -II	-	36	-	-	150	-	50	200	-	18	18
		Total	**-**	**44**	**-**	**-**	**200**	**-**	**100**	**300**	**-**	**22**	**22**

Savitribai Phule Pune University, Pune

Maharashtra, India

ME – Information Technology

Semester I

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-501-ITT- Applied Probability and Statistics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Discrete Mathematics

Course Objectives: The course aims to:

1. Use the fundamental properties and theorems of probability theory, sample spaces, events and random variables to model real-life phenomena and to compute and interpret probabilities of events.
2. Apply statistical methods to estimate parameters of numerical data from a representative sample of a population and interpret the results.
3. Perform matrix computations and use eigenvalues and eigen vectors to analyze the structure of a matrix.

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

- CO1: Apply matrices, Vectors for solving Linear systems
- CO2: Analyze Eigenvalues and Eigenvectors problems
- CO3. Solve examples using Inner product and dot product
- CO4: Demonstrate various PDFs with a suitable example
- CO5: Create Contingency Tables using Statistics

Course Contents

Unit I - Matrices, Vector Spaces, and Linear Transformations- (12 Hours)

Matrices and Vectors: Basic operations – addition, scalar multiplication, and matrix multiplication. **Linear Systems of Equations**: Formulation, solution methods, and applications, Gauss elimination method,Existence and uniqueness of solutions, Rank of a matrix, **Matrix Properties**: Inverse of a matrix, Gauss–Jordan elimination, **Vector Spaces**: Concepts of linear independence, basis, and dimension,**Inner Product Spaces**: Norms, orthogonality, and projections.**Linear Transformations**: Definition, properties, and matrix representation.

Unit II Linear Algebra: Eigenvalues and Eigenvectors (12 Hours)

Eigenvalue Problems: Definition and formulation, Determining eigenvalues and eigenvectors, **Applications of Eigenvalue Problems:** Real-world and computational applications, **Special Matrices:** Symmetric matrices, Skew-symmetric matrices, orthogonal matrices, **Eigenbases and Diagonalization:** Properties of eigenbases, Matrix diagonalization, **Quadratic Forms:** Definition and properties, Applications in optimization and geometry

Unit III Vector Calculus (12 Hours)

Vectors in 2D and 3D: Representation of vectors in 2-space and 3-space,Inner product (dot product) and vector product (cross product), **Vector and Scalar Functions:** Scalar and vector fields, Functions of several variables, **Vector Calculus:** Derivatives of vector functions, Curves, arc length, curvature, and torsion,

Unit IV Probability Theory (12 Hours)

Data Representation and Descriptive Statistics: Representation of data, Measures of central tendency (average), Measures of dispersion (spread), Fundamentals **of Probability:** Experiments, outcomes, and events, Basic probability rules, Permutations and combinations, **Random Variables and Distributions:** Definition of random variables, Probability distributions, Mean and variance of a distribution

Unit V Mathematical Statistics (12 Hours)

Statistics: Introduction to Statistical Inference Problems; Point Estimation; **Interval Estimation**; Test- ing of Hypotheses; Two Sample Problems Involving Normal Populations, Tests for Proportions, Chi- Square Goodness of Fit Test, Contingency Tables.

Learning Resources

Text Books:

1. **Probability and Statistics for Engineers and Scientists – Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye**
2. **Introduction to Probability and Statistics – William Mendenhall, Robert J. Beaver, Barbara M. Beaver**
3. **A First Course in Probability" – Sheldon Ross**
4. **Probability and Statistics – Morris H. DeGroot, Mark J. Schervish**
5. **"Introduction to Probability Models" – Sheldon M. Ross**
6. **Applied Statistics and Probability for Engineers" – Douglas C. Montgomery, George C. Runger**

Reference Books:

7. T.T. Soong, Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons Ltd, 2004, ISBN 0-470-86814-7
8. Glyn James & Phil Dyke, Advanced Modern Engineering Mathematics, Fifth Edition, Pearson Education Limited, 2018, ISBN: 978-1-292-17434-1

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-502-ITT - Information Quality and Business Rules		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Linear algebra and Probability

Course Objectives: The course aims to:

1. To understand the concept of speech processing.
2. To build speech-based systems.
3. To analyze the performance of speech processing systems.

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

- CO1: Critically appraise current theory and practice in Big Data Analytics, Decision Support Systems and Business Intelligence
- CO2: Appraise the role of BI strategy in driving companies' insight.
- CO3: Apply data analysis and visualization on a sample dataset, appropriate to the level of study, and to provide recommendations on the driven insights to specialist and non-specialist audiences.
- CO4: Identify and appraise emerging trends within the field and evaluate the social and ethical aspects
- CO5: Communicate complex topics and concepts effectively using different communication means such as report writing, use of ICT and/or presentation to specialist and non-specialist audience.

Course Contents

Unit I - Information Management and Business Intelligence- (08 Hours)

Introduction to Business Intelligence: Why Business Intelligence?, The Information Asset, Exploiting information for competitive advantage, **Foundations of Business Intelligence:** Definition and scope of Business Intelligence, Actionable knowledge and decision support, Building a business case for BI, **Business Intelligence Process:** BI lifecycle and program success factors, Data integration, transformation, and governance, **System Infrastructure for Business Intelligence:** Architecture and infrastructure requirements, Information access, delivery, and analysis services, **Management and Organizational Issues:** Strategic alignment of BI initiatives, Implementation challenges and success measures, Ethical and managerial considerations

Unit II - Business Models, Information Flow, and Data Warehousing (08 Hours)

Business Models and Information Flow: The business case for information management, Information processing and flow in organizations, Information flow models and their practical usage, Modeling frameworks and management considerations, Data Warehouses, OLAP, and Metadata: The business

case for data warehousing, Data models for warehouses and marts, Data warehouses vs. data marts, Online Analytical Processing (OLAP), Metadata management, Organizational and managerial issues

Unit III - Business Rules, Data Profiling, and Data Quality - (08 Hours)

Business Rules: Business case for implementing business rules, Business rules approach and definitions, Business rule systems and their functionality, Sources of business rules, Management considerations and issues, Data Profiling: Business case for data profiling, Profiling activities: data model inference, attribute analysis, relationship analysis, Management issues related to profiling, Data Quality and Information Compliance: Business case for data quality and compliance, Types of errors and common data issues, Data cleansing techniques, Business rule-based information compliance, Management considerations and issues

Unit IV - Information Integration- (08 Hours)

Information Integration: The Business Case, ETL: Extract, Transform, Load, Enterprise Application Integration and Web Services, Record Linkage and Consolidation, Management Issues

The Value of Parallelism: Business Case, Parallelism and Granularity, Parallel Processing Systems, Dependence, Parallelism and Business Intelligence, Management Issues

Alternate Information Contexts: Business Case, Psychographics and Demographics, Geographic Data , Web Behavior Intelligence, Management Issue

Unit V - Data Enhancement, Knowledge Discovery and Data Mining - (08 Hours)

Data Enhancement: The Business Case, Types of Data Enhancement, Incremental Enhancements, Batch Enhancements, Standardization Example: Address Standardization, Enhancement Methodologies Management Issues

Knowledge Discovery and Data Mining: The Business Case, Data Mining and the Data Warehouse, The Virtuous Cycle, Directed versus Undirected Knowledge Discovery, Six Basic Tasks of Data Mining, Data Mining Techniques, Management Issues

Using Publicly Available Data: Business Case, Management Issues, Public Data, Data Resources Semi Structured Data, The Myth of Privacy

Learning Resources

Text Books

1. Douglas K. Barry and David Loshin, Business Intelligence: The Savvy Manager's Guide, Morgan Kaufmann Publishers,2003, ISBN-13:978-1-55860-916-7

2. Ahmed Sherif, Practical Business Intelligence, Packt Publishing Ltd.,2016, ISBN 978-1-78588-543-3

Reference Books:

1. "The Data Warehouse Lifecycle Toolkit" – Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker

2. "Data Quality: Concepts, Methodologies and Techniques" – Carlo Batini, Monica Scannapieco

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-503-ITT - Applied Machine Learning		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Design of Analysis & Algorithms. And Machine Learning

Course Objectives: The course aims to:

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

Course Outcomes: Upon successful completion of this course, students will 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 - Introduction to Fundamentals, Supervised Algorithms, Parametric Methods - (12 Hours)

Fundamentals of Machine Learning and Pattern Recognition: Pattern representation and concepts of pattern recognition, Basics of probability and Bayesian decision theory, Maximum-likelihood and Bayesian parameter estimation, Error probabilities, modeling, and regression, Learning patterns and generalization.

Supervised Learning Algorithms: Linear regression and K-Nearest Neighbor (K-NN), Naïve Bayes and Bayesian networks, Bayes classification and decision theory, Evaluation metrics: losses and risks.

Parametric and Probabilistic Methods: Gaussian parameter estimation and maximum likelihood estimation, Bias-variance tradeoff, Bayes' estimator, and Bayesian estimation, Parametric classification and regression, Hidden Markov Models (HMMs), Support Vector Machines (SVMs), and Decision Trees.

Unit II - Kernels, Probabilistic Models, and Nonparametric Methods- (12 Hours)

Kernel Methods: Introduction to kernel methods, Basic kernels and types of kernels, Properties of kernels and kernel functions

Pattern Analysis and Dimensionality Reduction: Eigen decomposition for pattern analysis, Principal Component Analysis (PCA)

Probabilistic and Sequential Models: Hidden Markov Models (HMMs), Markov Decision Processes (MDPs)

Nonparametric Techniques: Density estimation methods, Parzen-window method and applications

Unit III - Convolutional Neural Networks- (12 Hours)

Introduction to CNNs: Overview and fundamental operations of CNNs, Convolution and pooling operations, Fully connected layers

Advanced Concepts: Convolution and pooling as an infinitely strong prior, Variants of basic convolutional and pooling functions, Efficient algorithms for CNN computation

Feature Extraction: Random or unsupervised feature learning, Neuroscientific basis for convolutional networks

Applications of CNNs: Real-world applications in image and video processing, computer vision, and AI

Unit IV - Recurrent Neural Networks and Sequence Modeling (12 Hours)

Introduction to RNNs: Overview and types of Recurrent Neural Networks, Encoder-Decoder and sequence-to-sequence architecture

Advanced RNN Architectures: Deep recurrent networks, Recursive neural networks, Long Short-Term Memory (LSTM) networks and other gated RNNs

Optimization Techniques: Handling long-term dependencies, Training and optimization strategies for RNNs

Applications: Natural language processing, speech recognition, and other sequential data tasks

Unit V - Use Cases and Applications (12 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

Learning Resources

Text Books:

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. Neural Networks and Deep Learning: A Textbook" – Charu C. Aggarwal
4. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition, Wiley, 2001.
5. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

6. Geoff Dougherty, “Pattern recognition and classification an Introduction”, Springer, 2013.

7. John Shae Taylor and NelloCristianini, “Kernel methods for pattern analysis” Cambridge university press, 2004.

Reference Books:

1. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow” – Aurélien Géron

2. C.M. Bishop, Pattern Recognition and Machine learning, Springer, 1st Edition, 2013, ISBN No.: 978-81-322-0906-5.

3. Hastie, Tibshirani, Friedman, Introduction to statistical machine learning with applications in R, Springer, 2nd Edition, 2013, ISBN No.: 978-1-4614-7138-7.

4. Tom Mitchell, Machine Learning, McGraw Hill, 1997, 0-07-042807-7.

5. Parag Kulkarni, Reinforcement and Systemic Machine learning for Decision Making, Wiley-IEEE Press, 2012, 978-0-470-91999-6.

6. Ranjjan Shinghal, “Pattern Recognition techniques and application”, Oxford university press, 2006.

7. Theodoridis and K.Koutroumbas, “Pattern Recognition”, 4th Edition, Academic Press, 2009.

E-Books Links

1. http://www.ru.ac.bd/wpcontent/uploads/sites/25/2019/03/207_05_01_Rajchka_Using-Python-for-machinelearning-2015.pdf

2. Foundation of Machine Learning: https://cs.nyu.edu/~mohri/mlbook/

3. Dive into Deep Learning: http://d2l.ai/

4. A brief introduction to machine learning for Engineers: https://arxiv.org/pdf/1709.02840.pdf

5. Feature selection: https://dl.acm.org/doi/pdf/10.5555/944919.944968

6. Introductory Machine Learning Nodes : http://lcsl.mit.edu/courses/ml/1718/MLNotes.pdf

MOOC Courses:

1. Introduction to Machine Learning: https://nptel.ac.in/courses/106105152

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-504-ITT- ADVANCE SOFTWARE ENGINEERING AND PROJECT MANAGEMENT		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisites:

Basic Principles of Software Engineering

Basics of Project planning and management

Course Objectives:

1. To apply a systematic, disciplined, quantifiable approach to the cost-effective development, operation and maintenance of software systems to the satisfaction of their beneficiaries.
2. To prepare a technologically competent computer by training them in the contemporary software engineering principles and paradigms.
3. To illustrate core project management techniques so as to manage project schedule, expenses and resources with the aid of suitable project management tools.
4. To analyze the various issues in each phase of project management and people management.
5. To provide the students with recent trends and practices in software engineering and supporting tools.
6. To emphasize the importance of software project management skills in order to cater the changing industry needs and constraints across the advancing domains of computing.

Course Outcomes:

By the end of the course, students should be able to

- CO1: Identify the resources required for a software project and to produce a work plan and resource schedule
- CO2: Decide and justify the use of most appropriate software process model for a given project definition Apply risk management analysis techniques
- CO3: Monitor the progress of a project and to assess the risk of slippage, revising targets counteract drift Use appropriate metrics to manage the software development outcome
- CO4: Understand emerging trends in software engineering and project management.

UNIT – I Introduction 08 Hours

Software Process Framework; Various Software Process Models: Prescriptive, Specialized, Unified, Personal and Team Process models; Software Requirement Engineering- Requirements elicitation, specification, Formal Specifications, Specification Qualities, Classification of Specification Styles , Descriptive Specifications: Logic and Algebraic Specifications , Operational Specifications: DFD, FSM,

Petri Nets, validation, change; System Modeling - Context, Interaction, Structural, Behavioral models; Unified Modeling Language.

UNIT – II Software Design Methodologies 08 Hours

Design Process, Design concepts, Design Models, User interface design, Pattern-based and web application design, Software Product Lines, Design modeling using UML [Specification techniques of diagrams in UML].

UNIT – III Agile Development 08 Hours

Agile methods, Agile development techniques, Extreme Programming, Various Agile Process Models – ASD, SCRUM, DSDM, Crystal, FDD, LSD, AM, AUP.

UNIT IV Software Project Management 08 Hours

Project Management Spectrum: Project Metrics; Project planning- Estimation and scheduling- PERT, CPM, GERT, Resource loading and Resource Leveling, Types of project Contracts from Project Management. , Agile Planning, Risk Mitigation and monitoring, , Project Control Techniques, Earned Value Project, Change Management, Quality management, Challenges in software project maintenance - Code Cloning: Detection, Classification, and Refactoring.

UNIT V In-Stream Activities in Project Management 08

Hours Software Measurement Framework, Ishikawa's seven tools, Process Assessment and patterns, CMMI –IPPD, Product and Process attributes, Software Quality and configuration management.

Text Books:

Roger S. Pressman, Software Engineering: A practitioners approach, TMH, Seventh Edition, ISBN 978– 0–07–337597–7, ISBN 0–07–337597–7.

Ian Sommerville, Software Engineering, Addison-Wesley, and Tenth Ed. ISBN-13:978- 0133943030 ISBN-10: 0133943038.

Reference Books:

Linda I. Shafer, Robert T. Futrell, Donald F. Shafer, Quality Software Project Management, Prentice Hall, ISBN 0130912972.

Scott Berkun, The Art of Project Management, O'Reilly, First Edition, ISBN 0596007868.

Orit Hazzan and Yael Dubinsky, Agile software engineering, Springer -Verlag London, First Edition, ISBN 978-1-84800-199-2

Pankaj Jalote, Software Project Management in practice, Addison-Wesley Professional, ISBN 0201737213.

Craig Larman, Applying UML and Patterns, Pearson Education, Third Edition.

Grady Booch, James Rambaugh, Ivar Jacobson, Unified Modeling Language Users Guide, Addison-Wesley, Second Edition, ISBN 0321267974.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-505-ITT - Computational Laboratory-I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Practical** : 25 Marks

Prerequisite Courses: Probability and Statistics, Advance Algorithms, Distributed Systems and Machine Learning

Course Objectives: The course aims to:

1. Use the fundamental properties and theorems of probability theory, sample spaces, events and random variables to model real-life phenomena and to compute and interpret probabilities of events.
2. Apply statistical methods to estimate parameters of numerical data from a representative sample of a population and interpret the results.
3. Perform matrix computations and use eigenvalues and eigenvectors to analyze the structure of a matrix.

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

- CO1: Apply matrices, Vectors for solving Linear systems
- CO2: Analyze Eigenvalues and Eigenvectors problems
- CO3. Solve examples using Inner product and dot product
- CO4: Demonstrate various PDFs with a suitable example
- CO5: Create Contingency Tables using Statistics

Guidelines:

- Computational Laboratory-I assignments are based on 4 Programme Core courses (Probability and Statistics, Advance Algorithms, Distributed Systems and Machine Learning)
- Respective course faculty assigned will frame course objectives, course outcomes, list of assignments, mini projects, if any
- The list of sample assignments is given for preparation of assignments which will be approved by the respective heads of Department before conduction of laboratory.

List of Assignments

Part A: Applied Probability and Statistics (Any TWO)

1	Statistical estimation and Chi-Square Test using R programming: Estimate the population parameters like mean variance from sample data. Construct the confidence intervals. Perform the Chi-Square test for Goodness of fit.
2	Vector calculus and probability theory using R programming: Perform the basic vector calculus operations like dot product, cross product, gradient, etc. Apply probability theory on continuous distributions and simulate random variables. Calculate gradient of probability density function.
3	Applications of linear programming and dynamic programming using R / Python: Apply the linear programming in real world resource optimization application. Use diet optimization problem. Chose a combination of two foods to meet minimum daily nutrition requirements at minimum cost. Optimize the cost or profit under constraints. Sample data:(i) Food A, Cost- 50, Protein -3, Fat-2. (ii) Food B, Cost- 30, Protein -2, Fat-4. (iii) Minimum Daily Requirements: Protein >= 8 units, Fat >= 6 units.
Part B: Information Quality and Business Rules	
	Select any two BI Tools and compare their features. (BI tools: Power BI, Tableau, Google Data Studio)
	Create a Basic BI Dashboard using Power BI to visualize a dummy sales dataset
	Create an interactive dashboard using Power BI / Google Data Studio for Supermarket Sales and perform analysis of trends.
Part C: Applied Machine Learning	
1	Support vector machine for multiclass classification using Python: Implement a classification model using Support vector machine algorithm for news article topic classification like science, technology, politics, sports, etc. Use sklearn dataset and/or fetch dataset using APIs.
2	Convolution Neural Network for face recognition using Python: Implement a real-world application like AI Face Recognition Entry Agent using CNN. It detects and recognizes faces in real-time environment. It should grant or denies the entry based on known faces of pre-trained databases
Part D: Adavanced Software Engineering and Project Management(Any Two)	
1	Select a real-world software project idea (e.g., Online Healthcare System, Smart Parking System, or E-Learning Platform).
2	1. Consider the same project idea (or a new one). 2. Design a **Scrum-based Agile plan** including: • Product Backlog • Sprint Backlog (for at least 2 sprints) • Burn-down chart (can use tools like Jira, Trello, or Excel). 3. Identify **at least 5 risks** associated with the project (technical, managerial, financial,

	etc.) and prepare a **Risk Mitigation Plan**. 4. Estimate project effort using **PERT/CPM chart** (manual or software-based).
3	1. Select one emerging trend from Unit VI (e.g., Aspect-Oriented Programming, Distributed Software Engineering, Service-Oriented SE, Real-Time SE, Software Process Improvement, Agents in SE). 2. Conduct a mini research study that includes: • Literature survey (at least 5 recent research papers/articles). • Case study or tool-based demonstration (if applicable). • Benefits, challenges, and industry adoption. 3. Prepare a comparative analysis report highlighting how this trend differs from traditional approaches.
Mini Project (Any ONE)	
1	Matrix Eigenvalue Problems using R: Compute the eigenvalues and eigenvectors of a matrix. Apply diagonalization and check dimension reduction of eigenvector. Perform the principal component analysis (PCA) using covariance matrix of sample data.
2	Applications of decision-making problems using dynamic programming for investment allocation problem using R / Python. Consider, a company is interested to invest 50 Lakhs across 3 projectsto maximize total return. Each project has minimum and maximum investment levels. Apply dynamic programming to determine optimal allocation at multi-stage decision levels: 0, 10, 20, 30, 40, 50.
3	Recurrent Neural Networks for Language Translation using Python: Implement a real-world application like English to Marathi translation using RNN Encoder-Decoder model. LSTM Encoder reads input sentences and encodes into a fixed length context vector to generate translated sentence. Define a tiny dataset for demonstration.

Learning Resources

Reference Books:

1. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples," Wiley, ISBN 978-81-265-0986-7, 1st edition 2006.
2. https://ps-iitd.vlabs.ac.in/List%20of%20experiments.html
3. http://www.ru.ac.bd/wpcontent/uploads/sites/25/2019/03/207_05_01_Rajchka_Using-Python-for-machine
4. Hastie, Tibshirani, Friedman, Introduction to statistical machine learning with applications in R, Springer, 2nd Edition, 2013, ISBN No.: 978-1-4614-7138-7.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-521A- IT : Data Engineering		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	CCE : 50 Marks End-Semester: 50 Marks

Prerequisite Courses: Design of Analysis & Algorithms

Course Objectives: The course aims to:

1. Introduce the foundational concepts and tools used in data engineering.
2. Understand the architecture of modern data pipelines and platforms.
3. Explore data ingestion, transformation, storage, and orchestration techniques.
4. Gain insight into scalable data processing using batch and stream frameworks.
5. Enable students to design reliable, secure, and ethical data pipelines.

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

- **CO1:** Explain the core concepts, lifecycle, and goals of data engineering.
- **CO2:** Design data pipelines for data ingestion, storage, and processing.
- **CO3:** Apply data transformation and ETL principles using conceptual tools.
- **CO4:** Evaluate batch vs stream processing architectures and their use cases.
- **CO5:** Analyze challenges of scalability, security, quality, and ethics in data workflows.

Course Contents

Unit I - Introduction to Data Engineering (08 Hours)

Introduction to data engineering, role in the AI/ML lifecycle, types of data, Structured, Semi-structured, Unstructured, data engineering for data science and ML engineering, data lifecycle, ingestion, storage, processing, analysis, data formats, CSV, JSON, Avro, Parquet, ORC, overview of data engineering roles and real-world examples, scope and responsibilities in data engineering, data types handled in real-world systems.

Unit II - Query Processing & Optimization (08 Hours)

Data sources, databases, APIs, IoT, social media, Logs, batch and real-time ingestion, file systems, HDFS, object storage, S3, GCS, Azure clouds, databases, relational, PostgreSQL, NoSQL, MongoDB, Cassandra, Data lakes and data warehouses, Concepts of data lakehouse, Delta Lake, Apache Iceberg, data ingestion and architectures for various use cases, storage solutions based on data structure and scale.

Unit III- ETL

ETL and ETL pipelines, concepts and use cases, data cleansing, enrichment, deduplication, normalization, data validation and quality checks, data modeling: Star and Snowflake schema, conceptual tools, Apache NiFi, Airbyte, dbt, Informatica, data transformation, data handling schema evolution, concept of underpinnings of ETL and transformation pipelines, evaluate data quality, consistency, and schema design.

Unit IV- Hadoop Apache Spark- (08 Hours)

Need for distributed processing, batch processing, Hadoop, Apache Spark – architecture and concepts, stream processing, Apache Kafka, Flink, Spark Structured Streaming, data partitioning and shuffling, fault tolerance and parallelism, AI/ML pipelines – training large models, feature engineering, batch processing systems, stream processing systems, scalable systems, real-time ML systems workflows

Unit V- Data Engineering Applications- (08 Hours)

Data engineering workflow, data orchestration, metadata management and lineage, data security, encryption, access control, anonymization, Applications: Recommendation systems, agricultural AI pipelines, Fraud detection, Predictive maintenance, use of pipelines in high-impact AI/ML applications.

Learning Resources

Text Books:

1. Joe Reis and Matt Housley, Fundamentals of Data Engineering, 1st Edition O'Reilly, July 2022, ISBN: 978-1-098-10830-4 https://freecomputerbooks.com/books/Fundamentals-of-Data-Engineering.
2. Yupo Chan, John R. Talburt, Tery M. Tally, "Data Engineering: Mining, Information and Intelligence", Springer, ISBN: 978-1-4419-0176-1.
    - https://archive.org/download/springer_10.1007-978-1-4419-0176-7/10.1007-978-1-4419-0176-7.pdf

Reference Books:

1. Martin Kleppmann,"Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems", O'Reilly Media, Inc., 2017.
2. Paul Crickard, "Data Engineering with Python", Packt, ISBN: 978-1-83921-418-9, 2020

E-Book:

1. Big Book of Data Engineering, 3rd Edition - Databricks, https://www.databricks.com/resources/ebook/book-of-data-engineering

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-521B-IT- Speech Processing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses :Students should have prior knowledge of

- Fundamentals of Mathematics and programming
- Basics of Machine Learning

Course Objectives: The course aims to:

1. To understand the concept of speech processing.
2. To build speech-based systems.
3. To analyze the performance of speech processing systems.

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

CO1: Analyze the structure of Speech signals using time-domain and frequency-domain techniques.

CO2: Extract key features such as MFCCs, pitch, and formats for speech recognition and synthesis.

CO3: Implement Automatic Speech Recognition (ASR) systems using Hidden Markov Models (HMMs)

CO4: Develop and evaluate text-to-speech (TTS) systems using rule-based and statistical methods.

CO5: Apply speech technologies in real-world applications such as speaker identification , speech emotion detection, and voice-enabled interfaces.

Course Contents

Unit I - Introduction to Speech Processing - (07 Hours)

Speech production mechanism, Acoustics: vowels and consonants, Digital speech Signal: sampling and quantization, Applications: ASR, TTS, speaker verification

Unit II - Speech Analysis - (07 Hours)

Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual– Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization– Dynamic Time Warping, Multiple Time– Alignment Paths.

Unit III - Speech Modeling - (07 Hours)

Speech Modeling: Hidden Markov Models: Markov Processes, HMMs– Evaluation, Optimal State Sequence– Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issue

Unit IV - Speech Recognition- (07 Hours)

Speech Recognition: Large Vocabulary Continuous Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.

Unit V - Speech Synthesis- (07 Hours)

Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

Learning Resources

Text Books

1. D. Jurafsky and J. H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition. Upper Saddle River, NJ, USA: Pearson Education.
2. L. Rabiner and B.-H. Juang, Fundamentals of Speech Recognition. Upper Saddle River, NJ, USA: Pearson Education, 2003.

Reference Books:

1. J. Benesty, M. M. Sondhi, and Y. Huang, Springer Handbook of Speech Processing. Berlin, Germany: Springer-Verlag, 2007.
2. T. F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice. Upper Saddle River, NJ, USA: Pearson Education.
3. C. Becchetti and L. Prina Ricotti, Speech Recognition. New York, NY, USA: John Wiley & Sons, 1999.
4. B. Gold and N. Morgan, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley India Edition, 2006.
5. F. Jelinek, Statistical Methods of Speech Recognition. Cambridge, MA, USA: MIT Press.

SWAYAM / MOOC / YouTube Links

1. Digital speech processing, IIT Kharagpur Prof. Shyamal Kumar Das Mandal nptel.ac.in/courses/117105

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-521C-IT - Blockchain Technology		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses:

- Linear Algebra
- Basic Probability and Statistics
- Foundations of Machine Learning

Course Objectives: The course aims to:

1. To understand the core concepts, architecture, and functioning of blockchain technology.
2. To explore consensus algorithms and their role in maintaining distributed ledgers.
3. To study smart contracts and decentralized applications (D-Apps).
4. To analyze the integration of blockchain in data systems for trust, transparency, and auditability.
5. To examine recent advancements in data storage, processing, and sharing mechanisms.
6. To gain practical experience using blockchain platforms and next-generation data systems.

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

CO1: Understand foundational concepts of blockchain architecture and cryptographic tools.
CO2: Develop and deploy smart contracts using Ethereum/Solidity and Hyperledger.
CO3: Analyze blockchain-based solutions in real-world domains like healthcare and DeFi.
CO4: Explore decentralized file systems and blockchain-based data sharing.
CO5: Integrate blockchain with modern data platforms and architectures.

Course Contents

Unit I - Introduction to Blockchain - (07 Hours)

Basics of Blockchain: Blocks, Hashes, Chains, Transactions, Public vs Private Blockchains, Cryptographic foundations: Hashing, Public-Key Cryptography, Merkle Trees, Blockchain structure and data immutability, Distributed Ledger Technologies (DLT): basics

Unit II - Distributed Ledger Technologies (DLT) - (07 Hours)

Architecture of DLTs: Nodes, Transactions, and Blocks, Popular Platforms: Bitcoin, Ethereum, Hyperledger Fabric, Peer-to-Peer Networks and IPFS, Challenges in Decentralized Data Sharing

Unit III - Smart Contracts and Blockchain Applications - (07 Hours)

Smart Contracts: Design, Deployment, and Testing, Ethereum and Solidity programming, Hyperledger Fabric and chaincode, Use Cases: Voting systems, DeFi, Healthcare, Supply Chain, Token Standards: ERC-20, ERC-721 (NFTs)

Unit IV - Blockchain with Modern Data Architectures - (07 Hours)

Modern Data Architecture: Data Lakehouse, Data Mesh, Delta Lake, Apache Hudi, Apache Iceberg, Real-time streaming systems: Apache Kafka, Apache Pulsar, Object Storage Systems: AWS S3, MinIO, Data Governance and Provenance

Unit V - Blockchain for Data Integrity and Decentralized Storage - (07 Hours)

Blockchain for Data Integrity, Provenance, and Sharing, InterPlanetary File System (IPFS): hands-on and applications, Decentralized Storage Systems (Filecoin, Arweave), Case Studies: Blockchain in healthcare data, audit trails, and finance, Project Work: Build a prototype integrating blockchain with a modern data pipeline

Learning Resources

Text Books

1. Imran Bashir, Mastering Blockchain.
2. Daniel Drescher, Blockchain Basics.
3. Stephen Grider, Ethereum and Solidity: The Complete Developer's Guide.
4. Martin Kleppmann, Designing Data-Intensive Applications.
5. Hyperledger & Ethereum Developer Documentation, [Online].
6. Apache Iceberg, Delta Lake, and Kafka Documentation, [Online].

Reference Books:

1. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, O'Reilly Media, 2017.
2. Roger Wattenhofer, The Science of the Blockchain, CreateSpace Independent Publishing Platform, 2016.
3. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly Media, 2015

SWAYAM / MOOC / YouTube Links

1. Blockchain Technology — IIT Madras -https://onlinecourses.nptel.ac.in/noc22_cs93/preview
2. Blockchain and Cryptocurrency — IIT Kanpur -https://onlinecourses.nptel.ac.in/noc21_cs68/preview
3. Introduction to Cryptography and Security — IIT Kanpur -https://onlinecourses.nptel.ac.in/noc21_cs61/
4. Decentralized Finance and Blockchain Technology — IIT Madras (periodic/offered sometimes)

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-521D-IT - Internet of Things		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. To understand the concept of IoT.
2. To build IoT based Applications.
3. To analyze the performance of IoT based Systems.

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

- CO1: Summarize the concepts of network connected embedded devices.
- CO2: Design suitable network architecture and use appropriate protocols for a given IOT application.
- CO3: Identify and summarize different components required for IOT applications.
- CO4: Analyse the system through Data Analytics tools.

Course Contents

Unit I - Introduction & Basic of IoT - (08 Hours)

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

Unit II -IoT: Components, Communication and Networking - (08 Hours)

Introduction to Sensing and Networking: Sensing & actuation, Wireless Senor network, Senor nodes, Communication Protocols, M2M Communication, Networking Hardware, Networking Protocols.

Unit III - IoT System Management - (08 Hours)

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 - Networking and Computing- (08 Hours)

File Handling, Python Packages for IoT, IoT Physical Servers – Cloud Storage Models, Communication APIs.

Unit V - IoT Clouds and Data Analytics and Applications - (08 Hours)

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.

Learning Resources

Text Books

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 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.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-522-IT - Skill Based Laboratory - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 02 Hours/Week	01	**Term Work** : 25 Marks **Oral**: 25 Marks

Prerequisite Courses : Programme Elective Course

Guidelines for Skill Based Laboratory

- Skill Based Laboratory are based on the electives chosen by the students.
- Respective course faculty assigned will frame course objectives, course outcomes, list of assignments, mini projects and references
- The list of assignments should be prepared and approved by the respective Heads of Departments before conduction of laboratory

List of Assignments

Select practical assignments from part A and Mini- Project from part B.

Part A - Data Engineering

1. Identify Data Sources in Your Daily Life and classify them as structured, semi-structured and unstructured. (Data sources: ATM logs / online orders / weather data).
2. Write a Python script to read a CSV file and insert the data into a SQLite database.
3. Build a Data Pipeline for Weather Data from a public weather API and perform extraction, transformation, and loading (ETL) operations on it using Python.

Part A – Blockchain Technology

1. To implement basic blockchain operations and explore cryptographic foundations.
2. To design, deploy, and test smart contracts on Ethereum using Solidity.
3. To integrate blockchain with modern data architectures for trust, transparency, and provenance.

Part A - Internet of Things

1. Identify and describe IoT devices used in daily life for smart home communication. (IoT Devices: smart TV, smartwatch, Alexa, etc.).
2. Write a Python program to simulate temperature readings collected from sensor data and send them to a CSV file.
3. Write a Python program to simulate the smart irrigation system using IoT and Firebase. Represent the real-time view of moisture and logs. Use sensors for soil moisture, humidity and Platform: Arduino/RPi.

Part B - Mini Project

- **Data Engineering :** ETL Pipeline using Python programming: Extract weather data from an open API, clean it and load it into a CSV /r SQLite database using tools Python pandas, sqlite3, CSV file
- **Business Intelligence :** BI Dashboard for Grocery Store Sales: Create a dashboard that shows top-selling items, monthly sales, and sales by region using Power BI/ Google Data Studio.
- **Internet of Things :** IoT-based Room Temperature Monitor: Measure temperature and humidity using sensors, send it to a serial monitor / cloud platform. Use Arduino and DHT11 sensors, construct the circuit diagram and record the output.

Learning Resources

Text Books:

1. Martin Kleppmann, Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media, Inc., 2017.
2. Francois Chollet, Deep Learning with Python.
3. Ahmed Sherif, Practical Business Intelligence, Packt Publishing Ltd.,2016, ISBN 978-1-78588-543-3.
4. Massimo Banzi, Michael Shiloh, Getting Started with Arduino, Third Edition, Maker Media, Inc., 978-1-449-36333-8.

Savitribai Phule Pune University, Pune

Maharashtra, India

M. E. – Information Technology

Semester II

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-551-ITT: Deep Learning and Applications		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Applied Linear Algebra, Statistics and Probability, Advanced Machine Learning

Course Objectives: The course aims to:

1. Understand fundamental concepts of deep learning.
2. Apply deep learning algorithms to solve real-world problems.
3. Develop and evaluate deep learning models.
4. Critically analyze deep learning methodologies.

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

- CO1: Fundamentals: Demonstrate mastery of fundamental deep learning concepts.
- CO2: Application: Apply deep learning algorithms to solve practical engineering problems.
- CO3: Model Development: Design, implement, and evaluate deep learning models.
- CO4: Critical Analysis: Critically evaluate deep learning methodologies and their limitations.
- CO5: Problem Solving: Develop and implement solutions using deep learning techniques appropriate to given contexts.

Course Contents

Unit I - Fundamentals of Artificial Neural Networks and Deep Learning- (08 Hours)

Introduction to Artificial Neural Networks (ANNs): Perceptrons and Multilayer Perceptrons (MLPs), Activation Functions: Sigmoid, Tanh, ReLU, Leaky ReLU, Backpropagation Algorithm, Optimization Algorithms: Gradient Descent, Stochastic Gradient Descent, Adam, Regularization Techniques: Dropout, L1/L2 Regularization, Introduction to Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) – basic concepts only

Assessment: Homework assignments focused on implementing basic neural networks using Python libraries (e.g., TensorFlow/Keras)

Unit II - Advanced Deep Learning Architectures and Applications- (08 Hours)

Convolutional Neural Networks (CNNs): Architectures: LeNet, AlexNet, ResNet, Inception, Applications: Image Classification, Object Detection, Image Segmentation

Recurrent Neural Networks (RNNs): Architectures: Vanilla RNN, LSTM, GRU, Applications: Natural Language Processing, Time Series Analysis

Advanced Architectures: Long Short-Term Memory (LSTM) Networks and Gated Recurrent Units

(GRUs), Generative Adversarial Networks (GANs)

Assessment: Practical project on image classification or a simple NLP task using a chosen deep learning framework

Unit III Deep Learning Model Development, Evaluation, and Deployment- (08 Hours)

Deep Learning Model Development and Evaluation: Data Preprocessing for Deep Learning, Model Selection, Training Strategies, and Hyperparameter Tuning, Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, AUC-ROC, Model Deployment and Monitoring, Techniques for Handling Imbalanced Datasets in Deep Learning, Introduction to Transfer Learning.

Assessment: A medium-sized project requiring the design, implementation, and evaluation of a deep learning model on a given dataset (e.g., complex image classification or text classification task)

Unit IV - Advanced Deep Learning Techniques, Explainability, and Ethics- (08 Hours)

Advanced Deep Learning Techniques:Autoencoders: Undercomplete Autoencoders, Regularized Autoencoders (Sparse Autoencoders), Stochastic Encoders and Decoders, Denoising Autoencoders, Contractive Autoencoders, Applications of Autoencoders, **Ensemble Methods in Deep Learning, Variational Autoencoders (VAEs), Deep Reinforcement Learning:** Basic concepts, **Explainable AI (XAI):** Role in deep learning, **Ethical Considerations** in deep learning

Assessment:A presentation on advanced deep learning techniques along with a critical analysis of their strengths and limitations

Unit V - Deep Learning Applications and Case Studies- (08 Hours)

Applications of Deep Learning: Deep Learning applications in Computer Vision, Natural Language Processing, and other relevant fields, Image Classification, Social Network Analysis, Speech Recognition, Recommender Systems, Case studies: Robotics, Signal Processing, Healthcare

Assessment: A final project focusing on a deep learning application that solves a specific problem in Computer Engineering (e.g., anomaly detection using sensor data, image-based defect detection)

Practical Assignments / Mini Project Problem Statements

Mini project focusing on a deep learning application that solves a specific problem in Computer Engineering (e.g., anomaly detection using sensor data, image-based defect detection). Throughout the course: Python programming, TensorFlow / Keras, PyTorch, and relevant libraries will be utilized extensively for practical implementation.

Learning Resources

Text Books

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville.
2. Deep Learning for Computer Vision" – Rajalingappaa Shanmugamani

Reference Books:

1. "Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow" by Aurélien Géron
2. "Neural Networks and Deep Learning" by Michael Nielsen

3. "Deep Learning with Python" by Francois Chollet

SWAYAM / MOOC / YouTube Links

1. https://www.deeplearningbook.org/
2. https://www.youtube.com/channel/UCF9O8Vj-FEbRDA5DcDGz-Pg/videos
3. https://onlinecourses.nptel.ac.in/noc20_cs62/preview
4. https://swayam.gov.in/search_courses?searchText=deep%20learning

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-552-ITT - Cyber Security		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. To understand various types of cyber-attacks and cyber-crimes
2. To learn threats and risks within context of the cyber security
3. To have an overview of the cyber laws & concepts of cyber forensics
4. To study the defensive techniques against these attacks
5. To study the data protection techniques and address the privacy issues.

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

- CO1. Analyze cyber-attacks to protect them for the entire Internet community.
- CO2. Interpret and forensically investigate security incidents
- CO3. Apply policies and procedures to manage Privacy issues
- CO4. Design and develop secure software modules
- CO5. Apply data protection techniques to solve the privacy issues.

Course Contents

Unit I- Introduction to Cyber Security - (12 Hours)

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

Unit II- Cyberspace and Cyber Forensics-(12 Hours)

Introduction to cyberspace and cyber forensics, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics

Unit III- Cyber Security for Mobile and Wireless Devices - (12 Hours)

Introduction to Cyber security for Mobile and Wireless Devices, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security

Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops.

Unit IV- Cyber Security for digital Infrastructure-(12 Hours)

Cyber Security for Organizational Implications, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations, digital Infrastructure Security, data Centre and its infrastructure, IT Security Act , ethical hacking, Hackers - Attacker, Countermeasures, Web Application Security.

Unit V- Privacy Issues and Protection - (12 Hours)

Privacy Issues, Basic Data Privacy Concepts, Data Privacy Attacks, Datalinking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc. Online Banking, Credit Card and UPI Security, Overview of Online Banking Security, Mobile Banking Security, Security of Debit and Credit Card, UPI Security. Cloud Computing Threats, Solutions,Vulnerabilities; Risks, Cloud Security. Case study: e-mail spoofing instances, online Gambling, Intellectual Property Crime, Financial Frauds in Cyber Domain.

Learning Resources

Text Books

1. Nina Godbole and SunitBelpure, Cyber Security Understanding Cyber Crimes,Computer Forensics and Legal Perspectives,Wiley
2. B.B.Gupta,D.P. Agrawal, Haoxiang Wang, Computerand CyberSecurity: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335,2018.

Reference Books:

1. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRCPress.
2. Introduction to Cyber Security, Chwan-Hwa(john) Wu,J. David Irwin, CRC Press T&FGroup.
3. Introduction to Cyber Security: Jatindra Pandey.

SWAYAM / MOOC / YouTube Links

1. Introduction to Cyber Security. http://uou.ac.in/foundation-course
2. Fundamentals of Information Security http://uou.ac.in/progdetail?pid=CEGCS-17
3. Cyber Security Techniques. http://uou.ac.in/progdetail?pid=CEGCS-17
4. Cyber Attacks and Counter Measures: User Perspective http://uou.ac.in/progdetail?pid=CEGCS-17
5. Information System. http://uou.ac.in/progdetail?pid=CEGCS-17

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-553- ITT - Generative AI		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses: Students should have prior knowledge of
Fundamentals of NLP, Deep learning and Application, Programming

Course Objectives: The course aims to:

1. To define and describe fundamental Generative modeling techniques (GANs, VAEs, Transformers, Diffusion Models)
2. To implement and fine-tune Generative models using modern ML frameworks.
3. To analyze model performance and behavior using quantitative and qualitative evaluation techniques.
4. To evaluate the ethical, legal, and societal implications of generative AI applications.
5. To design and create end-to-end generative AI solutions for real-world use cases

Course Outcomes: After successful completion of this course, students will be able to:
CO1: Develop mathematical foundations for generative AI
CO2: Implement and fine-tune generative models using Hugging Face, langChain.
CO3: Comprehend the issues in the existing architectures of generative AI.
CO4: Understand the RAG implementation for contextual responses.
CO5: Apply generative AI techniques to tasks such as image synthesis, text generation, and data augmentation.

Course Contents

Unit I - Foundations of Generative AI - (07 Hours)

Discriminative vs. Generative models, Latent variable models, Maximum Likelihood Estimation (MLE), KL divergence, ELBO, Basic probabilistic models: Gaussian Mixture Models, Hidden Markov Models

Case Study: Implement a basic Gaussian Mixture Model and sample from it

Unit II - Probabilistic Models & VAEs - (07 Hours)

GAN architecture: Generator and Discriminator, Loss functions, minimax optimization, Variants: DCGAN, Conditional GANs, StyleGAN, CycleGAN, Challenges: Mode collapse, training instability, Lab: Implement a DCGAN for MNIST or CIFAR-10

Case study: Image-to-image translation using CycleGAN

Unit III - Variational Autoencoders (VAEs) and Diffusion Models - (07 Hours)

Autoencoders and limitations, Introduction to VAEs: Probabilistic encoding, reparameterization trick, Denoising Diffusion Probabilistic Models (DDPM), Latent Diffusion, Stable Diffusion overview

Lab: Train a VAE on Fashion-MNIST

Project Idea: Text-to-image generation using latent diffusion models

Unit IV - Generative Transformers and Large Language Models - (07 Hours)

Language modeling and autoregressive generation, Transformer architecture (Self-attention, Positional encoding),GPT family, T5, BERT vs GPT, Fine-tuning, prompt engineering, in-context learning,

Lab: Use HuggingFace Transformers to fine-tune a GPT-2 model

Project Idea: Story or poetry generation using GPT-2 or GPT-3 API

Unit V - Applications, Safety, and Ethics in Generative AI - (07 Hours)

Applications: Art, code (Codex), audio (Jukebox), video, medicine, Evaluation metrics: Inception Score, FID, BLEU, ROUGE, Risks: Misinformation, bias, deepfakes, copyright, Guardrails: RLHF, Vector databases, RAG, watermarking, policy and governance frameworks

Lab: Build a fake image detector using CNNs

Discussion: Case studies on AI hallucination and model misuse

Learning Resources

Text Books

1. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT Press.
2. Foster, D. (2022). Generative deep learning: Teaching machines to paint, write, compose, and play (2nd ed.). O'Reilly Media.
3. Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., & Polosukhin, I. (2017). Attention is all you need. In Advances in Neural Information Processing Systems (Vol. 30, pp. 5998–6008). https://papers.nips.cc/paper_files/paper/2017/file/3f5ee243547dee9Paper.pdf

Reference Books:

1. Kingma, D. P., & Welling, M. (2013). Auto-encoding variational Bayes. arXiv preprint arXiv:1312.6114. https://arxiv.org/abs/1312.6114
2. Ho, J., Jain, A., & Abbeel, P. (2020). Denoising diffusion probabilistic models. arXiv preprint arXiv:2006.11239. https://arxiv.org/abs/2006.11239
3. OpenAI. OpenAI API documentation. Retrieved May 21, 2025, from https://platform.openai.com/docs
4. Hugging Face. Hugging Face documentation. Retrieved May 21, 2025, from https://huggingface.co/do

SWAYAM / MOOC / YouTube Links

1. Generative AI with Large Language Models - https://www.coursera.org/learn/generative-ai-with-llms
2. Programming with Generative AI – NPTEL (IISc Bangalore)
3. Generative AI and Large Language Models – SWAYAM

Generative AI: Prompt Engineering Basics - https://www.coursera.org/learn/generative-ai-prompt-engineering-for-everyone

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-554-ITT - Computational Laboratory-II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Oral** : 25 Marks

Course Objectives: The course aims to:

1. Provide knowledge related to quantum algorithms to aware 1-qubit / 2-qubit gate operators and ability to design simple quantum circuits.
2. Explain various types of cyber-attacks and cyber-crimes, threats and risks within context of the cyber security.
3. Explain Tokenization, Part-of-Speech Tagging, Bag of Words (BOW), N-Grams Models in NLP

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

- CO1. Analyze quantum algorithms considering 1-qubit / 2-qubit gate operators and ability to design quantum circuits.
- CO2. Demonstrate various types of cyber-attacks and cyber-crimes, threats and risks within the context of application.
- CO3. Use of Tokenization, Part-of-Speech Tagging, Bag of Words (BOW), N-Grams Models in NLP

Guidelines:

- Computational Laboratory - II assignments are based on 3 Programme Core courses (Quantum Computing, Cyber Security, Natural Language Processing)
- Respective course faculty assigned will frame course objectives, course outcomes, list of assignments, mini projects, if any
- The list of sample assignments is given for preparation of assignments which will be approved by the respective Heads of Departments before conduction of laboratory.

List of Assignments

Part A: Deep Learning	
1.	Design and implement logic gates (AND, OR, NOR, XOR) using a Perceptron model.

2	To observe how different weight initialization strategies affect the training behavior of a neural network using a simple 2D classification task. Use the make_moons dataset from sklearn.datasets, which generates a non-linearly separable two-class dataset ideal for visualizing decision boundaries and convergence behavior.
3	Text Generation with LSTM Train an LSTM to generate Shakespeare-like text.
Part B: Cyber Security	
1	Identify assets, vulnerabilities, and threats and calculate risk levels using a formula or Python script and create a mitigation strategy report.
2	Analyze provided web applications and Identify vulnerabilities such as SQL injection or XSS and Propose mitigation strategies
3	Simulate a DDoS attack in a controlled environment, Configure mitigation tools and Document findings mitigation strategies
4	Collect logs from different sources, Parse logs using regex and Python and Analyze for anomalies.
Part C: Generative AI	
1	Implement a Gaussian Mixture Model (GMM) from scratch or using PyTorch/Scikit-learn. Train on a synthetic 2D dataset. Visualize clusters and sample new points from the trained GMM.
2	AI-Generated Music Composition: Build a tool that composes music based on user-defined parameters by using Python, Magenta, TensorFlow.
3	Voice Cloning and Synthesis Application: Create a system that generates synthetic speech from text input by using Python, Tacotron, WaveGlow tools.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-561A-ITT- Cloud and Edge Technology		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. To introduce concepts of Cloud and Edge Computing.
2. To build Cloud based Applications.
3. To analyze the performance of Cloud and Edge based Systems.

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

- CO1: Approach designing of parallel computation based better.
- CO2: Implement the solutions for various applications
- CO3 : Learn and use Open Source and Commercial Clouds
- CO3: Design and implement distributed applications using cloud and edge platforms
- CO4: Apply security, privacy, and compliance mechanisms for cloud and edge computing scenarios.

Course Contents

Unit I - Introduction to Cloud Computing- (08 Hours)

Introduction to Cloud Computing, Recent Trends in Computing Cloud Computing, Evolution of cloud computing.

Unit II - Cloud Computing Architecture- (08 Hours)

Cloud Computing Architecture, Service Management in Cloud Computing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service(SaaS), Data Management in Cloud Computing, Resource Management in Cloud Computing, Cloud Implementation.

Unit III - Open Source and Commercial Clouds - (08 Hours)

Open Source and Commercial Clouds, Cloud Simulator, Research trend in Cloud Computing, Fog Computing, VM Resource Allocation, Management and Monitoring, Introduction to Edge Computing, the Cloud Computing analytics pipeline, Coordination of Cloud Services.

Unit IV - Serverless Computing- (08 Hours)

Serverless Computing and FaaS Model, Cloud-Fog-Edge enabled Analytics, Cloud Security, Case Studies and Recent Advancements

Unit V -IoT Clouds and Data Analytics and Applications - (08 Hours)

Edge Computing, edge network, Edge computing architectures, Edge Computing: Design Issues, Lightweight Container Middleware for Edge Cloud Architectures, Case Study: open source platforms like Apache Edgent.

Learning Resources

Text Books

1. Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley,2011.
2. Enterprise Cloud Computing - Technology, Architecture, Applications, GautamShroff, Cambridge University Press, 2010.
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India, 2010.
5. Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012.

Reference Books:

1. Javid Taheri, Shuiguang Deng, “Edge Computing: Models, technologies and applications”, IET, 2020
2. Khaldoun Al Agha, Pauline Loygue, Guy Pujolle, “ Edge Networking”,Wiley-ISTE,2022.

Savitribai Phule Pune University Master of Engineering - Computer Engineering (2025 Course)		
PEC-561B-ITT: Social Media Analytics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to: To understand the structure, sources, and scale of social media data.

1. To explore methods for collecting, processing, and analyzing textual and multimedia social data.
2. To study the use of machine learning and NLP techniques in sentiment and opinion mining.
3. To analyze user interactions and social networks using graph theory concepts.
4. To apply analytics techniques to real-world social media case studies for business, healthcare, disaster management, etc.

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

- CO1: Explain social media ecosystems and the characteristics of social data.
- CO2:Describe data collection mechanisms and preprocessing techniques.
- CO3: Apply theoretical models for sentiment analysis, topic modeling, and opinion mining.
- CO4: Analyze social networks and user behaviors using graph-based metrics.
- CO5: Evaluate the impact of social media analytics in various domains with ethical awareness

Course Contents

Unit I- Foundations of Social Media Analytics-(08 Hours)

Introduction to Social Media, Web platforms and world wide websites (www), types of social media data, Text, Image, Video, Metadata, Social media data characteristics, Volume, Velocity, Variety, Veracity, challenges in social media data analysis, SMA applications, marketing, politics, healthcare, disaster management, SMA architecture, ingestion, storage, analysis, visualization, data ecosystem, analytics opportunities across platforms, domain-specific applications of SMA.

Unit II- Data Acquisition and Preprocessing-(08 Hours)

Overview of social media APIs, Facebook Graph, Reddit, X-Twitter, Instagram, structure and access policies, web scraping, architecture, ethics, and methods, text preprocessing, tokenization, case folding, stopword removal, stemming, lemmatization, handling multilingual text, hashtags, mentions, emojis, metadata, data challenges, spam, bots, noise, redundancy, techniques for extracting and preparing social media data, common challenges in raw social data.

Unit III- Text Analytics and Natural Language Processing -(08 Hours)

Text representation, Bag-of-Words, TF-IDF, Word Embeddings, Sentiment Analysis, Rule-based approaches, ML-based approaches, topic modeling, Latent Dirichlet Allocation (LDA), Non-negative Matrix Factorization (NMF), Named Entity Recognition (NER), Overview of deep learning approaches, BERT, transformers, NLP techniques to sentiment and topic analysis, extracting insight from text data and evaluation.

Unit IV- Social Network and User Interaction Analysis-(08 Hours)

Introduction to graph theory, nodes, edges, degree, centrality, social graphs, user mentions, replies, retweets, network metrics, Betweenness, Closeness, PageRank, community detection: modularity, Louvain algorithm, Influence and virality analysis, Behavioral analytics: likes, shares, content engagement patterns, graph-based representation of social networks

Unit V- Applications of social media-(08 Hours)

Applications of Politics - Election sentiment, propaganda detection, Healthcare - Vaccine hesitancy, pandemic trend tracking, Disaster response - Earthquake, flood, or COVID alerting via social media, Agriculture - Farmer sentiment, feedback analytics, Visual analytics: Word clouds, sentiment timelines, conceptual network diagrams, Ethics - data privacy, fake news, bots, bias, misinformation, real-world applications of SMA, ethical and responsible use of social media data

Learning Resources

Text Books

1. Gupta, Mukul, Gupta, Deepa, Gupta, Parth Mukul, "Social Media and Web Analytics: Turning Insights into Action in a Digital World", PHI publisher, ISBN: 9789354439605, 2024.
2. Matthew Ganis, Avinash Kohirkar, "Social Media Analytics: Techniques and Insights for Extracting Business Value Out of Social Media", IBM Press

Reference Books:

1. Subodha Kumar, Liangfei Qiu, "Social Media Analytics and Practical Applications: The Change to the Competition Landscape", 1st Edition, CRC Press,
2. Marshall Sponder, "Social Media Analytics", McGraw-Hill Publisher, ISBN: 2800071768292, 2011.

SWAYAM / MOOC / YouTube Links

1. Alex Gonçalves, "Social Media Analytics Strategy Using Data To Optimize Business Performance", Apress publisher, ISBN: 978-1-4842-3102-9.
1. https://nibmehub.com/opac-service/pdf/read/social%20media%20analytics% 20strategy%20%20usi

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-561C-ITT : Game Theory and Applications		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. To understand the game concept and visualization
2. To study user interface and various elements of game.
3. To understand game design process and & apply to develop game applications.
4. To be able to design 2D and 3D Models using tools.
5. To study AI principles to problem solving, knowledge representation, learning.

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

- CO1. Understand game logic and visualization
- CO2. Understand user interface and various elements of game.
- CO3. Understand the game design process and decision making
- CO4. Students will be able to design various face 2D and 3D game characters.
- CO5. Apply the principles of AI to problem solving, knowledge representation, learning.

Course Contents

Unit I- Fundamentals of Game Theory-(08 Hours)

Introduction to Game, Game History, Game Architecture, Game Logic, Game View for the Human Player, Game Views for AI Agents, game idea visualization and storytelling, and game documentation. Game Programming, Software Tools, Building the Game, creating a Project, Creating Build Scripts, Introduction to Unity, prototyping using Unity, Photoshop and flash.

Case study: Write a game architecture for target shooting game

Unit II- Game UI Design Elements-(08 Hours)

Introduction to User Interface, Web and Graphic User Interfaces, Visual Design Basics, Usability, Visual and Interactive elements, buttons, icons, spacing, sliders and scrollbars, typography, color schemes, text style, shapes and layers to create screens, fundamental principles of visual design, pixel precision to UI elements.

Case study: Design the UI for “candy catch game "and represent essential components

Unit III- Game Design Process-(08 Hours)

Pre-Production, Production, Post-Production, MDA Framework, Planning and Iteration: Under planning and Over planning, Iteration, Knowledge Creation: Knowledge Creation Methods, Rumination, Research, artistic methods, Brainstorming, written analysis, Debate, testing,metrics, invented methods, Organic Process, Dependencies:Dependency Stack, Cascading uncertainty, Design Backlog, Authority, Motivation:Extrinsic Rewards, meaningful work, expectations-Driven motivation, Complex Decisions: Decision Effects, Decision Effects Case Study, Values: Openness, Candor, Humility, Hunger.

Unit IV-2D & 3D Modeling for Game -(08 Hours)

Definition of Computer-based Animation, Basic Types of Animation: Real Time, Non-real-time, Definition of Modelling. Understanding 2D Splines & shape using unity, Extrude & Bevel 2D object to 3D using Unity SNAPS, Understanding Loft & terrain, Creation of 3D objects. Modelling with Polygons, using Unity. Creating and Destroying Game Objects , the scene view, building simple and complex games in 2D and 3D using Unity.

Case study: Design 2D and 3D face models.

Unit V- Game Applications -(08 Hours)

Introduction to AI, Model of Game AI, Movement, Decision Making, Strategy, Infrastructure, Game AI, The Pathfinding Graphs, Weighted Graphs, Directed Weighted Graphs, Dijkstra Algorithm, Data Structures and Interfaces, Performance of Dijkstra, Decision Making, Decision Tree, Knowledge Representation, Implementation of Nodes, Performance of Decision Trees, Balancing the Tree, Random Decision Trees.

Case study: AI in Video Games.

Learning Resources

Text Books

1. Florian Bartholomae, Marcus Wiens, “Game Theory and Applications: A Guide for Students and Researchers”, 1st edition, 2024
2. Dario Calonaci, Designing User Interfaces: Exploring User Interfaces, UI Elements, Design Prototypes and the Figma UI Design Tool, BPB Publisher, ISBN-13- 978-9389898743, 2021.

Reference Books:

1. Michael E. Mortenson , 3D Modeling, Animation, and Rendering: An Illustrated Lexicon, Color Edition, Create Space Independent Publishing Platform Publisher, ISBN:1453728481, 2010
2. Tatsuro Ichiishi, Abraham Neyman and Yair Tauman, “Game Theory and Applications “, Elsevier.

SWAYAM / MOOC / YouTube Links

1. Mike MrMike McShaffry , David Rez Graham, “Game Coding Complete”, Fourth Edition, Course Technology, a part of Cengage Learning Publisher, ISBN-13: 978-1-133-77657-4. https://ms.z-library.sk/book/2072433/3f7bf2/game-coding-complete-fourth-edition.html
2. Gabe Zechermann, Christopher Cunningham, Gamification by Design, Oreilly, ISBN: 978-1-449-39767-8, 2011. http://storage.libre.life/Gamification_by_Design.pdf

3. Jun Tanimoto, Fundamentals of Game Theory and its Applications, Volume 6, Springer, ISBN: 978-4-431-54961-1, 2015. https://link.springer.com/book/10.1007/978-4-431-54962-8

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-561D-ITT- Bio-Inspired Computing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. To learn how natural and biological systems influence computational field
2. To understand the strengths and weaknesses of nature-inspired algorithms
3. To learn the functionalities of various Bio-inspired optimization algorithms.

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

- CO1. Describe the natural phenomena that motivate the algorithms
- CO2. Apply nature-inspired algorithms to optimization
- CO3. Select the appropriate strategy or optimal solution based on bio-inspired algorithms.
- CO4: Formulate real-life projects using algorithms studied
- CO5 : Analyze the strengths and limitations of various bio-inspired algorithms for solving optimization and search problems

Course Contents

Unit I- Natural Computing-(08 Hours)

From nature to natural computing, Introduction, sample idea, Philosophy of natural computing, Natural computing approaches, Conceptualization – introduction, general concept, Problem solving as a search track, Hill climbing, Simulated annealing.

Unit II- Evolutionary Computing-(08 Hours)

Evolutionary computing, Evolutionary biology, Evolutionary computing standard evolutionary algorithm, Genetic algorithm, evolutionary strategies, Evolutionary programming.

Unit III- Swarm Intelligence-(08 Hours)

Swarm intelligence-biological motivation, from natural to artificial, standard algorithm of Ant colony optimization, Ant clustering algorithm, Particle swarm optimization.

Unit IV- Biological Motivation-(08 Hours)

Biological motivation, from natural to artificial, standard algorithm of cuckoo search, bat algorithm, flower pollination, firefly algorithm, framework for self-tuning algorithms - case study of firefly algorithm. The essence of life, Examples of A Life projects- flocks, herds and schools, synthesizing emotional behavior, Scope of artificial life,

Unit V- Immune Systems-(08 Hours)

Immune system, Artificial immune systems - biological motivation, Design principles, main types of algorithms - Bone marrow, Negative selection, Clonal selection, Continuous immune network models, Discrete immune network models, Scope of artificial immune systems, computer viruses, AIBO robot, Turtles, termites, and traffic jams, framsticks, Current trends and open problems

Learning Resources

Text Books

1. L. N. de Castro, "Fundamentals of Natural Computing: Basic Concepts, Algorithms, and Applications", 2006, CRC Press, ISBN-13: 978-1584886433

2. D. Floreano and C. Mattiussi, " Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", 2008, MIT Press, ISBN-13: 978-0262062718

Reference Books:

1. D. Simon,"Evolutionary Optimization Algorithms",2013, Wiley,ISBN: 10: 0470937416;13: 978-0470937419.

2. Russell C. Eberhart , Yuhui Shi , James Kennedy, " Swarm Intelligence: The Morgan Kaufmann Series in Evolutionary Computation",ISBN-13: 978-1558605954.

SWAYAM / MOOC / YouTube Links

1. Tao Song, Pan Zheng, Dennis Mou Ling Wong, Xun Wang, "Bio-inspired Computing Models And Algorithms", World Scintific Publishing, Singapur. 9789813143197, 9813143193, 2019. https://share.google/9UNkn48Ah7dQr0lZv

2. Anu Bajaj, Ajith Abraham, K. Reddy Madhavi, Dalia Kriksciuniene, "Bio-Inspired Computing", Proceedings, 14-15, 2023, Volume 5, 2025. https://link.springer.com/book/10.1007/978-3-031-78949-6

3. De-Shuang Huang, Yong Gan, Prashan Premaratne, Kyungsook Han, "Bio-Inspired Computing and Applications, 7th International Conference on Intelligent Computing", ICIC2011, Zhengzhou, China, August 11-14, Springer, 2011.https://link.springer.com/book/10.1007/978-3-642-24553-4

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PCC-562A-ITT - Quantum Computing		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:

1. Being able to analyze simple quantum algorithms and argue optimality.
2. Familiarity with 1-qubit / 2-qubit gate operators and ability to design simple quantum circuits.
3. Ability to read and understand recent results as well as research papers on quantum algorithms

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

- CO1: Explain how the physics of quantum computation is different from classical computational models.
- CO2: Describe the theoretical performance improvements that quantum algorithms offer compared to classical algorithms.
- CO3: Analyze the life cycle of hybrid applications and decompose their execution on a hybrid quantum-classical computational continuum.
- CO4: Develop their own (hybrid) quantum algorithms and implement them using (real or simulated) quantum computers using quantum toolkits such as Qiskit.

Course Contents

Unit I -Introduction and The Leap from Classical to Quantum - (12 Hours)

Introduction: Cbits and Qbits, Reversible and Manipulating operations on Cbits and Qbits, Circuit diagrams, Measurement gates and state preparation, Constructing arbitrary 1- and 2-Qbit states
The Leap from Classical to Quantum: Classical Deterministic Systems, Probabilistic Systems, Quantum Systems, Assembling Systems

Unit II - Basic Quantum Theory & Architecture- (12 Hours)

Basic Quantum Theory: Quantum States, Observables, Measuring, Dynamics, Assembling Quantum Systems
Architecture: Bits and Qubits, Classical Gates, Reversible Gates, Quantum Gates

Unit III -Algorithms & Programming Languages - (12 Hours)

Algorithms: Deutsch's Algorithm, The Deutsch–Jozsa Algorithm, Simon's Periodicity Algorithm, Grover's Search Algorithm, Shor's Factoring Algorithm,
Programming Languages: Programming in a Quantum World, Quantum Assembly Programming, Toward Higher-Level Quantum Programming, Quantum Computation Before Quantum Computers

Unit IV - Theoretical Computer Science and Cryptography- (12 Hours)

Theoretical Computer Science: Deterministic and Nondeterministic Computations, Probabilistic Computations, Quantum Computations

Cryptography: Classical Cryptography, Quantum Key Exchange I: The BB84 Protocol, Quantum Key Exchange II: The B92 Protocol, Quantum Key Exchange III: The EPR Protocol, Quantum Teleportation

Unit V - Information Theory & Hardware - (12 Hours)

Information Theory: Classical Information and Shannon Entropy, Quantum Information and von Neumann Entropy, Classical and Quantum Data Compression, Error-Correcting Codes

Hardware: Quantum Hardware: Goals and Challenges, implementing a Quantum Computer I: Ion Traps, implementing a Quantum Computer II: Linear Optics, Implementing a Quantum Computer III: NMR and Superconductors, Future of Quantum Ware

Learning Resources

Text Books

1. Eleanor Rieffel and Wolfgang Polak, "Quantum Computing: A Gentle Introduction," The MIT Press, 2011, ISBN 978-0-262-01506-6
2. Quantum Computation and Quantum Information by Nielsen and Chuang (NC), Classical and Quantum Computation by Kitaev, Shen, and Vyalyi (KSV)
3. Scott Aaronson, "Quantum Computing Since Democritus," Cambridge University Press, March 2013, ISBN: 9780521199568

Reference Books:

1. N. David Mermin, "Quantum Computer Science: An Introduction," Cambridge University Press, August 2007, ISBN: 9780521876582
2. Noson S. Yanofsky and Mirco A. Mannucci, "Quantum Computing for Computer Scientists," Cambridge University Press, August 2008, ISBN: 9780521879965
3. "IBM Quantum Computing- Qiskit - ibm.com," https://www.ibm.com/quantum/qiskit

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-562B-ITT- Real-Time Operating Systems		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Course Objectives: The course aims to:To understand the real-time systems environment

1. Setup and demonstrate the development environment for RTOS
2. Illustrate strategies to interface memory and I/O with RTOS kernels
3. Interpret tasks used in handling multiple activities
4. impart skills necessary to develop software for embedded computer systems using a real-time operating system

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

- CO1: Create, test and debug on RTOS environment
- CO2: Implement Inter task communication mechanism.
- CO3: Compare general purpose OS with RTOS
- CO4: Demonstrate methods in storing, retrieving data in RTOS
- CO5: Analyze performance of task during multitasking.

Course Contents

Unit I- Introduction to Real Time Operating System-(08 Hours)

Introduction to real-time operating systems. Hard versus soft real-time systems and their timing constraints. Temporal parameters of real-time process: Fixed, Jittered and sporadic release times, execution time. Types of real-time tasks, Precedence constraints and data dependency among real-time tasks, other types of dependencies for real-time tasks. Functional parameters and Resource parameters of real-time process. Real-time task and task states, task and data. Approaches to real-time scheduling: clock driver, weighted round-robin, priority-driven- Fixed priority and dynamic priority algorithms –Rate Monotonic (RM), Earliest-Deadline-First (EDF), Latest-Release-Time (LRT), Least-Slack- Time-First (LST). Static and Dynamic systems, on-line and off-line scheduling, Scheduling aperiodic and sporadic real-time tasks

Unit II- Inter-Process Communication-(08 Hours)

Resources and resource access control-Assumption on resources and their usage, Enforcing mutual exclusion and critical sections, resource conflicts and blocking, Effects of resource contention and resource access control - priority inversion, priority inheritance.

Inter-process communication-semaphores, message queues, mailboxes and pipes. Other RTOS services-Timer function, events, Interrupts - enabling and disabling interrupts, saving and restoring context,

interrupt latency, shared data problem while handling interrupts. Interrupt routines in an RTOS environment.

Unit III- Scheduling Algorithms-(08 Hours)

Scheduling algorithms: FCFS, SJF, Priority, Round Robin, UNIX Multi-level feedback queue scheduling, Thread Scheduling, Multiprocessor Scheduling concept, Concurrency: Principles of Concurrency, Mutual Exclusion H/W Support, software approaches, Semaphores and Mutex, Message Passing techniques. Time Management, Timer Management, Resource Management Disable/Enable Interrupts, Lock/Unlock Semaphores, Mutex, Deadlocks, Synchronization.

Unit IV- Real-Time Communication-(08 Hours)

Network Topologies, Protocols, Clocks, A Non-Fault Tolerant, synchronization Algorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Synchronization in Software. Fault Tolerant Techniques: Fault Types, Fault Detection, Fault and error Containment, Redundancy, Data Diversity, Reversal Checks, Malicious or Byzantine Failures, Integrated Failure Handing, Obtaining Parameter Values, Reliability Models for Hardware edundancy, Software Error models, Taking Time into Account.

Unit V- Real Time Systems-(08 Hours)

Real-time operating systems: Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux.

Real-time applications: Guidance and control, Signal processing, Multimedia, real-time databases. Real-Time Databases: Real-Time Vs General-Purpose Databases, Main Memory Databases, Transaction Priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling algorithm, A Two Phase Approach To Improve Predictability, Maintain Serialization Consistency, Databases for Hard Real Time Systems.

Learning Resources

Text Books

1. Jane W. S. Liu, “Real-Time Systems”, Pearson Education, ISBN: 10: 0130996513.
2. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, Tata McGraw Hill
3. Dr. Jürgen Sauermann, Melanie Thelen, “Realtime Operating Systems :Concepts and Implementation of Microkernels for Embedded Systems“, https://dsp-book.narod.ru/DSPROSES.pdf

Reference Books:

1. Colin walls, "Building a Real Time Operating System: RTOS from the Ground Up", Newness, 2020.
2. Jean J Labrosse, "Micro C/OS-II, The Real Time Kernel", CMP, 3rd, 2016.

SWAYAM / MOOC / YouTube Links

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-562C-ITT - MOBILE AD-HOC		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week	03	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisites:

Discrete Mathematics

Computer Networks

Course Objectives:

1. To study the Mobile adhoc networks and its applications
2. To study the routing algorithm in mobile adhoc network
3. To study the transport protocols used in mobile adhoc network
4. To study the security mechanism used in mobile adhoc network
5. To understand the quality of service for mobile adhoc network

Course Outcomes:

- CO1: By the end of the course, students should be able to
- CO2: To understand the routing algorithm used mobile adhoc network
- CO3: To understand the Transport protocol of mobile adhoc network
- CO4: To understand the security mechanism used in mobile adhoc network
- CO5: To understand the quality of service.

UNIT – I Introduction of Ad Hoc Network 08 Hours

Introduction-Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum - Radio Propagation Mechanisms - Characteristics of the Wireless Channel - IEEE 802.11a,b Standard – Origin Of Ad-hoc: Packet Radio Networks - Technical Challenges - Architecture of PRNETs - Components of Packet Radios – Ad hoc Wireless Networks -What Is an Ad Hoc Network? Heterogeneity in Mobile Devices - Wireless Sensor Networks - Traffic Profiles - Types of Ad hoc Mobile Communications - Types of Mobile Host Movements - Challenges Facing Ad Hoc Mobile Networks-Ad hoc wireless Internet

UNIT – II Ad Hoc Routing Protocols 08 Hours

Introduction - Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks - Classifications of Routing Protocols -Table-Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV) - Wireless Routing Protocol (WRP) - Cluster Switch Gateway Routing (CSGR) - Source-Initiated

On- Demand Approaches - Ad Hoc On- Demand Distance Vector Routing (AODV) - Dynamic Source Routing (DSR) - Temporally Ordered Routing Algorithm (TORA) - Signal Stability Routing (SSR) - Location-Aided Routing (LAR) - Power-Aware Routing (PAR) - Zone Routing Protocol (ZRP)

UNIT – III Multicast Routing In Ad Hoc Networks 08 Hours

Introduction - Issues in Designing a Multicast Routing Protocol - Operation of Multicast Routing Protocols - An Architecture Reference Model for Multicast Routing Protocols - Classifications of Multicast Routing Protocols - Tree-Based Multicast Routing Protocols- Mesh-Based Multicast Routing Protocols - Summary of Tree-and Mesh-Based Protocols - Energy-Efficient Multicasting - Multicasting with Quality of Service Guarantees - Application-Dependent Multicast Routing - Comparisons of Multicast Routing Protocols

UNIT IV Transport Layer 08 Hours

Introduction - Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks - Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks - Classification of Transport Layer Solutions - TCP over Ad Hoc Wireless Networks - Other Transport Layer Protocols for Ad Hoc

UNIT V Security Protocols 08 Hours

Wireless Networks - Security in Ad Hoc Wireless Networks - Network Security Requirements - Issues and Challenges in Security Provisioning - Network Security Attacks - Key Management - Secure Routing in Ad Hoc Wireless Networks

UNIT VI QoS and Energy Management 08 Hours

Introduction - Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks - Classifications of QoS Solutions - MAC Layer Solutions - Network Layer Solutions - QoS Frameworks for Ad Hoc Wireless Networks Energy Management in Ad Hoc Wireless Networks –Introduction - Need for Energy Management in Ad Hoc Wireless Networks - Classification of Energy Management Schemes - Battery Management Schemes - Transmission Power Management Schemes - System Power Management Schemes

Text Books:

1. Siva Ram Murthy C. and B.S. Manoj “Ad Hoc Wireless Networks: Architectures and Protocols”, Prentice Hall PTR,2004
2. Toh C.K., Ad Hoc Mobile Wireless Networks: Protocols and Systems, Prentice Hall PTR ,2001

Reference Books:

1. Charles E. Perkins, Ad Hoc Networking, Addison Wesley, 2000
2. Holger Karl, Andreas Willig, Protocols and Architectures for Wireless Sensor Networks ISBN: 978-0-470-09510-2, Wiley.
3. Kazem Sohraby, Daniel Minoli, Taieb Znati Wireless Sensor Networks: Technology, Protocols, and Applications, Wiley.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
PEC-562D-ITT - ELECTIVE-III ENTERPRISE APPLICATION INTEGRATION AND MANAGEMENT		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisites:

Software Engineering

Software Architecture

Course Objectives:

1. To focus on the basics and benefits of EAI with Integration Models.
2. To highlight on the importance and applications of EAI and Middleware Interfaces.
3. To present the association of EAI and various Information Systems scenario.
4. To focus on the Integration of Business Processes and Enterprise Application on various software platforms.
5. To apply and strengthen the integration of EAI and Design Patterns.
6. To apply and extensify the practical implementation of EAI and XML services.

Course Outcomes:

By the end of the course, students should be able to

- CO1:Learn the basics of EAI and Integration Models.
- CO2: Inculcate the importance of EAI and Middleware Integration.
- CO3: Learn the various EAI and Information Systems integration.
- CO4: Focus on EAI and Business Process Integration on Software Platforms.
- CO5: Apply the EAI and Design patterns integration.
- CO6: Apply the EAI and XML integration through Web based applications.

UNIT – I Introduction to EAI 08 Hours

EAI, Levels of EAI: Data, Method, User Interface and Application Interface, Benefits of EAI, Barriers to EAI, Integration Models: Data, Functional, Message Oriented Middleware, Transaction Oriented Middleware, Distributed Object Technologies, Implementing and Integrating Packaged Applications—The General Idea.

UNIT – II EAI and Middleware 08 Hours

Message Brokers—The Preferred EAI Engine, Process Automation and EAI, Message Broker Architecture, Transaction Processing Monitors, An Introduction to EAI and Middleware, RPCs, Messaging, and EAI, Database-Oriented Middleware and EAI, Java Middleware and EAI, Enterprise JavaBeans Architecture, Java Based Middleware Standards and Application Integration: J2EE Architecture, Components.

UNIT – III EAI and Information Systems 08 Hours

Information systems evaluation, Enterprise application integration: scope, impact and classification, intra-organizational application integration, inter-organizational application integration, hybrid application integration, Case Study: EAI and WFMS.

UNIT IV Business Process Integration-Oriented Application Integration 08 Hours

BPIOAI: Definition, Implementation, Tools & Approaches, Process Modeling, BPIOAI and Application Integration, Compatibility between different software platforms for enterprise application development, Business process modeling and optimization based on integrated software systems and workflow analysis, Information Oriented Application Integration, Service Oriented Application Integration.

UNIT V Enterprise Application Patterns 08 Hours

Design Patterns, Layering, Organizing Domain Logic, Mapping to Relational Databases, Web Presentation, Domain Logic Patterns, Data Source Architectural Patterns, Object-Relational Behavioral Patterns, Object-Relational Structural Patterns, Object-Relational Metadata Mapping Patterns, Web Presentation Patterns, Distribution Patterns, Offline Concurrency Patterns.

UNIT VI EAI AND XML 08 Hours

EAI and XML, Integration Solutions, XML enabled standards, Web Services: SOAP, UDDI and WSDL, XML Encryption, XML Signature, XSLT, XSLT for B2B Application Integration, XSLT: Processors, Transformation and Applications, ebXML and EAI, ebXML: Components, Architecture, Business Process Modeling.

Text Books:

1. William A. Ruh, Francis X. Maginnis and William J. Brown, Enterprise Application Integration, A Wiley Tech Brief.
2. David S. Linthicum, Enterprise Application Integration, Addison-Wesley Information Technology Series).
3. David S. Linthicum, Next Generation Application Integration: From Simple Information to Web Services, Addison Wesley Pub Date: August 15, ISBN: 0-201-84456-7 Pages: 512.

4. http://www.eai.ittoolbox.com.
5. http://www.javaworld.com/javaworld/jw-08-2002/jw-0809eai.html (Enterprise application integration using J2EE).

Reference Books:

1. S. Duke, P. Makey, N. Kiras, Application Integration Management Guide: Strategies and Technologies, Butler Group Limited, Hull, UK.
2. J. Morgenthal, B. La Forge, Enterprise Application Integration with XML and Java, in: C. Goldfarb (Ed.), Open Information Management, Prentice-Hall, Englewood Cliffs, NJ, USA.
3. D. Avison, G. Fitzgerald, Information Systems Development: Methodologies, Techniques, and Tools, McGraw Hill, London, UK.
4. Martin Fowler, Patterns of Enterprise Application Architecture, 2003, Addison-Wesley Professional, ISBN10: 0321127420 ISBN-13: 9780321127426.
5. Fred A. Cummins, Enterprise Integration: An Architecture for Enterprise Application and Systems Integration, Wiley, ISBN-10: 0471400106 ISBN-13: 978-0471400103.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
SEM-581-ITT - Technical Seminar - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 04 Hours/Week	02	**Term Work** : 25 Marks **Oral/Presentation** : 25 Marks

Course Description:

The seminar aims to enhance students' research, presentation, and critical thinking skills, preparing them for advanced academic pursuits and professional careers. Technical Seminars will provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.

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

- **Deepen Technical Knowledge:** To enable students to explore a specialized topic within Computer Engineering beyond the regular curriculum, fostering in-depth understanding.
- **Develop Research Skills:** To provide practical experience in identifying, acquiring, evaluating, and synthesizing information from various technical sources (research papers, standards, technical reports).
- **Enhance Communication Skills:** To cultivate effective oral and visual presentation skills, enabling students to articulate complex technical concepts clearly and concisely to a knowledgeable audience.
- **Foster Critical Thinking:** To encourage students to critically analyze existing research, identify challenges, propose solutions, and engage in constructive discussions.
- **Promote Independent Learning:** To encourage self-directed learning and the ability to stay updated with emerging technologies and research trends.
- **Prepare for Thesis/Dissertation:** To serve as a foundational step for the Master's thesis/dissertation, allowing students to explore potential research areas.

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

- **CO1 : Formulate** the goals and objectives of scientific research;
- **CO2 :** Search, evaluate and **analyze** information about the achievements of science and technology in the target area and beyond;
- **CO3 : Interpret** data from different fields of science and technology;
- **CO4 : Build** the logic of reasoning and statements;
- **CO5 : Create**, design and edit text documents in accordance with the requirements of the organization or publisher;

Guidelines for Seminar

- **Responsibility of the students:**
  - The Seminar should be carried out individually by each student.
  - A student should identify the area or topics in recent trends and developments in consultation with the guide.
  - A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
  - A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
  - Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the diary. The diary must be presented during each review presentation to the reviewers.
  - A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
  - A student should incorporate constructive feedback to improve the quality and rigor of the research work towards seminar.
  - For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
  - Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
  - A student should invest time and effort in preparing for seminar presentations and the oral presentation of the seminar.
- **Topic Selection**
  - Relevance: Topics must be directly related to Computer Engineering, encompassing current research trends, emerging technologies, advanced concepts, or interdisciplinary applications.
  - Scope: The topic should be sufficiently focused to allow for in-depth exploration within the seminar timeframe, yet broad enough to demonstrate a comprehensive understanding. Avoid overly narrow or excessively broad topics.
  - Novelty (Desired): While not strictly a research paper, students are encouraged to explore topics that have recent advancements, open problems, or areas where their unique insights can be presented. Avoid merely summarizing introductory textbook material.
  - Guide / Supervisor Approval: Each student must select a seminar topic in consultation with and obtain approval from an assigned faculty supervisor. The supervisor will guide the student in refining the topic and identifying relevant resources.
  - Examples of Broad Areas: Artificial Intelligence/Machine Learning, Data Science & Big Data, Cybersecurity, Cloud Computing, Internet of Things (IoT), Computer Networks, Software Engineering, High-Performance Computing, Embedded Systems, Computer Vision, Natural Language Processing, Blockchain, Quantum Computing.

- **Seminar Structure and Deliverable :** The technical seminar typically involves the following stages and deliverable
  - Topic Proposal (2-3 weeks after topic approval)
  - A concise document (1-2 pages) outlining:
    * Proposed Seminar Title
    * Brief Description/Abstract of the Topic
    * Motivation and Relevance to Computer Engineering
    * Preliminary List of Key References (at least 5-7 reputable sources)
    * Tentative Scope and Outline of the Presentation
    * Submission: To the faculty supervisor for approval.
    * Literature Review and Research (Ongoing): Sources: Students must primarily rely on peer-reviewed academic sources (IEEE Xplore, ACM Digital Library, SpringerLink, arXiv, Google Scholar), reputable conference proceedings, and established industry standards. Wikipedia and unverified blogs are generally not acceptable as primary sources.
    * Critical Analysis: Beyond mere summarization, students are expected to critically analyze the literature, identifying different approaches, their advantages/disadvantages, open issues, and potential future directions.
    * Note-Taking & Organization: Maintain systematic notes and organize research material effectively.

- **Seminar Report (Due 2-3 weeks before presentation):**
  - A written report (typically 20-25 pages, excluding references and appendices) detailing the seminar content.
  - Format: Follow a professional academic paper format (e.g., IEEE transaction style).
  - Sections:
    * Abstract: A concise summary of the seminar topic and key findings.
    * Introduction: Background, motivation, problem statement (if applicable), and outline of the report.
    * Literature Review/Background: Detailed discussion of relevant concepts, theories, and existing work.
    * Core Content: In-depth exploration of the chosen topic, presenting different methodologies, architectures, algorithms, or challenges as relevant.
    * Analysis/Discussion: Critical evaluation of the presented material, comparing different approaches, discussing implications, and identifying gaps.
    * Future Trends/Conclusion: Summarization of key takeaways, potential future directions, and concluding remarks.
    * References: A comprehensive list of all cited sources, properly formatted.

* Appendices (Optional): Supplementary material if necessary.

- **Oral Presentation :**
  - Duration: Typically 25-30 minutes for presentation, followed by 10-15 minutes for Q&A.
  - Audience: Faculty members, peers, and potentially other interested individuals.
  - Content: The presentation should effectively convey the key aspects of the seminar topic. It should not simply be a reading of the report.
  - Visual Aids: High-quality presentation slides (e.g., PowerPoint, Google Slides, LaTeX Beamer) are mandatory. Slides should be clear, concise, visually appealing, and support the oral delivery. Avoid excessive text on slides.
  - Delivery: Clear articulation, confident posture, good eye contact, and appropriate pace. Practice the presentation thoroughly.
  - Q&A Session: Be prepared to answer questions from the audience on all aspects of the seminar topic. Demonstrate a strong understanding and ability to defend your perspectives.
- **Evaluation Criteria :** The technical seminar will be evaluated based on the following criteria:
  - **Topic Selection and Scope (10%):** Relevance, timeliness, and appropriate depth of the chosen topic. Clarity and focus of the topic proposal.
  - **Literature Review and Research (25%):** Breadth and depth of literature surveyed. Quality and credibility of sources used. Critical analysis and synthesis of information.
  - **Seminar Report/Paper (30%):** Clarity, organization, and logical flow of content. Technical accuracy and depth of discussion. Adherence to academic writing standards (grammar, spelling, formatting, referencing). Originality in synthesis and critical insights. Absence of plagiarism.
  - **Oral Presentation (35%):** Content: Clarity, completeness, and accuracy of the presented material. Organization: Logical flow, effective use of time. Visual Aids: Quality, clarity, and effectiveness of slides. Delivery: Confidence, clarity of speech, enthusiasm, engagement with the audience. Q&A: Ability to answer questions accurately, comprehensively, and confidently.

Learning Resources

Text Books

1. "Engineering Communication" by Charles W. Knisely & Karin I. Knisely
2. "Technical Communication: Principles and Practice" by Meenakshi Raman & Sangeeta Sharma
3. "The Craft of Scientific Presentations" by Michael Alley

NPTEL Courses

1. https://nptel.ac.in/courses/109/106/109106180/
2. https://www.udemy.com/course/technical-writing/
3. https://www.edx.org/course/writing-in-the-sciences

Savitribai Phule Pune University, Pune

Maharashtra, India

M. E. – Information Technology

Semester III

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
RM-601-ITT - Research Methodology		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 04 Hours/Week	04	**CCE** : 50 Marks **End-Semester**: 50 Marks

Prerequisite Courses:

1. Familiarity with project-based learning (e.g., mini projects, seminars, undergraduate theses)
2. Knowledge of basic statistics (mean, median, variance, standard deviation, probability concepts)
3. Basic skills in technical writing (reports, presentations, documentation).
4. Sound fundamentals of the core engineering/science domain

Course Objectives: The course aims to:

1. Understand the philosophy of research in general
2. Understand basic concepts of research and its methodologies
3. Learn the methodology to conduct the Literature Survey
4. Acquaint with the tools, techniques, and processes of doing research
5. Learn the effective report writing skills and allied documentations
6. Become aware of the ethics in research, academic integrity and plagiarism

Course Outcomes: Upon successful completion of this course, students will 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.

Unit I - Definition and Characteristics of Research:- (12 Hours)

Basic of 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. Types - Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.

Engineering Research: Why? Research Questions, Engineering Ethics, conclusive proof-what constitutes, A research project-Why take on?

Case Study: Code of Ethics, IEEE Code of Ethics, ACM Software Engineering Code of Ethics and Professional Practice, Code of Ethics especially covering Engineering discipline, various aspects- environment, sustainable outcomes, employer, general public, and Nation, Engineering Disasters.

Unit II - Literature Search and Review - (12 Hours)

Literature Review, Types of review, developing the objectives, preparing the research design including sample Design, Sample size. Archival Literature, Why should engineers be ethical? Types of publications- Journal papers, conference papers, books, standards, patents, theses, trade magazine, newspaper article, infomercials, advertisement, Wikipedia & websites, Measures of research impact, publication cost.

Case Study: Engineering dictionary, Shodhganga, The Library of Congress, Research gate, Google Scholar, Bibliometrics, Citations, Impact Factor, h-index, I-index, plagiarism, copyright infringement

Unit III - Analysis of Variance and Covariance:- (12 Hours)

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 IV - Technical Writing and IPR - (12 Hours)

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.

Unit V - Outcome of Research and Research Presentation:- (12 Hours)

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.

Research presentation: Introduction, Standard terms, Standard research methods and experimental techniques, Paper title and keywords, Writing an abstract, Paper presentation and review, Conference presentations, Poster presentations, IPR, Copyright, Patents.

Case Study: Intellectual Property India- services, InPASS - Indian Patent Advanced Search System, US patent, IEEE / ACM Paper templates.

Learning Resources

Text Books

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.
4. Neeraj Pandey, Intellectual Property Rights ,1st Edition, PHI
5. Shrivastava, Shenoy& Sharma, Quantitative Techniques for Managerial Decisions, Wiley

Reference Books:

1. Goode W J &Hatt P K, Methods in Social Research, McGraw Hill
2. Basic Computer Science and Communication Engineering – R. Rajaram (SCITECH)

SWAYAM / MOOC / YouTube Links

1. https://www.youtube.com/playlist?list=PLm-zueI9b64QGMcfn5Ckv_8W5Z1d3vMBY
2. https://onlinecourses.swayam2.ac.in/cec20_hs17/preview
3. https://onlinecourses.nptel.ac.in/noc23_ge36/preview

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
OJT-602-ITT - Internship/On Job Training (IN/OJT)		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 10 Hours/Week	05	Term Work : 100 Marks

Course objectives:

1. To put theory into practice.and expand thinking and broaden the knowledge and skills acquired through course work in the field.
2. To relate to, interact with, and learn from current professionals in the field.
3. To understand and adhere to professional standards in the field.
4. To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
5. To develop the initiative and motivation to be a self-starter and work independently.

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

- **CO1 - Gain** practical experience within industry in which the internship is done.
- **CO2 - Acquire** knowledge of the industry in which the internship is done.
- **CO3 - Apply** knowledge and skills learned to classroom work.
- **CO4 - Develop** and refine oral and written communication skills.
- **CO5 - Acquire** the knowledge of administration, marketing, finance and economics.

Course Description:

1. Internship/On Job Training provide students the opportunity of hands-on experience that includes personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc.
2. An internship is the phase of time for students when they are trained for their skills, they are good at, and it gives them a chance to apply their knowledge practically in industries
3. The internship can be carried out in any industry/R&D Organization/Research Institute/Institute of national repute/R&D Centre of Parent Institute.
4. The Department/college shall nominate a faculty to facilitate, guide and supervise students under internship.

Guidelines

- **Purpose:** Internships are designed to bridge the gap between academic learning and industry practice. They aim to provide hands-on experience, expose students to the industrial environment, develop technical and soft skills (communication, teamwork, problem-solving), and help in career exploration.
- **Internship Duration and Academic Credentials**
  - Student can take internship work in the form of Online/Offline mode from any of the Industry / Government Organization Internship Programmes approved by SPPU/AICTE/UGC portals
  - A intern is expected to spend 10 - 12 hours per week on Internship, Training will result in about 160-170 hours of total internship duration.
  - The minimum requirement regarding Internship duration should not be below 8 weeks
- **Type of Internship**
  - Industry/Government Organization Internship: Working directly with a company or government body.
  - Research Internship: Focused on research projects, often in collaboration with academic institutions or R&D labs.
  - Innovation/Entrepreneurship: Working on developing new products, processes, or even starting a venture.
  - Social Internship: Engaging in community-based projects.
- **Assessment Details (Term Work)**
  - Term work for 100 marks
  - A daily log submitted by the student and a work log signed by the office/HoDs where the student has interned will be considered towards the TW marking.
- **Indicative list of areas for OJT**
  - Trade and Agriculture
  - Economy & Banking Financial Services and Insurance
  - Logistics, Automotive & Capital Goods
  - Fast Moving Consumer Goods & Retail
  - Information Technology/Information Technology Enabled Services & Electronics
  - Handcraft, Art, Design & Music
  - Healthcare & Life Science
  - Sports, Wellness and Physical Education
  - Tourism & Hospitality
  - Digitization & Emerging Technologies (Internet of Things / Artificial Intelligence / Machine

- Learning / Deep Learning / Augmented Reality / Virtual Reality etc.)
- Humanitarian, Public Policy and Legal Services
- Communication
- Education
- Sustainable Development
- Environment
- Commerce, Medium and Small-Scale Industries

- **Faculty Supervision:** Students are usually assigned an internal faculty guide/mentor who supervises their internship activities. This faculty member acts as a teacher, mentor, and critic, and ensures the internship aligns with academic goals. External Supervision: In many cases, an external expert from the host organization also guides the student.

- **Documentation and Reporting:**
  - Joining Report: To be submitted within a specified time frame (e.g., one week from joining).
  - Daily/Periodical Diary: Students are often required to maintain a daily or weekly record of their observations, work, and learning.
  - Internship Report: A comprehensive report detailing the work done, learning outcomes, and achievements during the internship. This report needs to be duly signed by the company official and faculty mentor.
  - Completion Certificate: Issued by the host organization upon successful completion.

- **Evaluation:**
  - Evaluation is typically done by the institute, often within a short period after the internship ends.
  - It may involve presentations, viva-voce examinations, and assessment of the internship report and daily diary.
  - Performance-based feedback from the industry mentor is usually a key component.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
SEM-603-ITT - Technical Seminar - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 08 Hours/Week	04	**Term Work:50 Marks** **Practical: 50 Marks**

Course Description:

- Research Project seminar is the first stage of work on a master's thesis. During this course, students gain experience in the field of intellectual property and research ethics. They conduct patent searches and analyze related works to study the current state of the target area.
- Work on the "Research Project seminar" is carried out on the basis of the research and training laboratories of the Institute and the Scientific Library of the Institute/University and in close cooperation with the student's supervisor.
- The aim of the "Research Project Seminar" is to prepare for the implementation of the Final Project and for master's thesis defense. It includes finding or developing methods and tools to solve a stated problem, taking into account the latest research and trends; clarification of requirements for the object under development; planning experiments and tests to prove the effectiveness of the proposed solution

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

- To provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.
- To raise student's awareness in advanced methods of research and mastering the skills to apply them.
- Teach students to find and critically analyze sources of information.
- Develop their ability to build logic of reasoning and statements based on the interpretation of data combined from various fields of science and technology, to make judgments based on incomplete data.
- Improve the student's academic writing experience.

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

- **CO1 -** Gain fundamental concepts and categories in the field of scientific research- ways of organizing and planning research
- **CO2** - Advanced information technologies allowing us to **acquire** new knowledge in various fields
- **CO3 - Learn** features of the technical and scientific style of writing texts

- **CO4 -** Evaluation criteria and methods of handling incomplete data

By the end of the course, students will be able to:

- formulate the goals and objectives of scientific research;
- search, evaluate and analyze information about the achievements of science and technology in the target area and beyond;
- interpret data from different fields of science and technology;
- to build the logic of reasoning and statements;
- write a text in a scientific or scientific and technical style, use the appropriate vocabulary;
- create, design and edit text documents in accordance with the requirements of the organization or publisher;
- plan a pilot study
  - methods of planning scientific research, taking into account the peculiarities of the professional area.
  - methods of collecting and analyzing information on the achievements of science and technology in the target area and beyond.
  - proficiency in preparing publications on the topic of research
  - experience in data integration from different fields of science and technology and building evidence-based judgments.
  - methods of planning an experiment, taking into account the peculiarities of the field of professional activity.

Responsibility of the students:

- This Seminar should be carried out individually by each student based on the research project.
- A student should identify the area or topics in recent trends and developments in consultation with the guide
- A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
- A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
- Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the project diary. The project diary must be presented during each review presentation to the reviewers.

- A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
- A student should Incorporate constructive feedback to improve the quality and rigor of the research
- For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
- Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
- A student should invest time and effort in preparing for seminar presentations and the oral presentation of the seminar
- **Topic Selection**
  - Relevance: Topics must be directly related to Computer Engineering, encompassing current research trends, emerging technologies, advanced concepts, or interdisciplinary applications.
  - Scope: The topic should be sufficiently focused to allow for in-depth exploration within the seminar timeframe, yet broad enough to demonstrate a comprehensive understanding. Avoid overly narrow or excessively broad topics.
  - Novelty (Desired): While not strictly a research paper, students are encouraged to explore topics that have recent advancements, open problems, or areas where their unique insights can be presented. Avoid merely summarizing introductory textbook material.
  - Guide / Supervisor Approval: Each student must select a seminar topic in consultation with and obtain approval from an assigned faculty supervisor. The supervisor will guide the student in refining the topic and identifying relevant resources.
  - Examples of Broad Areas: Artificial Intelligence/Machine Learning, Data Science & Big Data, Cybersecurity, Cloud Computing, Internet of Things (IoT), Computer Networks, Software Engineering, High-Performance Computing, Embedded Systems, Computer Vision, Natural Language Processing, Blockchain, Quantum Computing.
- **Seminar Structure and Deliverable :** The technical seminar typically involves the following stages and deliverable
  - Topic Proposal (2-3 weeks after topic approval)
  - A concise document (1-2 pages) outlining:
    - Proposed Seminar Title
    - Brief Description/Abstract of the Topic
    - Motivation and Relevance to Computer Engineering
    - Preliminary List of Key References (at least 5-7 reputable sources)
    - Tentative Scope and Outline of the Presentation

    - Submission: To the faculty supervisor for approval.
    - Literature Review and Research (Ongoing): Sources: Students must primarily rely on peer-reviewed academic sources (IEEE Xplore, ACM Digital Library, SpringerLink, arXiv, Google Scholar), reputable conference proceedings, and established industry standards. Wikipedia and unverified blogs are generally not acceptable as primary sources.
    - Critical Analysis: Beyond mere summarization, students are expected to critically analyze the literature, identifying different approaches, their advantages/disadvantages, open issues, and potential future directions.
    - Note-Taking & Organization: Maintain systematic notes and organize research material effectively.

- **Seminar Report (Due 2-3 weeks before presentation):**
  - A written report (typically 20-25 pages, excluding references and appendices) detailing the seminar content.
  - Format: Follow a professional academic paper format (e.g., IEEE transaction style).
  - Sections:
    - Abstract: A concise summary of the seminar topic and key findings.
    - Introduction: Background, motivation, problem statement (if applicable), and outline of the report.
    - Literature Review/Background: Detailed discussion of relevant concepts, theories, and existing work.
    - Core Content: In-depth exploration of the chosen topic, presenting different methodologies, architectures, algorithms, or challenges as relevant.
    - Analysis/Discussion: Critical evaluation of the presented material, comparing different approaches, discussing implications, and identifying gaps.
    - Future Trends/Conclusion: Summarization of key takeaways, potential future directions, and concluding remarks.
    - References: A comprehensive list of all cited sources, properly formatted.
    - Appendices (Optional): Supplementary material if necessary.

- **Oral Presentation :**
  - Duration: Typically 25-30 minutes for presentation, followed by 10-15 minutes for Q&A.
  - Audience: Faculty members, peers, and potentially other interested individuals.
  - Content: The presentation should effectively convey the key aspects of the seminar topic. It should not simply be a reading of the report.
  - Visual Aids: High-quality presentation slides (e.g., PowerPoint, Google Slides, LaTeX Beamer) are mandatory. Slides should be clear, concise, visually appealing, and support the oral delivery. Avoid excessive text on slides.

- Delivery: Clear articulation, confident posture, good eye contact, and appropriate pace. Practice the presentation thoroughly.
- Q&A Session: Be prepared to answer questions from the audience on all aspects of the seminar topic. Demonstrate a strong understanding and ability to defend your perspectives.

- **Evaluation Criteria :** The technical seminar will be evaluated based on the following criteria:
  - **Topic Selection and Scope (10%):** Relevance, timeliness, and appropriate depth of the chosen topic. Clarity and focus of the topic proposal.
  - **Literature Review and Research (25%):** Breadth and depth of literature surveyed. Quality and credibility of sources used. Critical analysis and synthesis of information.
  - **Seminar Report/Paper (30%):** Clarity, organization, and logical flow of content. Technical accuracy and depth of discussion. Adherence to academic writing standards (grammar, spelling, formatting, referencing). Originality in synthesis and critical insights. Absence of plagiarism.
  - **Oral Presentation (35%):** Content: Clarity, completeness, and accuracy of the presented material. Organization: Logical flow, effective use of time. Visual Aids: Quality, clarity, and effectiveness of slides. Delivery: Confidence, clarity of speech, enthusiasm, engagement with the audience. Q&A: Ability to answer questions accurately, comprehensively, and confidently.

Learning Resources

Text Books

1. Kennett, B. (2014). Planning and managing scientific research. ANU Press. https://www.jstor.org/stabl (free access)
2. Sirotinina, N. (2012). History and methodology of computer science. Siberian Federal University. Tomsk: TPU Publishing House.
3. Moore, N. (2006). How to do research: a practical guide to designing and managing research projects. Facet publishing.

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
RPR-604-ITT - Research Project Stage - I		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 18 Hours/Week	09	**Term Work :** 25 Marks **Oral/ Presentation :** 25 Marks

Course Description:

The master's degree culminates in a research project of the student's own design. This research project is documented by a final research report or dissertation. The student's work is guided by an academic supervisor. Students are expected to choose real-world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc.

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

Course Outcomes:

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

- CO 1 : Demonstrate how to search the existing literature to gather information about a specific problem or domain.
- CO 2 : Identify the state-of-the-art technologies and research in the chosen domain, and highlight open problems that are relevant to societal or industrial needs.

- CO 3 : Evaluate various solution techniques to determine the most feasible solution within given constraints for the chosen dissertation problem.
- CO 4 : Apply software engineering principles related to requirements gathering and design to produce relevant documentation.
- CO 5 : Write a dissertation report that details the research problem, objectives, literature review, and solution architecture.

Guidelines for Research Project

1. **General Guidelines :**

   (a) The dissertation is a year-long project, conducted and evaluated in two phases. It can be carried out either in-house or within an industry as assigned by the department. The project topic and internal advisor (a faculty member from the department) are determined at the beginning of Phase I.

   (b) Student is expected to complete the following activities in Phase-I:

   i. Literature survey
   ii. Problem Definition
   iii. Motivation for study and Objectives
   iv. Preliminary design / feasibility / modular approaches
   v. Design of the research project

Phase 1: Informal conversations

Students are strongly encouraged to discuss possible research project ideas with the internal guide , fellow students, and other research professionals. All research projects begin with open-ended conversations and scoping exercises.

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 500 words. Writing an abstract for a research proposal or for completed research work is an important transferable skill.

The project title is understood to be provisional. Supervisors/guide will be assigned to students after the project title/ abstract forms have been submitted. The main responsibilities of the supervisor/guide are to assist the student with project management and to advise the student on criteria for assessment. It is a good idea to discuss a time line for your project with your supervisor/guide, and to establish a definite timetable.

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. 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.

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.
- **Citation format :** The style must be clear, explicit, and meaningful. 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.

Savitribai Phule Pune University, Pune

Maharashtra, India

M. E. – Information Technology

Semester IV

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
SEM-651-ITT - Technical Seminar - III		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 08 Hours/Week	04	**Term Work:**50 Marks **Oral/Presentation:** 50 Marks

Course Description:

The seminar aims to enhance students' research, presentation, and critical thinking skills, preparing them for advanced academic pursuits and professional careers. Technical Seminars will provide students with the opportunity and support to improve their self-study skills using modern information technologies and apply new knowledge and skills in practice, including in new areas.

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

- **Deepen Technical Knowledge:** To enable students to explore a specialized topic within Computer Engineering beyond the regular curriculum, fostering in-depth understanding.
- **Develop Research Skills:** To provide practical experience in identifying, acquiring, evaluating, and synthesizing information from various technical sources (research papers, standards, technical reports).
- **Enhance Communication Skills:** To cultivate effective oral and visual presentation skills, enabling students to articulate complex technical concepts clearly and concisely to a knowledgeable audience.
- **Foster Critical Thinking:** To encourage students to critically analyze existing research, identify challenges, propose solutions, and engage in constructive discussions.
- **Promote Independent Learning:** To encourage self-directed learning and the ability to stay updated with emerging technologies and research trends.
- **Prepare for Thesis/Dissertation:** To serve as a foundational step for the Master's thesis/dissertation, allowing students to explore potential research areas.

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

- **CO1 : Formulate** the goals and objectives of scientific research;
- **CO2 :** Search, evaluate and **analyze** information about the achievements of science and technology in the target area and beyond;
- **CO3 : Interpret** data from different fields of science and technology;
- **CO4 : Build** the logic of reasoning and statements;
- **CO5 : Create**, design and edit text documents in accordance with the requirements of the organization or publisher;

Guidelines for Seminar

- **Responsibility of the students:**
  - The Seminar should be carried out individually by each student.
  - A student should identify the area or topics in recent trends and developments in consultation with the guide.
  - A student should report to his/her respective guide regularly (at least once in a week) and report the progress of the seminar work.
  - A student should follow the timelines and deadlines and inform the supervisor in case of any difficulty/delay.
  - Students should maintain the record of all the meetings, remarks given by guide/reviewers and progress of the work in the diary. The diary must be presented during each review presentation to the reviewers.
  - A student should conduct the research ethically, adhere to the academic integrity standards, and cite sources whenever using any existing results
  - A student should incorporate constructive feedback to improve the quality and rigor of the research work towards seminar.
  - For final examination, students should complete the Seminar Report in all aspects including formatting and citation.
  - Each student should prepare the report, get it approved by his/her guide and submit the duly signed copy within the deadline.
  - A student should invest time and effort in preparing for seminar presentations and the oral presentation of the seminar.
- **Topic Selection**
  - Relevance: Topics must be directly related to Computer Engineering, encompassing current research trends, emerging technologies, advanced concepts, or interdisciplinary applications.
  - Scope: The topic should be sufficiently focused to allow for in-depth exploration within the seminar timeframe, yet broad enough to demonstrate a comprehensive understanding. Avoid overly narrow or excessively broad topics.
  - Novelty (Desired): While not strictly a research paper, students are encouraged to explore topics that have recent advancements, open problems, or areas where their unique insights can be presented. Avoid merely summarizing introductory textbook material.
  - Guide / Supervisor Approval: Each student must select a seminar topic in consultation with and obtain approval from an assigned faculty supervisor. The supervisor will guide the student in refining the topic and identifying relevant resources.
  - Examples of Broad Areas: Artificial Intelligence/Machine Learning, Data Science & Big Data, Cybersecurity, Cloud Computing, Internet of Things (IoT), Computer Networks, Software Engineering, High-Performance Computing, Embedded Systems, Computer Vision, Natural Language Processing, Blockchain, Quantum Computing.

- **Seminar Structure and Deliverable :** The technical seminar typically involves the following stages and deliverable
  - Topic Proposal (2-3 weeks after topic approval)
  - A concise document (1-2 pages) outlining:
    * Proposed Seminar Title
    * Brief Description/Abstract of the Topic
    * Motivation and Relevance to Computer Engineering
    * Preliminary List of Key References (at least 5-7 reputable sources)
    * Tentative Scope and Outline of the Presentation
    * Submission: To the faculty supervisor for approval.
    * Literature Review and Research (Ongoing): Sources: Students must primarily rely on peer-reviewed academic sources (IEEE Xplore, ACM Digital Library, SpringerLink, arXiv, Google Scholar), reputable conference proceedings, and established industry standards. Wikipedia and unverified blogs are generally not acceptable as primary sources.
    * Critical Analysis: Beyond mere summarization, students are expected to critically analyze the literature, identifying different approaches, their advantages/disadvantages, open issues, and potential future directions.
    * Note-Taking & Organization: Maintain systematic notes and organize research material effectively.

- **Seminar Report (Due 2-3 weeks before presentation):**
  - A written report (typically 20-25 pages, excluding references and appendices) detailing the seminar content.
  - Format: Follow a professional academic paper format (e.g., IEEE transaction style).
  - Sections:
    * Abstract: A concise summary of the seminar topic and key findings.
    * Introduction: Background, motivation, problem statement (if applicable), and outline of the report.
    * Literature Review/Background: Detailed discussion of relevant concepts, theories, and existing work.
    * Core Content: In-depth exploration of the chosen topic, presenting different methodologies, architectures, algorithms, or challenges as relevant.
    * Analysis/Discussion: Critical evaluation of the presented material, comparing different approaches, discussing implications, and identifying gaps.
    * Future Trends/Conclusion: Summarization of key takeaways, potential future directions, and concluding remarks.
    * References: A comprehensive list of all cited sources, properly formatted.

* Appendices (Optional): Supplementary material if necessary.

- **Oral Presentation:**
  - Duration: Typically 25-30 minutes for presentation, followed by 10-15 minutes for Q&A.
  - Audience: Faculty members, peers, and potentially other interested individuals.
  - Content: The presentation should effectively convey the key aspects of the seminar topic. It should not simply be a reading of the report.
  - Visual Aids: High-quality presentation slides (e.g., PowerPoint, Google Slides, LaTeX Beamer) are mandatory. Slides should be clear, concise, visually appealing, and support the oral delivery. Avoid excessive text on slides.
  - Delivery: Clear articulation, confident posture, good eye contact, and appropriate pace. Practice the presentation thoroughly.
  - Q&A Session: Be prepared to answer questions from the audience on all aspects of the seminar topic. Demonstrate a strong understanding and ability to defend your perspectives.
- **Evaluation Criteria :** The technical seminar will be evaluated based on the following criteria:
  - **Topic Selection and Scope (10%):** Relevance, timeliness, and appropriate depth of the chosen topic. Clarity and focus of the topic proposal.
  - **Literature Review and Research (25%):** Breadth and depth of literature surveyed. Quality and credibility of sources used. Critical analysis and synthesis of information.
  - **Seminar Report/Paper (30%):** Clarity, organization, and logical flow of content. Technical accuracy and depth of discussion. Adherence to academic writing standards (grammar, spelling, formatting, referencing). Originality in synthesis and critical insights. Absence of plagiarism.
  - **Oral Presentation (35%):** Content: Clarity, completeness, and accuracy of the presented material. Organization: Logical flow, effective use of time. Visual Aids: Quality, clarity, and effectiveness of slides. Delivery: Confidence, clarity of speech, enthusiasm, engagement with the audience. Q&A: Ability to answer questions accurately, comprehensively, and confidently.

Learning Resources

Text Books

1. "Engineering Communication" by Charles W. Knisely & Karin I. Knisely
2. "Technical Communication: Principles and Practice" by Meenakshi Raman & Sangeeta Sharma
3. "The Craft of Scientific Presentations" by Michael Alley

NPTEL Courses

1. https://nptel.ac.in/courses/109/106/109106180/
2. https://www.udemy.com/course/technical-writing/
3. https://www.edx.org/course/writing-in-the-sciences

Savitribai Phule Pune University Master of Engineering - Information Technology (2025 Pattern)		
RPR-652-ITT - Research Project Stage-II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical: 36 Hours/Week	18	**Term Work:**150 Marks **Oral/ Presentation :** 50 Marks

Prerequisite : Research Project Stage-I

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
- **Ability** to manage projects and to make constructive use of expertise associated with their project, while working as an independent learner
- **Ability** to relate their original data to existing literature, or to create an novel synthesis of existing materials
- **Identify** and **formulate** a problem of research interest in the chosen area of computing.

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

1. **CO1 : 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. **CO2 : Plan** their project in advance, using a proposal to describe their undertaking, describe how it will be managed, and reflect upon its value
3. **CO3 : Relate** their original research to existing literature on the subject and relate their work to general themes in their relevant scholarly literature
4. **CO4 : 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
5. **CO5 : Reflect** on the strengths and weaknesses of their research and methodology, understanding how they might improve their efforts in future work

Guidelines for Research Project

- **General Guidelines**
  - The student shall consolidate and complete the remaining part of the research work started in Semester III. This will consist of Selection of Technology, Installations, 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 like conference and/or peer reviewed journal.
- The student has to exhibit continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination/Head of the department. The continuous assessment of the progress needs to be documented unambiguously.
- Supervisor Interaction: Minimum one meeting per week.
- Logbook: Maintain a record of work progress and supervisor comments.
- Ethics: No plagiarism, false results, or unethical practices allowed.
- Backup: Keep source code, datasets, and reports backed up securely.
- Submission Format: Soft copy (PDF) + Hard copy as per institute norms.

- **Key Components:**
  - **Implementation**
    - Complete development/simulation/testing of the system or model.
    - Ensure correctness, efficiency, and validation of results.
  - **Results & Analysis**
    - Include experimental setup, datasets used, performance metrics.
    - Graphs, tables, and comparison with existing techniques.
    - Highlight key findings and their significance.
  - **Conclusion and Future Work**
    - Summarize outcomes, contributions, and applications.
    - Suggest extensions or improvements for future research.
  - **Paper Publication**
    - At least one paper (optional/encouraged) in peer-reviewed conference/journal.
    - Attach publication/proof as appendix (if available).
  - **Final Report Format**
    - Revised version of Stage 1 report with added implementation, results, and conclusion chapters.
    - Maintain academic writing standards and include all necessary references.
  - **Plagiarism Report**

- Final version must again be checked and should not exceed 15% similarity.

– **Evaluation Parameters**

- Completeness and quality of implementation
- Anaysis and originality of results
- Qulity of documentation and adherence to format
- Viv-voce performance and clarity of understanding
- Contribution to knowledge or innovation

Task Force for Curriculum Design and Development

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