KBTCOE

Maratha Vidya Prasarak Samaj's

Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013,

Maharashtra, India

Syllabus

Third Year B.Tech. Artificial Intelligence and Data Science

(2024 Pattern)

(As per NEP 2020)

Academic Year 2026-27

(Copy for Student Circulation Only)

25.03.2026

Program Specific Outcomes (PSOs).

PSO1: Apply core and advanced concepts of AI & Data Science to design and implement intelligent solutions for real-world challenges across various domains.

PSO2: Utilize research-based knowledge for innovation and technological advancements while exploring emerging technologies to create societal and industrial impact.

PSO3: Develop solutions with a strong ethical foundation while working effectively both individually and in teams to address global technological challenges.

Program Educational Outcomes (PEOs).

PEO1: To equip graduates with multidisciplinary knowledge and ethical AI expertise to solve real-world challenges responsibly.

PEO2: To enable graduates to apply research expertise and entrepreneurial skills for innovation and technological advancements.

PEO3: Graduates will possess industry-relevant skills and exhibit ethical behavior and societal responsibility.

Program Outcomes (POs)

PO1: **Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 to develop to the solution of complex engineering problems.

PO2: **Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development (WK1 to WK4).

PO3: **Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required (WK5).

PO4: **Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).

PO5: **Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: **The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5 and WK7).

PO7: **Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

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

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

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

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) Independent and life-long learning, ii) Adaptability to new and emerging technologies and iii) Critical thinking in the broadest context of technological change. (WK8).

Knowledge and Attitude Profile (WK)

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 is 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.

Third Year B.Tech. Artificial Intelligence and Data Science
Curriculum Structure (2024 Pattern) Semester – V

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
107501	**PCC-8**	Data Science and Visualization	3	2	-	40	60	25	25	**150**	3	1	-	**4**
107502	**PCC-9**	Machine Learning	2	2	-	40	60	25	25	**150**	2	1	-	**3**
107503	**PCC-10**	Automata Theory	3	-	-	40	60	-	-	**100**	3	-	-	**3**
107504	**PEC-1**	Program Elective Course-1	3	2	-	40	60	25	-	**125**	3	1	-	**4**
170505	**MDM-3**	Multi-Disciplinary Minor-3	3	2	-	40	60	25	-	**125**	3	1	-	**4**
107506	**VSEC-4**	Full Stack Development	-	4	-	-	-	50	50	**100**	-	2	-	**2**
Total			**14**	**12**	**0**	**200**	**300**	**150**	**100**	**750**	**14**	**6**	**0**	**20**

Course Code	PEC Course – 1
107504A	Software Engineering
107504B	UI/UX Design
107504C	Design and Analysis of Algorithms

Note: MDM-3 Courses are Listed on Page 6.

Third Year B.Tech. Artificial Intelligence and Data Science
Curriculum Structure (2024 Pattern) Semester – VI

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks					Credits			
			TH	PR	TU	CCE	ESE	TW	PR + OR	TOT	TH	PR	TU	TOT
107601	PCC-11	Computer Networks	3	2	-	40	60	25	25	150	3	1	-	4
107602	PCC-12	Artificial Neural Networks	3	2	-	40	60	25	25	150	3	1	-	4
107603	PEC-2	Program Elective Course-2	3	2	-	40	60	25	25	150	3	1	-	4
107604	PEC-3	Program Elective Course-3	3	2	-	40	60	25	25	150	3	1	-	4
170605	MDM-4	Multi-Disciplinary Minor-4	3	-	1	40	60	50	-	150	3	-	1	4
Total			**15**	**8**	**1**	**200**	**300**	**150**	**100**	**750**	**15**	**4**	**1**	**20**

Course Code	PEC Course – 2	Course Code	PEC Course – 3
107603A	Parallel and Distributed Computing	107604A	Big Data Analytics
107603B	Quantum Computing	107604B	Cloud Computing
107603C	Business Intelligence	107604C	Optimization Algorithms

Note: MDM-4 Courses are Listed on Page 6.

Third Year B.Tech. Multi-Disciplinary Course – 3 and 4
List of Courses (2024 Pattern) Semester – V and VI

S #	Offered by Department	Streams (Choose One Stream Only)	Semester-V		Semester-VI		Semester-VIII		Eligible Student
			MDM – 3 Code	MDM – 3 Courses	MDM – 4 Code	MDM – 4 Courses	MDM – 5 Code	MDM – 5 Courses	
1.	Mechanical Engineering	Automobile Engineering	**170505A**	Systems in Mechanical Engineering	**170605A**	Automotive Technology	**170805A**	Automotive Control System	All, except Mech. Engg. Dept
2.	Computer Engineering	Software Development	**170505B**	Data Structures and Algorithms	**170605B**	Database Systems	**170805B**	Software System Design	All, except Computer Engg., Information Tech. and AI&DS Dept.
3.	Instru. & Control Engg.	Measurement and Control	**170505C**	Engineering Measurements	**170605C**	Industrial Control Components	**170805C**	Industrial Control Applications	All, except Instru. Control Engg. Dept.
4.	Electronics & Tele. Engg.	Internet of Things	**170505D**	Sensors and Actuators	**170605D**	Embedded System in IoT	**170805D**	Applications of IoT	All, except E&TC Department
5.	Civil Engineering	Infrastructure Planning	**170505E**	Infrastructure and Planning	**170605E**	Governing Policies	**170805E**	Transportation Systems	All, except Civil Engg. Department
6.	Information Technology	Web Technology	**170505F**	Web Development	**170605F**	Application Development	**170805F**	Digital Governance	All, except Info. Tech., Computer and AI&DS Dept.
7.	AI&DS	Data Analytics	**170505G**	Applied Data Science	**170605G**	Data Visualization	**170805G**	Business Analytics	All, except AI&DS, Computer and Information Tech. Dept.
8.	Electrical Engineering	Electrical Machines & Drives	**170505H**	Electrical Machines	**170605H**	Drives and Controls	**170805H**	Industrial Applications	All, except Electrical Engg. Dept

- **Summary of Credits and Total Marks:**

Semester	Credits	Marks
V	20	750
VI	20	750
Total	**40**	**1500**

• Definition of Credit :

The Under Graduate (U.G.) programmes will have credit system. The details of credit will be as follow. 1 Credit = 1 hour/week for lecture = 2 hours/week for practical = 1 hour/week for tutorial

- **Description of Various Courses:**

Type of Course	Description
PCC	Programme Core Course
PEC	Programme Elective Course
MDM	Multidisciplinary Minor Course
VSEC	Vocational and Skill Enhancement Course (Skill Courses)

Semester – V

Course Code: 107501	Course Name: Data Science and Visualization	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Prerequisite Courses:

- Programming and Problem Solving, Data Structures.

Course Objectives:

- To introduce the fundamental concepts of Data Science and Data Analytics.
- To understand data transformation, normalization, and integration methods.
- To introduce statistical concepts and analytical techniques including probability, hypothesis testing, and regression analysis.
- To provide knowledge of visualization principles and develop skills in creating visualizations using Python libraries.
- To introduce geospatial technologies and spatial data standards.

Course Outcomes:

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

CO1: Explain the concept and evolution of data science and analytics.

CO2: Apply data cleaning and missing value handling techniques.

CO3: Apply statistical methods and perform basic regression analysis for data interpretation.

CO4: Design and generate appropriate visualizations using Python libraries.

CO5: Explain geospatial data concepts and spatial data standards.

Course Contents:

Unit-I: Introduction to Data Science **08 Hours**

Introduction to Data Science and Data Analytics, Evolution of Data Science, Roles and Stages in a Data Science project, Data Science Life Cycle, Types of Data (Structured, Semi-structured, Unstructured), Feature extraction, selection algorithms, and filtering techniques, Data Collection and Data Sources, Role of Data Scientist, Introduction to Python w.r.t. Data Science.

Case Study: Application of Data Science in E-Commerce Systems.

Unit-II: Data Preprocessing and Data Wrangling **08 Hours**

Data Objects, Attribute Types, and Metadata, Data Cleaning Techniques, Handling Missing

Values, Data Transformation and Normalization, Data Integration and Data Reduction, Statistical Summary of Data, Data Wrangling, Transformation (Scaling/Normalization), and Discretization.

Case Study: Improving Data Quality in Hospital Patient Records.

Unit-III: Exploratory Data Analysis and Model Selection 08 Hours

Exploratory Data Analysis (EDA), Measures of Central Tendency and Dispersion: Mean, Median, Mode, Range, Variance, Standard Deviation. Correlation and Covariance, Introduction to Probability: Conditional Probability and Bayes' Theorem, Hypothesis Testing: ANOVA, and Wilcoxon rank-sum test, Rigorous Model Selection: Validation methods including Hold-out, k-Fold, and LOOCV (Leave-One-Out Cross-Validation), Regression Analysis (Linear Regression basics).

Case Study: Predicting House Prices Using Data Analysis.

Unit-IV: Data Visualization Techniques and R Programming 08 Hours

Introduction to Data Visualization, Principles of Effective Visualization, Challenges of data visualization and principles of perception for design, Types of Data Visualization Techniques, Comparative Visualization, Multivariate Visualization, Visualization tools: Advanced plotting using Python libraries, Introduction to R-programming.

Case Study: Visualizing Health Data for Decision Making.

Unit-V: Advanced Applications of Data Visualization 08 Hours

Introduction to Geospatial Technologies and spatial data standards, Data Acquisition: Acquisition from Aerial images, Satellite images, and LiDAR, Principles of Map Design: Qualitative, quantitative, and terrain elevation mapping, Geo-visualization, Dashboard Creation, Storytelling using Data Visualization tools for Business Intelligence, Ethical Issues in Data Visualization.

Case Study: Geospatial Visualization for Urban Traffic Management.

Learning Resources:

Text Books:

1. Data Science from Scratch by Joel Grus, O'Reilly Media, 2nd Edition, 2019.
2. Python Data Science Handbook by Jake VanderPlas, O'Reilly Media, 2016.

Reference Books:

1. Python for Data Analysis: Data Wrangling with Pandas, NumPy, and Jupyter Wes McKinney 3rd Edition, O'Reilly Media, 2022.
2. Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code Jack Dougherty and Ilya Ilyankou 1st Edition, O'Reilly Media, 2021.

Web link for MOOC / NPTEL Links:

1. Python for Data Science.
   https://onlinecourses.nptel.ac.in/noc20_cs36/preview
2. Data Science for Engineers.
   https://onlinecourses-archive.nptel.ac.in/noc19_cs13/course

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107502	Course Name: Machine Learning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 2 Hours/Week **Practical :** 2 Hours/Week	**2** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Basics of Statistics and Probability.

Course Objectives:

- To understand the basic concepts of machine learning and apply them for the various problems.
- To learn various machine learning types and use it for the various machine learning tasks.
- To optimize the machine learning model and generalize it.
- To understand the need for multi-class classifiers.
- To learn the working of clustering algorithms.
- To learn fundamental neural network algorithms.

Course Outcomes:

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

CO1: Identify the needs and challenges of machine learning for real time applications.

CO2: Apply regression and classification techniques to solve machine learning problems.

CO3: Use appropriate supervised machine learning algorithms for different applications.

CO4: Compare and contrast different clustering algorithms.

CO5: Analyze the performance and architecture of neural networks for solving engineering problems.

Course Contents:

Unit-I: Foundation of Machine Learning **06 Hours**

Introduction to Machine Learning: Concepts, real-world applications, Architecture of ML. Data Types: Numerical, Categorical, Feature Selection, Data Pre-processing Techniques, and Dataset Preparation, Types of Learning: Supervised, Unsupervised and Reinforcement learning.

Case Study: Personalised Retail Strategy for E-Commerce.

Unit-II: Supervised Learning – Classification and Regression 06 Hours

Regression: Regression and its type, Cost Functions: MSE, MAE, R^2, over-fitting and under-fitting, Bias-Variance Trade-off, Gradient Descent Algorithm.

Classification: Binary and Multiclass Classification, Logistic Regression and Support Vector Machines. Evaluation Measures.

Case Study: Predictive Modeling for House Prices and Disease Diagnosis.

Unit-III: Non-Linear Machine Learning Classifiers 06 Hours

Non-Linear Models: Decision Trees, Probabilistic Models: Bayes Theorem, Naïve Bayes Classifier, K-Nearest Neighbor, Ensemble Learning.

Case Study: Spam Filtering and Document Classification.

Unit-IV: Unsupervised Learning 06 Hours

Types of Clustering: Hierarchical, Agglomerative clustering and Divisive clustering, Partition Clustering- K-means clustering, Elbow Method, Outliers, Associative rule Learning.

Case Study: Customer Segmentation and Market Basket Analysis.

Unit-V: Introduction to Neural Networks 06 Hours

Neural Network Fundamentals: Biological vs Artificial Neuron, McCulloch–Pitts Model, Perceptron Learning Rule, Multi-Layer Perceptron, Activation Functions, Loss functions and back propagation.

Case Study: Image Feature Extraction and Classification using Multi-Layer Perceptron and Back propagation.

Learning Resources:

Text Books:

1. Saikut Dutt, Subramanian Chandramouli and Amit Kumar das, Machine Learning (Pearson).
2. Nikhil Buduma, Fundamentals of Deep Learning: A Classroom Approach (OReilly).

Reference Books:

1. Ian H. Witten , Data Mining: Practical Machine Learning Tools and Techniques (Morgan Kaufmann Series in Data Management Systems).

Web link for MOOC / NPTEL Links:

1. Introduction to Machine Learning – Prof. P. K. Bora, IIT Guwahati. https://nptel.ac.in/courses/106/106/106106139
2. Machine Learning – Prof. Balaraman Ravindran, IIT Madras. https://nptel.ac.in/courses/106/106/106106202

3. Applied Machine Learning – IIT Madras.
   https://nptel.ac.in/courses/106106213
4. Neural Networks and Deep Learning – DeepLearning.AI.
   https://www.coursera.org/specializations/deep-learning

Suggested Activity-based Class Learning:

1. Flipped Classroom.
2. OSI Layer Role Play.
3. Simulation of routing protocol.
4. Poster Presentation.
5. Quizzes/Assignment.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107503	Course Name: Automata Theory	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week	**3**	**CCE : 40 Marks** **ESE : 60 Marks**

Expected Prerequisite Courses:

- Discrete Mathematics.

Course Objectives:

- Introduce the mathematical foundations of automata theory.
- Study different computational models like finite automata, regular expressions, context-free grammar, push-down automata, and Turing machines.
- Identify and design appropriate automata according to the type of language.
- Correlate different computational models to real-world applications.

Course Outcomes:

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

CO1: Construct finite automata and its variants to represent regular languages.

CO2: Apply regular expressions to represent regular languages.

CO3: Simplify context free grammars for regular and context free languages.

CO4: Examine the functionality of pushdown automata for recognizing context free languages.

CO5: Analyze the working of Turing Machines to solve computational problems for different requirements.

Course Contents:

Unit-I: Finite Automata **08 Hours**

Understanding formal language, the essentials of translation, and language representation.

Finite Automata (FA): Introduction, Acceptance of a string and a language, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), Equivalence of NFA and DFA, NFA with epsilon transition and its significance, Minimization of DFA.

FA with Output: Moore Machine, Mealy Machine, Equivalence of Moore and Mealy Machines, and Interconversion.

Case Study: Traffic Light Control System, Vending Machine Controller.

Unit-II: Regular Expressions **08 Hours**

Introduction, Operators of Regular Expressions (RE), Precedence of operators, Algebraic laws

for RE, Language to Regular Expressions, Equivalence of two REs.

Equivalence of RE and FA: RE to NFA with epsilon moves conversion, DFA to RE Conversion using Arden's Theorem, Pumping Lemma for Regular Languages and its applications, Applications of RE and FA.

Case Study: Validation of user email formats using regular expressions.

Unit-III: Context Free Grammars 08 Hours

Context Free Grammars (CFG): Introduction, Derivation Process and Tree, Writing grammar for languages, Context Free Languages (CFL), Ambiguous CFG, Removal of ambiguity, Simplification of CFG, Normal Forms: Chomsky Normal Form and Greibach Normal Form; Chomsky Hierarchy.

Case Study: Modeling of if-else, while, and block structures in any programming language; XML and Document Type Definitions.

Unit-IV: Pushdown Automata 08 Hours

Introduction, FA vs Pushdown Automata (PDA), PDA accepting CFLs, Instantaneous Description, Acceptance of CFL by Empty Stack and Final State, Deterministic PDA vs Nondeterministic PDA, Equivalence of CFG and PDA, Closure Properties of CFLs, Application of PDA for parsing, Comparison between FA and PDA.

Case study: Pattern recognition, Post machine.

Unit-V: Turing Machines 08 Hours

Introduction, Instantaneous Description, Techniques for Turing Machines (TM) Construction, Design of TM, Complexity of TM, Universal TM, TM Variants; Concepts of Halting Problem, Church-Turing Hypothesis, Recursively Enumerable Languages, Linear Bounded Automata.

Case Study: Compiler design tools: Lex and Yacc.

Learning Resources:

Text Books:

1. Vivek Kulkarni "Theory of Computation", Oxford University Press, 2013, ISBN-13 978-0198084587.
2. John Martin, "Introduction to Languages and The Theory of Computation", 2nd Edition, McGraw-Hill Education, 4th edition, 2010, ISBN-13: 978-0073191461.

Reference Books:

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, "Introduction to Automata Theory Languages and Computation", Pearson, 3rd Edition, 2008, ISBN-13: 978-8131720479.

Web link for MOOC / NPTEL Links:

1. Theory of Computation, By Prof. Raghunath Tewari, IIT Kanpur.

https://onlinecourses.nptel.ac.in/noc21_cs83/preview

Suggested Activity-based Class Learning:

1. Flipped Classroom.
2. Gamification.
3. Simulation Tools.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignments.
6. Vlab.

Course Code: 107504A	Course Name: Software Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Fundamentals of Programming, Operating Systems, Data Structures, Database Management System.

Course Objectives:

- To introduce systematic software development approaches
- To develop an understanding of project management principles and systematic requirements analysis.
- To introduce architectural principles and styles for designing robust software systems.
- To enable the modeling of software systems using standard UML diagrams.
- To introduce software testing techniques and quality assurance practices.
- To develop practical skills through real-world case studies.

Course Outcomes:

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

CO1: Explain software engineering principles and process models.

CO2: Apply requirement engineering techniques to manage functional and non-functional requirements.

CO3: Use suitable software architecture for software development.

CO4: Develop UML models to represent system structure and behavior.

CO5: Analyze test cases using appropriate testing techniques.

Course Contents:

Unit-I: Introduction to Software Engineering 08 Hours

Software Engineering: Definition, Characteristics, Software Crisis and Evolution, Software Engineering Ethics, Software Process Framework, SDLC, Process Models, Comparison and Selection of Process Models. Agile Manifesto and Principles, Overview of Scrum and Kanban (Jira Tool), Agile vs. Traditional Models, Introduction to DevOps culture, Emerging Trends in Software Engineering.

Case Study: Case studies of software failures and successes.

Unit-II: Requirements Engineering 08 Hours

Requirement Engineering: Types of Requirements (Functional, Non-Functional), Process, Requirement Validation and Management. User Stories and Acceptance Criteria, Requirement Traceability Matrix. Software Requirement Specification, Model-based requirement engineering, Software configuration management.

Software project management fundamentals, Project feasibility analysis, Project planning and scheduling, Software cost estimation techniques: LOC and Function Point (FP), COCOMO, Risk management: identification, analysis, mitigation.

Case Study: Denver Airport Baggage System and Hospital Management System.

Unit-III: Software Architecture 08 Hours

Introduction to Software Architecture, Architectural design principles and patterns, Design patterns vs Architecture patterns, **Modern software Engineering techniques and architectures:** Layered, Client-Server, Micro services, MVC, Cloud-native architecture, Server less architecture, API-First Design, Test Driven Development (TDD), Behaviour Driven development (BDD), Domain Driven Development, Infrastructure as a Code (IaC), CI/CD Development, Introduction to Figma Tool.

Case study: Netflix Micro services and Online Food Delivery System.

Unit-IV: Software Modelling and Modern Software Development 08 Hours

UML: Introduction to UML and its importance, Structural diagrams and Behavioural diagrams UML tools and notations, Role of UML in Agile projects, Mapping UML models to code.

Modern Software Development Techniques: AI Integration, Cloud Platforms, Frontend Technologies, Backend Technologies, Databases, Observability and Monitoring, Cybersecurity Technologies.

Case study: Online Shopping System and Online Banking System.

Unit-V: Software Testing 08 Hours

Fundamentals of software testing, Verification and Validation, Levels of testing: Unit, Integration, System, Acceptance, Testing techniques: Black box and White box testing, Test case design and test data preparation, Introduction to automated testing tools.

Modern Testing architectures: Test Automation Pyramid (Modernized), API-First Testing Architecture, Cloud-Native Test Infrastructure, Micro services-Aware Test Architecture, Event-Driven and Asynchronous Systems Testing, Test Data Management Architecture, Continuous Testing in CI/CD Architecture, Software Quality Concepts, Software Quality Assurance (SQA).

Case study: Ariane 5 Rocket Failure.

Learning Resources:

Text Books:

1. R. S. Pressman and B. R. Maxim, Software Engineering: A Practitioner's Approach, 9th ed. New York, NY, USA: McGraw-Hill Education, 2023.
2. P. Jalote, A Concise Introduction to Software Engineering: With Open Source and GenAI, 2nd ed. Cham, Switzerland: Springer Nature, 2025.
3. I. Sommerville, Software Engineering, 10th ed. Harlow, UK: Pearson Education, 2017. Pankaj Jalote, An Integrated Approach to Software Engineering, Springer.

Reference Books:

1. H. Washizaki, ed., Guide to the Software Engineering Body of Knowledge (SWEBOK Guide), Version 4.0. IEEE Computer Society, 2024.
2. C. Ghezzi, M. Jazayeri, and D. Mandrioli, Fundamentals of Software Engineering, 2nd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2003. (Classic reference)
3. A. S. Tamhane and S. A. Nirmal, Software Testing: Principles and Practices, 2nd ed. Oxford, UK: Oxford University Press, 2021.
4. F. Brooks, The Mythical Man-Month: Essays on Software Engineering, Anniversary ed. Boston, MA, USA: Addison-Wesley, 1995.

Web link for MOOC / NPTEL Links:

1. Software Engineering By Prof. Rajib Mall, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc25_cs108/preview
2. Software Engineering, Interactive Learning Portal
   https://www.nptelprep.in/courses/106105182

Suggested Activity-based Class Learning:

1. Online Examination System.
2. Library Management System.
3. Hostel Management System.
4. E-Commerce Website.
5. Smart Attendance System.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.

5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107504B	Course Name: UI/UX Design	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Problem Solving, Logical Thinking and Object-Oriented Technologies.

Course Objectives:

- To introduce fundamentals of User Interface (UI) and User Experience (UX) design.
- To teach students industry-standard design principles, workflows, and tools.
- To enable students to design interactive prototypes using modern tools.
- To develop skills in user research, usability testing, wireframing and visual design.
- To prepare students to apply UI/UX in real engineering and industrial applications.

Course Outcomes:

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

CO1: Explain key UI/UX concepts, human-centered design principles, and design thinking.

CO2: Conduct user research, create personas, and identify user needs.

CO3: Create wireframes, user flows, and information architecture for applications.

CO4: Create visual design and apply heuristic evaluation and conduct usability testing.

CO5: Design industry-ready interfaces for web, mobile, and IoT systems.

Course Contents:

Unit-I: Introduction to UI/UX 08 Hours

Disciplines involved in UI and UX, Why UI and UX study is important, Role of microcopy Importance of Human–Computer Interaction, Principles of UI/UX, User-centered Design, Measurable Human factors, Difference between UI and UX, Design Thinking process and Industrial relevance of UI/UX, Good vs. bad UX writing examples.

Case Study: ATM interface design.

Unit-II: User Research, Understanding the Human and Human Interaction 08 Hours

User research methods: Interviews, surveys, observation, contextual inquiry, Empathy maps, Persona creation, and user journey maps. Task analysis and scenario mapping, Input-output channels, Qualitative and Quantitative Research Methods, Human memory, Human emotions, Individual differences, Psychology. Ergonomics, Human errors, Models of interaction,

Paradigms of Interactions, Interaction styles.

Case Study: Social Media Application Interface Design.

Unit-III: Interaction Design, Wireframing and Prototyping 08 Hours

Sitemap Creation, Hierarchy, navigation models, Interaction design principles, User flows and task flows, Information Architecture, Cognitive load, mental models, Accessibility standards (WCAG, ADA), Low-fidelity vs high-fidelity wireframes, Sketching techniques, Use of Figma / Adobe XD / Sketch/Miro/Wireframe/Canva, Designing interactive prototypes and Components, grids, constraints, auto layout, Handoff and Collaboration.

Case Study: Online Learning Management System (LMS).

Unit-IV: Visual Design, Usability and Testing 08 Hours

Typography, Color theory, Iconography, Layout systems, UI patterns and components, Design systems and style guides, Material Design and Human Interface Guidelines, Nielsen's Heuristics, Usability metrics (SUS Score, task completion, error rates), A/B testing, Heatmaps and Eye-tracking basics, Portfolio Building.

Case Study: Travel Booking Website.

Unit-V: Industry Applications of UI/UX 08 Hours

Automotive infotainment, Mobile apps, Web applications, IoT dashboards, AR/VR interfaces and Healthcare and fintech applications.

Case studies: Google, Apple, Amazon and Tesla.

Learning Resources:

Text Books:

1. About Face: The Essentials of Interaction Design About Face: The Essentials of Interaction Design, Alan Cooper; Robert Reimann; David Cronin; Christopher Noessel, ISBN-13: 978-1-118-76658-3, Publisher: John Wiley and Sons.
2. The Psychology of Everyday Things, Don Norman (Donald A. Norman), ISBN-13: 978-0-465-05065-9, Publisher: Basic Books.
3. Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Guidelines, Jeff Johnson, ISBN: 978-0-12-818202-4, Publisher: Morgan Kaufmann.

Reference Books:

1. The UX Book: Process and Guidelines for Ensuring a Quality User Experience, Rex Hartson and Pardha S. Pyla, ISBN: 978-0-12-385241-0, Publisher : Morgan Kaufmann.
2. Don't Make Me Think: A Common Sense Approach to Web Usability, Steve Krug, ISBN: 0-7897-2310-7, Publisher: New Riders Publishing.

3. Visualizing Data: Exploring and Explaining Data with the Processing Environment, Ben Fry, ISBN-13: 978-0-596-51455-6, Publisher: O'Reilly Media.
4. Sketching User Experiences: Getting the Design Right and the Right Design, Bill Buxton, ISBN-13: 978-0-12-374037-3, Publisher: Morgan Kaufmann.

Web link for MOOC / NPTEL Links:

1. Design and Implementation of Human-Computer Interfaces by Prof. Samit Bhattacharya, IIT Guwahati.
   https://onlinecourses.nptel.ac.in/noc25_cs135/preview
2. User Interface Design by Prof. Saptarshi Kolay | IIT Roorkee.
   https://onlinecourses.nptel.ac.in/noc21_ar05/preview
3. UI/UX Design with Figma : SWAYAM Plus
4. Introduction to Interaction Design by Prof. Sonal Atreya | IIT Roorkee.
   https://onlinecourses.nptel.ac.in/noc24_ar23/preview

e-books:

1. UXPin Free E-Books.
2. UI, UX and Interaction Design Library (GitHub).
3. Free UX Tools and Strategy eBooks (Designflowww).
4. Free UX E-Books Worth Reading by WebFX.
5. Free UX Books for Designers (Lapa.Ninja).

Suggested Activity-Based Class Learning:

1. Paper Prototyping.
2. Card Sorting Activity.
3. Online Interactive Tool.
4. Quizzes/Assignment.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107504C	Course Name: Design and Analysis of Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Discrete Mathematics, Data Structures, Automata Theory.

Course Objectives:

- To enhance problem-solving skills through the application of mathematical theories.
- To evaluate and analyze the efficiency and performance of algorithms.
- To understand and study different algorithm design strategies.

Course Outcomes:

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

CO1: Analyse time and space complexity of various algorithms.

CO2: Analyze asymptotic performance of algorithms.

CO3: Decide between Divide and Conquer and Greedy strategies.

CO4: Apply Dynamic programming to solve problems.

CO5: Choose suitable algorithmic strategy for problem solving.

Course Contents:

Unit-I: Algorithmic Analysis **08 Hours**

Algorithm: The Role of Algorithms in Computing, Asymptotic notations (Big Oh, small oh, Big Omega, Theta notations). Best case, average case, and worst-case time and space complexity of algorithms, classification of time complexities (linear, logarithmic etc)-Growth of function, Overview of searching, sorting algorithms, Recurrences: Formulation and solving recurrence equations using Master Theorem

Case Study: Finding products using an E-commerce website.

Unit-II: Complexity Theory **08 Hours**

Introduction: P, NP, NP Hard, NP Complete, polynomial and non-polynomial problems, deterministic and non-deterministic algorithms, P-class problems, NP-class of problems, Polynomial problem reduction, NP complete problems- vertex cover and 3-SAT and NP hard problem - Hamiltonian cycle

Case Study: A Sudoku puzzle solving, Camera placement for security purposes.

Unit-III: Divide and Conquer and Greedy Strategies 08 Hours

Introduction to algorithmic strategies. **Divide and Conquer strategy**: Principle, control abstraction, time analysis of control abstraction, Binary search, Quick sort, Integer Arithmetic-Multiplication.

Greedy strategy: Principle, control abstraction, time analysis of control abstraction, knapsack problem, scheduling algorithms-Job scheduling and activity selection problem.

Case Study: Sorting employee salary records using Dynamic Programming, Scheduling of maximum events by event manager in a hall using greedy Strategy.

Unit-IV: Dynamic Programming 08 Hours

Dynamic Programming: Principle, control abstraction, time analysis of control abstraction, computing Fibonacci series, binomial coefficients, OBST, 0/1 knapsack, All pair shortest path algorithm, sum of subset.

Case Study: Population growth generation by applying fibonacci series.

Unit-V: Algorithmic Strategy and Concepts 08 Hours

Backtracking Strategy: Principle, control abstraction, 8-queen problem, graph coloring problem, knapsack problem.

Branch and Bound Strategy: Principle, control abstraction, strategies – FIFO, LIFO and LC approaches, knapsack problem (FIFO, LIFO, LC), TSP using Branch and Bound.

Concept and Use Case: Approximation algorithms, Randomization algorithms, Parallel algorithms, Distributed algorithms.

Case Study: Maximizing profit within a limited budget for a business using branch and bound, Weather forecast prediction using Parallel algorithms.

Learning Resources:

Text Books:

1. Horowitz and Sahani, "Fundamentals of Computer Algorithms", University Press, ISBN: 978817371-6126, 81-7371-61262.
2. Parag Himanshu Dave, Himanshu Bhalchandra Dave, Design and Analysis of Algorithms, Pearson Education, ISBN 81-7758-595-9.

Reference Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, " Introduction to Algorithms", MIT Press; ISBN 978-0-262-03384-8.
2. Gilles Brassard, Paul Bratley, "Fundamentals of Algorithmics", PHI, ISBN 978-81-203-1131-2.

3. Sipser, Michael. "Introduction to the Theory of Computation." *ACM Sigact News* 27.1 (1996): 27-29.

Web link for MOOC / NPTEL Links:

1. Design & Analysis of Algorithms by Madhavan Mukund, Chennai Mathematical Institute
   https://onlinecourses-archive.nptel.ac.in/noc18_cs20/preview

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 170505A	Course Name: Systems in Mechanical Engineering	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry.

Course Objectives:

- To identify the sources of energy and their conversions.
- To explain the basic concept of engineering thermodynamics and its application.
- To introduce proper manufacturing process applicable to produce components.
- To understand the basic concepts of mechanical engineering.

Course Outcomes:

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

CO1: Apply knowledge of thermodynamics concepts.

CO2: Explain basic laws of thermodynamics, heat transfer and their applications.

CO3: Select different materials for different applications.

CO4: Explain the basics of engineering components.

CO5: Describe and get exposure to the latest trends in manufacturing processes.

Course Contents:

Unit-I: Thermodynamic Concepts **08 Hours**

Introduction to thermodynamics, introduction to various thermodynamic properties, heat and work, thermodynamic laws. Power plant engineering and sources of energy : conventional thermal, nuclear, hydraulic power plant. Nonconventional- wind, solar, tidal, geothermal.

Unit-II: Heat Transfer **08 Hours**

Modes of heat transfer: conduction, convection and radiation. Fourier's law, Newton's law of cooling and Stefan-Boltzmann's law. Domestic appliances, viz., refrigerator, air-conditioner.

Unit-III: Material Science **08 Hours**

Classification of materials, their properties and applications, phase change material (PCM), composite material.

Unit-IV: Introduction to Transmission Devices **08 Hours**

Study of shafts, belt drive, chain drive, gear and gear trains and clutches.

Unit-V: Manufacturing Processes **08 Hours**

Metal casting, forging, sheet metal working, machining and machine tools, and metal joining processes.

Learning Resources:

Text Books:

1. Nag, P. K., “Engineering Thermodynamics" Tata McGraw-Hill Publisher Co. Ltd.
2. Chaudhari and Hajra, “Elements of Workshop Technology”, Volume I and II, Media Promoters and Publishers, Mumbai.
3. Rajput, R.K., “Basic Mechanical Engineering”, Laxmi Publications Pvt. Ltd.
4. Raghavan V.,“Materials Science And Engineering: A First Course”,Hall of India.

Reference Books:

1. Khan, B. H., “Non-Conventional Energy Sources, Tata McGraw-Hill Publisher Co Ltd.
2. Khurmi, R.S, and Gupta, J. K., “A Textbook of Thermal Engineering”, S. Chand & Sons.
3. Incropera, F. P.and Dewitt, D.P., “Fundamentals of Heat and Mass Transfer, John Wileyand Sons, USA.
4. Juvinal, R. C., Fundamentals of Machine Component Design, John Wiley & Sons, USA.
5. Kripal Sing, “Automobile Engineering”, Vol.1 and Vol.2.

Web link for MOOC / NPTEL Links:

1. Energy resources. https://www.youtube.com/watch?v=Zgp86PVXXuQ
2. Thermodynamic Concepts. https://nptel.ac.in/courses/112103275
3. https://www.youtube.com/playlist?list=PLbRMhDVUMngeVrxtbBzn8HvP8KAWBpI5

List of Practicals: (Any 5)

1. Study of non-conventional or renewable sources of energy.
2. Study of laws of thermodynamics.
3. Study of laws of heat transfer.
4. Study of domestic appliances like the refrigerator and the air conditioner.
5. Study of materials used for different applications.
6. Study of power transmission devices.
7. Study of manufacturing processes.

Course Code: 170505B	Course Name: Data Structures and Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Fundamentals of Programming, Programming and Problem Solving.

Course Objectives:

- To learn the fundamentals of data structures.
- To understand how data can be logically organized using data structures.
- To illustrate the types of data structures and their use in engineering.
- To choose suitable data structures for real engineering problems.
- To learn system efficiency, such as time and memory usage, without mathematics or programming.

Course Outcomes:

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

CO1: Understand basic concepts of data structures.

CO2: Apply the concepts of stacks and queues.

CO3: Implement appropriate non-linear data structures.

CO4: Demonstrate searching and sorting techniques in engineering data handling.

CO5: Illustrate real-world engineering case studies using data structures.

Course Contents:

Unit-I: Introduction to Data Structures **08 Hours**

Need for data organization, Overview of Data structures: Types of data structures, **Abstract Data Types (ADT):** Concept and significance, **Arrays:** Characteristics and representation, types of arrays: 1D and 2D, Use in storing engineering measurements and parameters.

Case Study: Engineering Data Management in a Weather Monitoring System.

Unit-II: Linear Data Structures **08 Hours**

Introduction to linear data structures, **Stack**: Concept, operations, and behavior (LIFO), Applications: undo operations and automation systems. **Queue**: Concept, operations, and behavior (FIFO), Applications: scheduling, buffering, and resource management, Conceptual comparison between stack and queue, **Linked Lists:** Introduction, need, types and applications.

Case Study: Smart Office Management System.

Unit-III: Non-Linear Data Structures 08 Hours

Need for non-linear data representation, Trees: Terminology: root, node, parent, child, and level, Types of trees: Binary tree, Binary search tree, Tree traversal, Applications of Non-linear Data Structures, Graphs: Basic concepts, Concept of directed and undirected graphs, graph representation. Case Study: College Campus Management System.

Unit-IV: Searching and Sorting 08 Hours

Importance of searching and sorting, **Searching techniques:** Concept of linear and binary search, Use cases in engineering, **Sorting techniques:** Concept of ordering and prioritization, Examples such as sorting by size, cost and priority using bubble sort, selection sort, merge sort, Time and Space Complexity Concepts. **Case Study:** Engineering Inventory and Component Management System.

Unit-V: Engineering Case Studies 08 Hours

Data structures used in real time applications, Identification of case studies from Mechanical / Civil / Electrical systems etc., Selection of appropriate data structures for given engineering problems, and discussion on the benefits of proper data structuring.

Learning Resources:

Text Books:

1. Y. Kanetkar and A. Kanetkar, Let Us C++, New Delhi, India: BPB Publications.
2. E. Horowitz and S. Sahni, Fundamentals of Data Structures in C++, New York, NY, USA: W. H. Freeman, ISBN: 978-0716782926.

Reference Books:

1. M. A. Weiss, Data Structures and Algorithm Analysis in C++, 2nd ed., New Delhi, India: Pearson Education, ISBN: 81-7808-670-0.

Web link for MOOC / NPTEL Links:

1. Data Structures And Algorithms By Prof. Naveen Garg, IIT Delhi. https://nptel.ac.in/courses/106102064

List of Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications, and current trends related to the subject.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment or mini-project that goes beyond the syllabus but aligns with the course.

List of Suggested Assignments:

1. Implementation of an array.
2. Implementation of stack.
3. Implementation of queue.
4. Implementation of trees.
5. Implementation of graphs.
6. Implementation of searching techniques.
7. Implementation of sorting techniques.
8. Mini project.

List of Suggested Activity-based Learning:

1. Flipped Classroom.
2. Gamification.
3. Online Interactive Tool.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignments.
6. VLab.

Course Code: 170505C	Course Name: Engineering Measurements	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Engineering Physics, Engineering Chemistry, Basic Electronics and Electrical Engineering.

Course Objectives:

- To explain the static/dynamic characteristics of measurement systems and the working principles of displacement, speed, vibration, and force/torque transducers.
- To impart knowledge on industrial pressure and vacuum measurement techniques along with standard calibration methods.
- To explain the construction, signal compensation, and operational characteristics of contact and non-contact temperature sensors.
- To introduce the mechanics, and selection criteria of various fluid level and flow monitoring instruments.
- To familiarize students with the principles of viscosity, density, humidity, and chemical sensors, alongside an introduction to intelligent SMART sensing systems.

Course Outcomes:

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

CO1: Evaluate the performance of transducers used for mechanical parameters like displacement, speed, vibration, force, and torque.

CO2: Calibrate pressure and vacuum measuring devices using standard dead-weight or vacuum testing rigs.

CO3: Select appropriate temperature sensors for precise thermal monitoring.

CO4: Evaluate the operational dynamics of industrial fluid flow and level sensors based on principles.

CO5: Demonstrate miscellaneous sensors according to their working principles.

Course Contents:

Unit-I: Fundamentals of Engineering Measurements 08 Hours

Measurement system elements, static and dynamic characteristics.

Need for sensors and transducers, definition and classification of transducers.

Displacement Measurement: Resistive-potentiometers, inductive-LVDT, capacitive, piezoelectric, ultrasonic, and proximity sensors.

Speed measurement, vibration measurement, force and torque measurement.

Unit-II: Pressure Measurement 08 Hours

Units and their relations, manometers, elastic sensors, piezoelectric secondary transducers, differential pressure sensors, capacitive (delta cell), vacuum gauges, dead weight tester.

Unit-III: Temperature Measurement 08 Hours

Temperature scales, units and their relations, classification of temperature sensors, bimetallic thermometer, Resistance temperature detectors (RTD), types of RTD, lead wire compensation, thermistors, Thermocouples, thermopiles, thermos-well, cold junction compensation techniques, pyrometers, temperature IC sensor LM35.

Unit-IV: Flow Measurement 08 Hours

Bernoulli's equation for incompressible flow, head type flow meters (orifice, venture meter and pitot tube), variable area type (Rotameter), turbine, electromagnetic, ultrasonic, mass flow meter: Coriolis flow meter.

Unit-V: Level and Miscellaneous Measurement 08 Hours

Level Measurement: Float, DP cell, ultrasonic, capacitive.

Viscosity: Saybolt, Searle's rotating cylinder, rotameter. Density: Hydrometers. Humidity: Resistive and capacitive type sensors. PH sensors, conductivity sensors.

Learning Resources:

Text Books:

1. Instrumentation Measurement and Analysis – B.C. Nakra, K.K. Chaudhry, 4th Edition, McGraw Hill, 2010, ISBN: 978-0070709868
2. Principles of Industrial Instrumentation" — D. Patranabis, ISBN (latest editions): 978 0070605502 (approximate for recent editions)
3. Transducers and Instrumentation – D.V.S. Murty, 3rd Edition, PHI Learning, 2011, ISBN: 978-8120346876.

Reference Books:

1. Industrial Instrumentation – A.K. Sawhney, 4th Edition, Dhanpat Rai & Co., 2010, ISBN: 978-8177000311
2. Measurement Systems: Application and Design – Ernst O. Doebelin, 5th Edition, McGraw Hill, 2003, ISBN: 978-0071223122.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee105
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee32

List of Practicals (Any 8):

1. Measure linear displacement using a Linear Variable Differential Transformer (LVDT).
2. Determine the characteristics of different proximity sensors.
3. Calibrate a load cell and determine its sensitivity for weight measurement.
4. Measure angular displacement using a shaft angle encoder.
5. Calibrate a Bourdon tube pressure gauge using a dead-weight tester.
6. Calibrate a vacuum gauge using a vacuum gauge tester.
7. Calibrate a Resistance Temperature Detector (RTD) and determine the temperature of an unknown liquid.
8. Determine temperature using LM35.
9. Flow measurement using DP transmitter.
10. Measure pH sensor output and calibrate it using standard buffer solutions.
11. Flow measurement using Orifice / Venturi flowmeter.

Course Code: 170505D	Course Name: Sensors and Actuators	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Fundamentals of Electronic Engineering, Programming Language C.

Course Objectives:

- To enable students to apply IoT concepts, architectures (3-layer and 5-layer), and system components (sensors, actuators, devices) in designing basic IoT-based solutions for real-world applications.
- To analyse different types of sensors (such as temperature, pressure, proximity, and optical sensors) and their applications in real-world systems.
- To study various actuators (electrical, mechanical, hydraulic, and pneumatic) and understand their role in control systems.
- To develop the ability to interface sensors and actuators with microcontrollers and embedded systems for data acquisition and control.
- To apply knowledge of sensors and actuators in designing and implementing practical systems used in automation, robotics, and industrial applications.

Course Outcomes:

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

CO1: Apply knowledge of IoT building blocks, architectures, and components to develop and implement simple IoT applications for real-world applications.

CO2: Analyze sensor/transducer performance, signal conditioning, and data acquisition to assess measurement accuracy and errors.

CO3: Apply principles of temperature, pressure, force, flow, and level sensors to select and use appropriate sensors for measurement applications.

CO4: Examine the operating principles and performance characteristics of position, proximity, and motion sensors to compare and select appropriate sensors for specific measurement and control applications.

CO5: Evaluate performance, working principles and control mechanisms of electrical, fluid power, and specialized actuators for various automation and control system applications.

Course Contents:

Unit-I: Introduction to IoT and Architecture **08 Hours**

Definition, Need & Scope of IoT, Evolution of IoT, Industry 4.0, Basic Components of IoT: Sensors, Actuators, Devices, IoT System Building Blocks, IoT Architecture: 3-Layer, 5-Layer models (simple explanation), IoT Applications across various sectors, (healthcare, manufacturing, smart homes, agriculture, transport).

Unit-II: Introduction to Signal Conditioning **08 Hours**

Concepts: Sensors vs. Transducers, Sensor Classification (Active/Passive, Digital/Analog), Performance Characteristics (Static and Dynamic: Sensitivity, Linearity, Hysteresis, Response Time). **Signal Conditioning:** Bridge circuits, Amplifiers (Op-Amp), Filtering (Low-pass, High-pass), Data Acquisition (ADC/DAC). **Error Analysis:** Calibration, Sensitivity Analysis, and Uncertainty.

Unit-III: Thermal and Mechanical Sensors **08 Hours**

Temperature Sensors: Thermocouples (Seebeck effect), Resistance Temperature Detectors (RTDs), Thermistors (NTC/PTC), Bimetallic strips, Pyrometers.

Pressure Sensors: Manometer, Bourdon Tube, Diaphragm, Bellows, Piezoelectric and Strain Gauge.

Force & Weight Sensors: Strain Gauges (Bridge circuits, gauge factor), Load Cells.

Flow & Level Sensors: Ultrasonic, Capacitive, Float Sensors, Turbine Flowmeters, Venturi Tubes.

Unit-IV: Position, Proximity and Motion Sensors **08 Hours**

Position and Displacement Sensors: Potentiometers (Linear/Rotary), Linear Variable Differential Transformers (LVDT), Eddy current probes.

Proximity Sensors: Inductive (metallic), Capacitive (non-metallic), Optical/Photoelectric, Magnetic (Reed switches), Light Dependent Resistors (LDR), Fiber-optic sensors.

Motion & Acceleration Sensors: Accelerometers (1-3 axis), Gyroscopes, MEMS inertial sensors, Velocity sensors.

Unit-V: Actuation Systems **08 Hours**

Electric Actuators: DC Motors, AC Motors, Stepper Motors, Servo Motors, Solenoids, Relays.

Fluid Power Actuators: Hydraulic and Pneumatic Cylinders, Valves, Pumps.

Specialized Actuators: Piezoelectric actuators, Shape Memory Alloys.

Control Methods: PWM (Pulse Width Modulation) speed control.

Learning Resources:

Text Books:

1. Milan Milenkovic, “Internet of Things: Concepts and System Design”, Springer, 2020.
2. D. V. S. Murthy, “Transducers and Instrumentation” Prentice Hall of India, 2nd Edition, 2012.
3. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley, 2014
4. Rolando Herrero, “Fundamentals of IoT Communication Technologies”, Springer, 2022.

Reference Books:

1. Ian Sinclair & John Dunton, “Sensors and Transducers”, Newnes (Elsevier) 3rd Edition, 2016.
2. Samayveer Singh, Manju, Aruna Malik, Pradeep Kumar Singh, “IoT-enabled Sensor Networks: Architecture, Methodologies, Security, and Futuristic Applications”, Bentham Science Publishers, 2024.
3. C.S. Rangarajan, “Instrumentation Devices and Systems”, Tata McGraw-Hill, 1st Edition, 2010.
4. Mohan Lal Kolhe, Kailash J. Karande, Sampat G. Deshmukh, “Artificial Intelligence, Internet of Things (IoT) and Smart Materials for Energy Applications”, CRC Press (Taylor & Francis), 2023.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc25_ee76/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee82/preview
3. https://onlinecourses.nptel.ac.in/noc26_ee41/preview

List of Practicals: (Any 8)

1. Interfacing of an LED with Arduino board.
2. Display real-time temperature & humidity values on serial monitor using DHT11.
3. IoT-Based Motion Detection / Security System (Interface PIR Motion Sensor. Send alert notification (app pop-up, buzzer or LED indicator).
4. IoT-Based Gas/Smoke Detection System. (Interface MQ-2 Gas sensor (or simulator). Trigger buzzer/alert message when gas level exceeds a threshold. Send alert notification to mobile using cloud app (Blynk/MQTT).
5. IoT-Controlled Servo Motor / Door Lock System. (Interface a servo motor. Control angle/position remotely using a cloud dashboard or mobile app.)
6. Heartbeat / Pulse Monitoring System (IoT-Based). (Interface pulse sensor or simulated heartbeat data. Send health parameters to cloud for real-time monitoring.)

7. Water Level Monitoring & Alert System. (Use ultrasonic sensor to measure water tank level. Send water-level data to cloud and generate alerts when level is low or high.)
8. Fire Detection and Alert System. (Flame sensor or temperature sensor combination. Trigger instant alerts and send real-time fire detection signals to mobile/cloud.)
9. Voice-Controlled IoT Device (Google Assistant/Alexa Integration). Control LED/Fan simulation using voice commands through Google Assistant + IFTTT or Alexa IoT skills.
10. IoT-Based Smart Street Lighting System. Automatically control a street light (LED) using an LDR sensor and send status (ON/OFF) to an IoT dashboard.
11. Smart Energy Monitoring System. Measuring and visualizing electrical parameters (current/voltage simulation allowed) and uploading data to cloud.
12. IoT-Based Weather Station (Multi-Sensor System). Interfacing two or more sensors (temperature, humidity, light, pressure) and publishing combined data to cloud.

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Course Code: 170505E	Course Name: Infrastructure and Planning	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Fundamentals of Building Technology and Architectural Planning.

Course Objectives:

- To understand and analyze urban infrastructure systems, including their types, planning data, standards, and the roles of stakeholders in urban development.
- To apply concepts of water supply, sanitation, stormwater, solid waste, and transport planning to propose sustainable and efficient urban infrastructure solutions.
- To develop knowledge of rural planning principles and government schemes to improve village infrastructure, housing, livelihoods, and social services.
- To use modern planning tools and technologies (GIS, remote sensing, drones) for the implementation, monitoring, management of urban and rural infrastructure projects.

Course Outcomes:

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

CO1: Explain the role and types of urban infrastructure, key planning data and standards, and the planning process with stakeholder roles.

CO2: Apply concepts of water supply, sanitation, stormwater, and solid waste management to plan and propose basic urban infrastructure improvements.

CO3: Apply transport and land-use planning concepts to improve urban mobility, accessibility, and sustainability

CO4: Develop rural planning strategies using government schemes to improve village infrastructure, housing, and livelihoods.

CO5: Implement rural infrastructure and connectivity solutions using GIS and other planning tools.

Course Contents:

Unit-I: Introduction to Urban Planning and Infrastructure 08 Hours

Role of infrastructure in urban development, Types of infrastructure: physical (water, power, transport), social (education, health), utilities Planning data, resource analysis, norms and standards Infrastructure planning process and stakeholder roles layouts.

Unit-II: Water, Sanitation and Stormwater Systems 08 Hours

Water supply sources, treatment, storage, distribution, Water demand forecasting, leakage, reuse, rainwater harvesting, Sanitation systems: sewage generation, collection, treatment, greywater management, Stormwater drainage, natural drainage, stormwater harvesting Institutional and management issues, Municipal solid waste: generation, collection, treatment, recycling.

Unit-III: Transport and Mobility Planning 08 Hours

Importance of transport infrastructure in urban form transport modes (public, private, non-motorized), and mobility demand land use–transport integration, accessibility, TOD (Transit-Oriented Development) transport modeling basics, pricing, congestion and sustainable mobility.

Unit-IV: Principles and Strategies of Rural Planning 08 Hours

Introduction to rural planning: need, scope, and objectives, rural settlement patterns and typologies, planning strategies for rural development central and State government schemes: MGNREGA, PMAY-G, Swachh Bharat Mission, PMGSY, Jal Jeevan Mission, role of planning in livelihood, housing, and social infrastructure.

Unit-V: Rural Infrastructure Management 08 Hours

Physical infrastructure: water supply, sanitation, drainage, roads, energy, solid waste management, social infrastructure: schools, healthcare, community centers, Transport and connectivity: rural road hierarchy, public transport, traffic management, Tools and technology: GIS, remote sensing, drones for rural planning, Implementation, monitoring, and governance of rural projects.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications.
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives - Vivek Saurath & Manoj Agarwal).

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.
3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.
4. MRTP Act 1966 : The director, government printing, stationary and publications,

Maharashtra state, Mumbai.
5. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
6. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
7. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
8. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
2. https://www.edx.org/certificates/professional-certificate/delftx-inclusive-and-sustainable-cities?index=product&queryId=2d5f1360201b4959787e19d485c4178e&position=3
3. https://www.coursera.org/learn/smart-cities
4. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
5. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
6. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
7. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals:

1. Prepare a case study for any infrastructure project of India and give presentation. (Group Activity).
2. Design a practical rainwater harvesting solution for any building. (Individual work).
3. Prepare a land-use map for a neighborhood with classification (residential, commercial, industrial, etc.) by calculation. (Group Activity)
4. Identify the major causes of congestion on any busy road in the city and suggest practical improvements to reduce traffic delays. Present your findings with brief observations and supporting photos or sketches. (Group work)
5. Draw a simple O–D diagram of your route from home to college, marking key points like home, major junctions, bus stops, and the college gate. Include the approximate distance and travel time with neat sketch map with brief travel details. (Individual work)
6. Select one rural development scheme (MGNREGA, PMAY-G, SBM, PMGSY, or JJM) and prepare a brief report covering its objectives, beneficiaries, key components, impact on rural livelihood or infrastructure, and a simple implementation flowchart (Individual work)
7. Prepare a village infrastructure improvement proposal for a hypothetical village of 1,000–1,500 people, listing existing issues, suggesting improvements in water supply,

sanitation, housing, livelihood, and roads, and identifying relevant government schemes for implementation. (Group work)

8. Site visit to any urban infrastructure or rural infrastructure management project.

Course Code: 170505F	Course Name: Web Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Computer Networks.

Course Objectives:

- To familiarize students with Web Programming basic concepts.
- To learn and understand Web scripting languages.
- To introduce students to responsive web design frameworks and modern UI components.
- To provide knowledge of web page styling and layout design for effective user interfaces.
- To familiarize students with website development using no-code platforms.

Course Outcomes:

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

CO1: Understand a basic of web application.

CO2: Develop structured web pages using HTML.

CO3: Apply styling and layout design principles to create visually appealing web interfaces.

CO4: Develop responsive and user-friendly web pages using modern design frameworks and layout approaches.

CO5: Create and publish functional websites using modern website development tools.

Course Contents:

Unit-I: Introduction to Web Applications 08 Hours

Internet, Basic internet protocols, World Wide Web, HTTP Request message, HTTP response message, Client–Server Architecture, Frontend vs Backend, World Wide Web, Role of browsers and web servers, Introduction to W3C and web standards.

Unit-II: Web Essentials and Mark-up Language- HTML 08 Hours

HTML: Introduction, history and versions. Tags, elements, and attributes, HTML elements: headings, paragraphs, line break, links, frames, lists, tables, images and forms, Input elements and basic validation, difference between HTML and HTML5.

Unit-III: CSS Styling and Layout Design **08 Hours**

CSS: Introduction to Style Sheet, CSS features, Types of CSS, CSS core: Properties, Classes, Child-Class (Nested CSS), Colors, Text, Background, Border, Margin, Padding, Positioning (flex, grid, inline, block), Animation, Transition.

Unit-IV: Bootstrap for Responsive Web **08 Hours**

Bootstrap vs plain CSS, Installing and using Bootstrap, Bootstrap grid system, Responsive design using Bootstrap, **Common Bootstrap Classes:** Buttons, Tables, Forms, Cards, Navigation bar, Alerts and Models.

Unit-V: Website Design Using No-Code Platforms **08 Hours**

Introduction to no-code and low-code web development and Advantages, Website design using **Wix Studio:** Page structure and layout, Responsive design tools, Customization of UI components, **Website design using WordPress:** Themes and templates, Page builders, Content management basics, Publishing and maintaining websites.

Learning Resources:

Text Books:

1. Jeffrey C. Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Robert W. Sebesta, “Programming the World Wide Web”, 4th Edition, Pearson Education.
3. Jon Duckett, HTML and CSS: Design and Build Websites, Wiley Publications.

Reference Books:

1. Marty Hall, Larry Brown, "Core Web Programming", Second Edition, Pearson Education, 2001, ISBN 978-0130897930.
2. HTML5 & CSS3 Complete Reference”, McGraw-Hill.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr26_ed79

List of Practicals:

1. Create a simple HTML webpage that displays basic information about yourself including name, photo, educational details, hobbies, and contact information using headings, paragraphs, images, and hyperlinks, ordered and unordered list.
2. Develop a webpage that displays a student marksheet using HTML tables including subjects, marks, and total percentage.
3. Create an HTML form for student registration including fields such as name, email, gender, date of birth, course selection, and submit/reset buttons. Apply basic input validation.

4. Design a webpage using external CSS to demonstrate styling of text, background colors, borders, and fonts also make use CSS Flexbox to arrange elements such as header, navigation bar, content section, and footer.
5. Design a webpage demonstrating CSS animation and transition effects on buttons, images, or text elements.
6. Create a responsive webpage using Bootstrap that includes navigation bar, image banner, cards, alerts, buttons, and tables and content sections.
7. Design a responsive webpage using Bootstrap Grid System that adjusts layout for mobile, tablet, and desktop screens.
8. Develop and publish a basic website using a No-Code platform such as WordPress or Wix Studio that includes at least three pages (Home, About, Contact).
9. Mini Project: Design and develop a complete responsive website for a small business, institute, or portfolio using HTML, CSS, and Bootstrap or a No-Code platform. The website should include navigation, forms, images and a responsive layout.

Course Code: 170505G	Course Name: Applied Data Science	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 25 Marks

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamentals of Data Science.
- To apply Data Science in different domain.
- To do exploratory analysis on a given data.
- To understand the concept of regression models.
- To facilitate learning of data pre-processing using R Programming.

Course Outcomes:

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

CO1: Apply statistics and probability methods to solve real-life problems.

CO2: Demonstrate the Data Science Process and how its components interact.

CO3: Apply basic tools (plots, graphs, summary statistics) to carry out EDA.

CO4: Solve real life problems using regression techniques.

CO5: Apply machine learning algorithms for real world applications.

Course Contents:

Unit-I: Probability and Statistics 08 Hours

Basics: sample space, outcomes, probability. Events: mutually exclusive, Conditional probability, Bayes' rule. Describing a Single Set of Data, Correlation and Causation Probability: Dependence and Independence, Conditional Probability, Random Variables, Continuous Distributions, The Normal Distribution. **Case Study:** Probability Analysis of Credit Card Fraud Detection.

Unit-II: Introduction to Data Science and Data Preprocessing 08 Hours

Defining data science and big data, Recognizing the different types of data, Machine Learning Definition and relation with Data Science, Data Science Process: Data collection; Data preparation; Training a model on the data, evaluation of the model performance, Data visualization techniques and inferences. **Case Study:** Data Preprocessing for Online Shopping

Recommendation System.

Unit-III: Exploratory Data Analysis (EDA) 08 Hours

Statistical measures, Basic tools (plots, graphs and summary statistics) of EDA, Data Analytics Lifecycle, Discovery Developing Initial Hypotheses, Identifying Potential Data Sources, EDA case study, testing hypotheses on means, proportions and variances. **Case Study:** Analysis of Food Delivery Trends.

Unit-IV: Regression models 08 Hours

Simple linear regression, least-squares principle, MLR, logistic regression, Multiple correlation, Partial correlation, Cross Validation, Overfitting, Under Fitting and Model Selection, Prediction by using Ridge Regression. **Case Study:** House Price Prediction Using Real Estate Data.

Unit-V: Introduction to Machine Learning & R Programming 08 Hours

Supervised learning, Unsupervised learning, Association Rule mining, Naive Bayes Classifier, k-means clustering, Introduction to R, R packages, Tidy data, Tabular data and data import, Strings and regular expressions. **Case Study:** Customer Segmentation in Retail Business.

Learning Resources:

Text Books:

1. Data Science from Scratch: Joel Grus, O'Reilly Media Inc. 2015, ISBN: 9781491901427.
2. R for data science: import, tidy, transform, visualize, and model data", Wickham, Hadley, and Garrett Grolemund. O'Reilly Media, Inc.", 2016.
3. Cathy O'Neil and Rachel Schutt, "Doing Data Science", O'Reilly, 2015, ISBN: 9781449358655.

Reference Books:

1. Introduction to Probability and Statistics for and Engineers and Scientists, S. Ross, 3rd Edition, Elsevier, 2004.
2. Software for Data Analysis: Programming with R (Statistics and Computing), John M. Chambers, Springer.
3. Hadley Wickham,Garrett Grolemund, " R for Data Science" , O'Reilly Media, 12 December 2016, ISBN:9781491910344, 1491910348.

Web link for MOOC / NPTEL Links:

1. Python for Data Science
   https://onlinecourses.nptel.ac.in/noc20_cs36/preview

List of Practicals:

1. Download any standard dataset from Kaggle. Using a programming language such as Python /R, perform statistical analysis to understand the structure, distribution, and relationships within the data.
2. Write python code that loads any standard dataset downloaded from Kaggle and plot the graph.
3. Perform some basic data cleaning operations on standard dataset using Python / R (Dataset should contain minimum 1000 records)
4. Perform data preprocessing, exploratory analysis on any standard dataset (dataset should contain minimum 1000 records) Using Python /R.
5. Perform correlation and regression analysis for any standard dataset downloaded from Kaggle, Government databases etc using Python / R.
6. Perform Simple Linear regression on for any standard data set downloaded from Kaggle, UCI, Government databases Using Python / R
7. Perform data analysis using Python / R / Weka for readily available data set using any one machine learning algorithm.

Course Code: 170505H	Course Name: Electrical Machines	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks**

Expected Prerequisite Courses:

- Basic Electrical Engineering.

Course Objectives:

- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of various motors.
- To test & analyze the performance of single phase and three phase motors.

Course Outcomes:

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

CO1: Understand the principles of electromechanical energy conversion, torque equation, and constructional features of electric motors.

CO2: Apply characteristics and speed control methods of DC motors to select suitable drives for applications.

CO3: Examine performance characteristics of three-phase induction motors for selection and control in mechanical loads.

CO4: Compare single-phase motors to select appropriate types for domestic and light-industrial use.

CO5: Apply operating principles and control methods of synchronous, BLDC, stepper, and servo motors in engineering applications.

Course Contents:

Unit-I: Fundamentals of Electric Motors 08 Hours

Basic concepts of electromechanical energy conversion, Fleming's rules, torque and EMF equations. Constructional features: Stator, rotor, windings, bearings, cooling systems, Comparison of AC vs DC motors and their industrial relevance, Safety considerations & motor nameplate data interpretation.

Unit-II: DC Motors **08 Hours**

Construction: Lap and wave windings, commutator, field excitation, Working principle and back EMF, Types: shunt, series, compound motors, Torque-speed characteristics and performance curves, Speed control techniques (armature and field control), Applications in traction, lifts, rolling mills, robotics. Brushless DC motors: construction, electronic commutation, uses in EV and drones.

Unit-III: Three-Phase Induction Motors **08 Hours**

Construction and working: squirrel cage vs slip-ring, Rotating magnetic field concept, slip, torque production, Torque-speed characteristics: starting torque, breakdown torque, Starting methods: DOL, star-delta, auto-transformer, Speed control: V/f control, rotor resistance, slip power recovery, Selection criteria for mechanical drives (load type, duty cycle), Use in pumps, compressors, crushers, conveyors, HVAC systems.

Unit-IV: Single-Phase Induction Motors & Auxiliary Motors **08 Hours**

Limitations of single-phase supply, double-revolving field theory, Types: split-phase, capacitor-start, capacitor-run, shaded pole, Universal motor: working and uses, Applications in domestic & light-industrial mechanical equipment (fans, washing machines, small tools).

Unit-V: Synchronous & Special Motors **08 Hours**

Synchronous Motors: excitation, torque-angle characteristics, Starting methods, V-curves, power factor improvement. **PMSM:** Construction, electronic controller, uses in EV. **Stepper Motors:** Variable reluctance & PM types, step angle, control, Servo motors for automatic control systems & CNC automation, Application focus in robotics, precision positioning and aerospace actuators.

Learning Resources:

Text Books:

1. Edward Hughes “Electrical Technology”, ELBS, Pearson Education.
2. Ashfaq Husain, “Electrical Machines”, Dhanpat Rai & Sons.
3. S. K. Bhattacharya, “Electrical Machine”, Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
4. Nagrath & Kothari, “Electrical Machines”, Tata McGraw Hill.
5. Bhag S Guru, Husein R. Hiziroglu, “Electrical Machines”, Oxford University Press.
6. K Krishna Reddy, “Electrical Machines- I and II”, SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

1. I. J. Nagrath and D. P. Kothari, Electric Machines, Tata McGraw Hill, New Delhi, 2005.
2. M. G. Say, The performance and design of alternating current machines, CBS Publishers and distributors, Delhi, 1983.
3. Fitzgerald, Kingsley and Umans, Electric Machinery, Tata McGraw Hill, New Delhi, 2003
4. S. K. Sen, Electrical Machinery, Khanna Pub., Delhi, 2012.
5. Mukherjee and Chakravorty, Electrical Machines, Dhanpat Rai Pub., New Delhi, 2005.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc19_ee69/preview
2. https://archive.nptel.ac.in/courses/108/102/108102146/

List of Practicals (Any 8):

1. Load test on DC shunt motor to obtain torque-speed, efficiency and performance characteristics.
2. Speed control of DC motor using armature voltage and field control methods.
3. No-load and blocked-rotor tests on 3-phase induction motor to determine equivalent circuit parameters.
4. Load test on 3-phase induction motor to obtain performance characteristics.
5. Study and comparison of DOL, star-delta & auto-transformer starters for induction motor.
6. V/f (open-loop) speed control of induction motor using inverter (simulation or hardware).
7. Load test on synchronous motor to plot V-curves and study power-factor control.
8. Performance characterization of BLDC motor (simulation or hardware kit).
9. Stepper motor stepping and micro-stepping experiment to determine step angle and positioning accuracy.
10. Servo motor position control using PID controller and performance analysis.
11. Thermal/run-down and insulation resistance test (theoretical analysis for motor selection).
12. Motor selection and design mini-project based on given mechanical load (simulation/theoretical).

Course Code: 107506	Course Name: Full Stack Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Practical : 4 Hours/Week	**2**	**TW : 50 Marks** **PR + OR : 50 Marks**

Expected Prerequisite Courses:

- Fundamentals of Programming, Computer Networks and Security.

Course Objectives:

- To understand fundamental web technologies for responsive web development.
- To develop dynamic user interfaces using modern frontend frameworks.
- To build backend applications and RESTful APIs for data management.
- To integrate frontend and backend technologies to develop full-stack web applications.
- To apply version control, deployment, testing.

Course Outcomes:

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

CO1: Design and develop responsive web pages using HTML5, CSS3, Bootstrap, and JavaScript.

CO2: Implement dynamic web interfaces using React.

CO3: Develop and Analyze RESTful APIs.

CO4: Apply version control concept using Git and GitHub.

CO5: Integrate and deploy the frontend and backend of web applications.

Course Contents:

HTML semantic tags, CSS3 styling, Bootstrap components including navbar, grid system, cards, tables, and forms, JavaScript, Basic git commands & Repository Handling, frontend development using React JS, Basic REST API using Node.js, Express, MongoDB, GitHub, deployment of functional website on cloud.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.

4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Learning Resources:

Text Books:

1. Web Development with Node and Express, 2nd Edition, O'Reilly Media, 2019.
2. Learning React, 2nd Edition, O'Reilly Media, 2020.
3. Angular: Up and Running, 2nd Edition, O'Reilly Media, 2018.

Reference Books:

1. Professional JavaScript for Web Developers, 4th Edition, Wiley, 2023.
2. Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Apress, 2019.
3. Eloquent JavaScript, 3rd Edition, No Starch Press, 2018.

Web link for MOOC / NPTEL Links:

1. https://www.tops-int.com/fullstack-training-course

Semester – VI

Course Code: 107601	Course Name: Computer Networks	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Discrete Mathematics, Operating Systems.

Course Objectives:

- To learn fundamental concepts of computer networks, layered architectures, protocols, and network devices.
- To learn data link layer services such as framing, error control, flow control, and multiple access protocols.
- To understand network layer addressing schemes, routing algorithms, routing protocols, and congestion control.
- To study transport layer protocols including TCP and UDP with emphasis on reliability, flow and congestion control.
- To study application layer protocols and examine advanced networking technologies such as High-Performance Networks, SDN, ICN, and Network Virtualization.

Course Outcomes:

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

CO1: Explain the fundamentals of computer networks, network models, and transmission media.

CO2: Apply error control, flow control, and MAC techniques in data link communication.

CO3: Analyze IP addressing, subnetting, and routing algorithms.

CO4: Evaluate transport layer functions, TCP/UDP services, and congestion control.

CO5: Demonstrate application layer protocols and understand emerging technologies.

Course Contents:

Unit-I: Foundation of Computer Networks **08 Hours**

Introduction to Computer Networks, Goals and applications of networks, Types of Networks, Network Topologies, OSI Model – Layers and functions, TCP/IP Protocol Suite,

Physical Layer: Network Hardware and Software, Transmission Media: wired and wireless, Network Devices

Case Study: Study of College Campus Network.

Unit-II: Data Link Layer 08 Hours

Data Link Layer design issues, Framing techniques, Error detection and correction, Flow control and Error control mechanisms.

Data Link Protocols: Stop-and-Wait, Go-Back-N, Selective Repeat.

MAC Sub-layer Protocols: HDLC, PPP, CSMA: CSMA/CA, CSMA/CD.

Switching Techniques: Circuit, Packet, Message Switching.

Case Study: Demonstration of DLL Protocol.

Unit-III: Network Layer 08 Hours

Network Layer functions, IPv4 and IPv6 addressing, Subnetting and Supernetting.

Routing Algorithms: Distance Vector, Link State, Dijkstra's Algorithm, Bellman-Ford.

Routing Protocols: RIP, OSPF, BGP.

IP Protocols: ARP, RARP, ICMP, NAT, Mobile IP. Congestion Control approaches.

Case Study: Demonstration of Network Simulator: OMNeT++ /CISCO packet tracer/ NS2.

Unit-IV: Transport Layer 08 Hours

Transport Layer Services, Multiplexing and Demultiplexing, Socket Address, Socket Primitives, Transport Layer Protocol: User Datagram Protocol (UDP), Transmission Control Protocol (TCP): TCP connection management (3-way handshake), Flow control and Congestion control, Reliable data transfer, TCP segment format, Quality of Service (QoS) concepts, SCTP.

Case Study: Network analyzer tool: Wireshark.

Unit-V: Application Layer 08 Hours

Introduction to application layer services, Application Layer Protocols: DNS, Email protocols: SMTP, POP3, IMAP, HTTP, HTTPS, SNMP, DHCP, FTP, TELNET.

Introduction to Advanced Computer Networks.

Case Study: High-Performance Networks/ Information-Centric Networking/ Software-Defined Networking.

Learning Resources:

Text Books:

1. Fourauzan B., "Data Communications and Networking", 4th edition, Tata McGraw Hill, Publications, 2006, ISBN 0 - 07 – 0634145.

2. Kurose, Ross "Computer Networking a Top-Down Approach Featuring the Internet", Pearson; 6th edition (March 5, 2012), ISBN-10: 0132856204, ISBN-13: 978-0132856201.

Reference Books:

1. Andrew Tenenbaum, "Computer Networks", 4th Edition, PHI, ISBN81-203-2175-8.
2. Computer Networks: A Top-Down Approach, Behrouz A. Forouzan, Firouz Mosharraf, McGraw-Hill Education.
3. Larry L. Peterson and Bruce S. Davie, Computer Networks - A Systems Approach 5th Edition, Morgan Kaufmann, Elsevier, 2011.
4. Engineering Approach to Computer Networks - S. Keshav, 2nd Edition, Pearson Ed.

Web link for MOOC / NPTEL Links:

1. Computer Networks and Internet Protocol by Prof. Soumya Kanti Ghosh, Prof. Sandip Chakraborty, IIT Kharagpur.
   https://onlinecourses.nptel.ac.in/noc26_cs35/preview
2. Advanced Computer Networks by Prof. Neminath Hubballi, IIT Indore, Prof. Sameer G Kulkarni, IIT Gandhi Nagar.
   https://onlinecourses.nptel.ac.in/noc26_cs60/preview
3. Networking Basics by Cisco Networking Academy.
   https://www.cisco.com/site/us/en/learn/topics/small-business/networking-basics.html

Suggested Activity-based Class Learning:

1. Flipped Classroom.
2. OSI Layer Role Play.
3. Simulation of routing protocol.
4. Poster Presentation.
5. Quizzes/Assignment.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107602	Course Name: Artificial Neural Networks	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Artificial Intelligence.

Course Objectives:

- Understand the basic concepts and architectures of Artificial Neural Networks.
- Learn different learning algorithms used in ANN.
- Design and train feedforward neural networks using backpropagation.
- Implement ANN models for classification and prediction problems.
- Explore applications of ANN in Artificial Intelligence.

Course Outcomes:

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

CO1: Explain the fundamentals and architecture of Artificial Neural Networks.

CO2: Apply different learning algorithms for training neural networks.

CO3: Design and implement feedforward neural networks using backpropagation.

CO4: Evaluate ANN models using standard performance metrics.

CO5: Develop simple ANN-based solutions for real-world applications using Python and Keras.

Course Contents:

Unit-I: Introduction to Artificial Neural Networks **08 Hours**

Introduction to Artificial Intelligence and Neural Networks, Biological Neuron vs Artificial Neuron, McCulloch-Pitts Neuron Model, Perceptron Model, Characteristics and Applications of ANN, Learning Methods: Supervised, Unsupervised and Reinforcement Learning, Activation Functions.

Case Study: Email Spam Detection using Perceptron.

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

Single-Layer Perceptron, Multi-Layer Perceptron (MLP), Perceptron Learning Rule, Delta Learning Rule, Adaline and Madaline Networks, Forward Propagation, Introduction to Gradient Descent.

Case Study: Student Performance Prediction.

Unit-III: Backpropagation Algorithm 08 Hours

Backpropagation Algorithm, Error Calculation, Training and Testing of Neural Networks, Batch, Stochastic and Mini-Batch Learning, Model Performance Evaluation, Accuracy, Precision, Recall, F1-Score and Confusion Matrix.

Case Study: Handwritten Digit Recognition (MNIST Dataset).

Unit-IV: Advanced Neural Networks 08 Hours

Radial Basis Function Network (RBFN), Self-Organizing Map (SOM), Hopfield Network, Introduction to Recurrent Neural Networks (RNN), Comparison of Different ANN Architectures, Applications of ANN.

Case Study: Customer Segmentation using Self-Organizing Maps (SOM).

Unit-V: ANN Using Python and Keras 08 Hours

Introduction to TensorFlow and Keras, Data Preprocessing, Building a Simple ANN Model, Model Training and Testing, Hyperparameter Basics, Real-World Applications of ANN in Healthcare, Finance, Image Classification, and Prediction.Emerging Trends: Explainable AI (XAI), Edge AI, TinyML, Hybrid Neural Networks.

Case Study: Heart Disease Prediction using ANN.

Learning Resources:

Text Books:

1. Neural Networks a Comprehensive Foundations, Simon Haykin, PHI edition.
2. B. Yegnanarayana - Artificial neural network PHI Publication.2005.

Reference Books:

1. Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction – SPIE Press, 2005.
2. Mohammad H. Hassoun – Fundamentals of artificial neural networks - MIT Press, 1995.

Web link for MOOC / NPTEL Links:

1. https://ocw.mit.edu/courses/9-641j-introduction-to-neural-networks-spring-2005/
2. https://nptel.ac.in/courses/117105084

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.

2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107603A	Course Name: Parallel and Distributed Computing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Digital Logic & Computer Organization, Operating Systems.

Course Objectives:

- To introduce the fundamental concepts of parallel and distributed computing systems and their importance in modern computing environments.
- To understand different parallel programming models, synchronization mechanisms, and tools used for developing parallel applications.
- To explore GPU computing and high-performance computing architectures for accelerating computational tasks.
- To study distributed system architectures, communication models, and cloud computing environments.
- To understand how parallel and distributed computing techniques are used to improve the performance and scalability of machine learning and AI applications.

Course Outcomes:

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

CO1: Explain fundamentals of parallel and distributed computing systems.

CO2: Apply parallel programming models such as MPI and OpenMP.

CO3: Analyze GPU architecture and high-performance computing systems.

CO4: Describe distributed system architectures and cloud computing concepts.

CO5: Analyze the use of parallel and distributed computing in improving the performance of AI and machine learning applications.

Course Contents:

Unit-I: Fundamentals of Parallel and Distributed Computing 08 Hours

Introduction to Parallel and Distributed Computing, need for parallel computing in modern systems, Applications in AI, scientific computing and data analytics, Flynn's classification of computer architectures, Parallel vs Distributed computing, shared memory and distributed memory architecture, Multicore processors and cluster computing, Performance metrics: Speedup, efficiency and scalability, Amdahl's Law and Gustafson's Law.

Case Study: Distributed Data Processing in a Web Search Engine.

Unit-II: Parallel Programming Models **08 Hours**

Memory hierarchy in parallel systems, Cache coherence concepts, Data dependencies in parallel programs, Task parallelism vs data parallelism, Synchronization fundamentals, Parallel programming models, Message passing model, Shared memory programming, MPI architecture and communication model, OpenMP directives and multithreading concepts.

Case Study: Parallel Image Processing using OpenMP Multithreading.

Unit-III: GPU Computing and High Performance Systems **08 Hours**

GPU computing fundamentals, CPU vs GPU architecture, SIMD and SIMT execution models, GPU memory hierarchy, CUDA programming concepts, Kernel execution model, Thread blocks and grid architecture, GPU performance considerations, High Performance Computing systems, Cluster computing and supercomputers.

Case Study: Accelerating Image Recognition using GPU Computing.

Unit-IV: Distributed Systems and Cloud Computing **08 Hours**

Fundamentals of distributed systems, Characteristics of distributed computing environments, Client-server architecture, Peer-to-peer systems, distributed coordination and communication, Synchronization in distributed systems, Mutual exclusion and deadlock handling, Cloud computing architecture, Virtualization and distributed storage systems.

Case Study: Cloud-Based Online File Storage System (like Google Drive).

Unit-V: Parallel and Distributed Computing for AI Applications **08 Hours**

Performance optimization in parallel systems, load balancing techniques, Parallel algorithms for large data processing, Parallel computing for machine learning, Data parallelism and model parallelism, distributed gradient descent, Parameter server architecture, Distributed training pipelines, GPU acceleration in deep learning, Applications in AI, computer vision and NLP.

Case Study: Distributed Training of Deep Learning Models.

Learning Resources:

Text Books:

1. "Distributed Systems: Concepts and Design" by George Coulouris, Jean Dollimore, and Tim Kindberg (2011).
2. "Parallel Computing: Theory and Practice" by Michael J. Quinn (2018)"Parallel Computing: Theory and Practice" by Michael J. Quinn (2018).

Reference Books:

1. Algorithms and Parallel Computing, by Fayez Gebali, John Wiley & Sons, 2011. ISBN 978-0-470-90210-3.

2. Big Data: Principles and Best Practices of Scalable Real-time Data Systems by Nathan Marz and James Warren (2015).

Web link for MOOC / NPTEL Links:

1. Cloud Computing and Distributed Systems, By Prof. Rajiv Misra.
   https://onlinecourses.nptel.ac.in/noc26_cs29/preview

Suggested Activity-based Class Learning:

1. Flipped Classroom.
2. Gamification.
3. Online Interactive Tool.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignment.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107603B	Course Name: Quantum Computing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Fundamentals of Computer & Programming, Operating Systems, Basic concepts of Networks.

Course Objectives:

- To introduce the fundamental concepts and motivation behind quantum computing.
- To develop the ability to use vector spaces, Hilbert spaces, operators, and tensor products in quantum mechanics.
- To enable students to evaluate the advantages and limitations of quantum algorithms in solving computational problems.
- To provide insight into quantum supervised and unsupervised learning techniques.
- To familiarize with Quantum AI approaches for decision-making and problem-solving in diverse domains.

Course Outcomes:

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

CO1: Apply principles of superposition, entanglement, and quantum interference to represent and manipulate qubits.

CO2: Utilize the postulates of quantum mechanics to describe quantum measurements, expectation values, and time evolution of quantum systems.

CO3: Make use of fundamental quantum algorithms to address computational problems efficiently.

CO4: Analyze quantum learning techniques and quantum circuits for solving complex problems.

CO5: Examine Quantum AI techniques for decision-making and problem-solving in diverse domains.

Course Contents:

Unit I: Fundamentals of Quantum **08 Hours**

Overview of Quantum Computing: Motivation and evolution of quantum computing. Limitations of Classical Computing: Computational complexity, parallelism limits, and the

need for quantum advantage. Quantum Mechanics for Computing: Superposition, entanglement, and quantum interference. Qubits vs Classical Bits: Representation of qubits and Bloch sphere visualization. Quantum Gates: Pauli gates (X, Y, Z), Hadamard gate, ControlledNOT gate (CNOT). Quantum Circuits and Measurement: Quantum circuit model and measurement in quantum systems.

Unit-II: Mathematical Foundations of Quantum Mechanics 08 Hours

Linear Algebra Framework for Quantum Mechanics: Vector spaces, complex Hilbert spaces, inner products, orthogonality, linear operators, eigenvalues and eigenvectors, Hermitian and unitary operators, tensor products. Postulates of Quantum Mechanics: Quantum states and state space, observables as operators, measurement postulate and Born rule, expectation values, time evolution of quantum states, quantum states in Hilbert space, qubits and Bloch sphere representation, quantum measurement theory, density operator formalism, composite quantum systems. Fundamentals of Quantum Principle: No-cloning theorem and implications for quantum information and quantum AI.

Unit-III: Quantum Algorithms 08 Hours

Overview of quantum algorithms and quantum speedup, Phil's algorithm, David Deutsch's algorithm, and David Deutsch–Jozsa algorithm, Daniel Simon's algorithm, Lov Grover's Search algorithm, Quantum Fourier Transform (QFT), Peter Shor's algorithm for integer factorization, introduction to quantum walk and search application.

Unit-IV: Quantum Machine Learning 08 Hours

Introduction to quantum-classical hybrid learning, data encoding and quantum feature maps, vibrational quantum circuits (VQC) and parametrized quantum circuits, quantum optimization and the parameter shift rule.

Quantum Supervised Learning: Quantum support vector machine (QSVM) and quantum neural networks.

Quantum Unsupervised Learning: Quantum K-Means and Quantum Principal Component Analysis (QPCA), quantum generative models, and the barren plateau problem.

Unit-V: Applications of Quantum Artificial Intelligence 08 Hours

Quantum AI for Optimization Problems: Quantum-enhanced combinatorial optimization, logistics and supply chain optimization, resource allocation and scheduling, smart grid, and traffic optimization.

Quantum AI in Finance and Business Analytics: Portfolio optimization, risk analysis and modeling, fraud detection, and financial forecasting.

Quantum AI in Healthcare and Life Sciences: Drug discovery optimization, molecular

modeling, genomic data analysis.

Quantum AI in Cybersecurity: Quantum-enhanced anomaly detection, intrusion detection systems, AI-assisted post-quantum cryptanalysis.

Quantum AI in Intelligent Systems: Quantum machine learning applications, intelligent decision systems, and advanced AI architectures.

Learning Resources:

Text Books:

1. Wichert, Andreas, "Quantum Artificial Intelligence with Qiskit," 1st Edition, Chapman & Hall / CRC Press, 2025, ISBN 978-1032448978.
2. Bernhardt, Chris, "Quantum Computing for Everyone," 1st Edition, The MIT Press, 2019, ISBN 978-0262039253.

Reference Books:

1. Nielsen, M. A., Chuang, I. L., "Quantum Computation and Quantum Information", 10th Edition, Cambridge University Press, 2010, ISBN 978-1107002173.
2. Wittek, Peter, "Quantum Machine Learning: What Quantum Computing Means to Data Mining", 1st Edition, Elsevier Science, 2014, ISBN 978-0128010990.
3. Yanofsky, Noson S., Mannucci, Mirco A., "Quantum Computing for Computer Scientists", 1st Edition, Cambridge University Press, ISBN 978-0-521-87996-5.

Web link for MOOC / NPTEL Links:

1. Quantum Computing by Prof. Debabrata Goswami, IIT Kanpur. https://nptel.ac.in/courses/104104082
2. Introduction to Quantum Computing: Quantum Algorithms and Qiskit by Prof. Prabha Mandayam, Prof. Anupama Ray, Prof. Sheshashayee Raghunathan, IIT Madras & IBM Research. https://onlinecourses.nptel.ac.in/noc26_cs89/preview

Suggested Activity-based Class Learning:

1. Flipped Classrooms.
2. Virtual Lab.
3. Quizzes /Assignments.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.

5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107603C	Course Name: Business Intelligence	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Database Management Systems, Data Structures.

Course Objectives:

- To understand the fundamentals of Business Intelligence and Data Warehousing.
- To study Data Warehouse architecture, design methodologies and OLAP operations.
- To learn data preprocessing, reporting and data visualization techniques.
- To understand data mining and machine learning techniques used in BI.
- To explore BI tools and real-world business applications.

Course Outcomes:

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

CO1: Apply conceptual knowledge on how BI is used in decision support systems.

CO2: Use Modeling Concepts in Business Intelligence.

CO3: Apply different data pre-processing techniques on datasets and build graphical reports for effective data analysis.

CO4: Implement machine learning algorithms as per business needs.

CO5: Identify role of BI in marketing, logistics, and finance and telecommunication sector.

Course Contents:

Unit-I: Introduction to Business Intelligence 08 Hours

Fundamentals of Business Intelligence, Evolution of BI and Decision Support Systems, BI Architecture and Components, Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Role of BI in Business Decision Making, Applications of BI in various domains (Healthcare, Finance, Retail, Manufacturing), Introduction to BI Tools (Power BI, Tableau, Google Data Studio).

Case Study: How American Nationwide Insurance Company Used Bl to Enhance Customer Service. https://www.chegg.com/homework-help/questions-and-answers/case-study-3-end-chapter-1-nationwide-insurance-used-bl-enhance-customer-service-nationwid-q86305996

Unit-II: Modelling in Business Intelligence 08 Hours

Models and modelling in BI, Model Presentation, Model Building, Model Assessment and Quality of Models, Modelling using Logical Structures: ontology & Frame, Modelling using graph, structure: Business process model and notation (BPMN), Modelling using probabilistic structures, Modelling using analytical structure. Model and Data: data Generation, The Role of time, Data Quality.

Case Study: https://link.springer.com/chapter/10.1007/978-3-642-31095-9_33

Unit-III: Data Provisioning & Reporting 08 Hours

Data Provisioning: Data warehouse and schemas (star, snowflake), data quality and basic data validation, ETL architecture and ETL process, data extraction and change data capture (CDC), data transformation concepts, data loading (initial and incremental loading), staging area, data marts and OLAP cubes.

Business Reporting: Concept of business reporting, reporting and authoring concepts, building reports using relational and multidimensional data models, types of reports (list, crosstab, chart).

Reporting Operations: Data grouping and sorting, filtering reports, calculations and summary lines, conditional formatting, drill-down and drill-through capabilities, report scheduling and report output formats (PDF, Excel, CSV).

Case Study: Retail Analysis Sample Dashboard (Power BI Case Study): https://learn.microsoft.com/en-us/power-bi/create-reports/sample-retail-analysis.

Unit-IV: Data Pre-processing and Machine Learning in BI 08 Hours

Data validation (handling incomplete and noisy data), data transformation (standardization, feature extraction), data reduction techniques (sampling, feature selection, principal component analysis), data discretization, basic data exploration including univariate, bivariate and multivariate analysis. Role of machine learning in business intelligence, overview of regression, classification, clustering and association rule mining, structure of association rules, support and confidence, Apriori algorithm, applications of machine learning techniques in business intelligence.

Case Study: Business applications for comparing the performance of a stock over a period of time https://cleartax.in/s/stock-market-analysis.

Unit-V: BI Tools and Applications 08 Hours

Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA,KNIME, Rapid Miner, R;Data analytics, Business analytics, ERP and Business Intelligence, BI and operation management, BI in inventory management system, BI and human resource management, BI Applications in CRM, BI Applications in Marketing, BI

Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI in salesforce management.

Case Study: Logistics planning in the food industry. https://www.foodlogistics.com/case-studies, https://www.barrettdistribution.com/food-distribution-case-study

Learning Resources:

Text Books:

1. Fundamentals of Business Intelligence, Grossmann W, Rinderle-Ma, Springer, 2015.
2. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support, 10th Edition. Pearson/Prentice Hall, 2015.
3. Grossmann W, Rinderle-Ma, "Fundamentals of Business Intelligence", Springer, ISBN: 978-662-46531-8.
4. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", 3rd Edition", Elsevier Publishers, ISBN: 9780123814791.

Reference Books:

1. Paulraj Ponnian, "Data Warehousing Fundamentals", John Willey.
2. Introduction to business Intelligence and data warehousing, IBM, PHI.
3. Business Intelligence: Data Mining and Optimization for Decision Making, Carlo Vercellis, Wiley, 2019.
4. Data Mining for Business Intelligence, Wiley.
5. EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138.
6. Ken W. Collier, Agile Analytics: A value driven Approach to Business Intelligence and Data Warehousing, Pearson Education,2012, ISBN-13 978 8131786826.

Web link for MOOC / NPTEL Links:

1. Business Intelligence and Analytics
   https://nptel.ac.in/courses/106106361
2. Business Analytics for Management Decision.
   https://nptel.ac.in/courses/110105089
3. Business Analytics and Data Mining Modelling using R.
   https://nptel.ac.in/courses/110107092
4. Business Analysis for Engineers
   https://nptel.ac.in/courses/110106050

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.

2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107604A	Course Name: Big Data Analytics	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Database Management Systems, Data structures, Operating systems.

Course Objectives:

- To understand the fundamentals and challenges of Big Data.
- To learn distributed storage and processing frameworks.
- To implement data processing using Hadoop and MapReduce.
- To understand Big Data tools such as Hive, Pig, and Spark.
- To apply Big Data analytics techniques to large datasets.

Course Outcomes:

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

CO1: Explain the concepts, characteristics, and applications of Big Data and Big Data Analytics.

CO2: Describe the Hadoop ecosystem and HDFS architecture used for the distributed storage of large datasets.

CO3: Apply the MapReduce programming model for processing and analyzing big data.

CO4: Use Big Data tools such as Hive, Pig, and NoSQL databases for managing and querying large datasets.

CO5: Implement Big Data analytics using Apache Spark for large-scale data processing.

Course Contents:

Unit-I: Introduction to Big Data **08 Hours**

Evolution of Big Data, Definition and Characteristics of Big Data (5V's: Volume, Velocity, Variety, Veracity, Value), Traditional Data Processing vs Big Data Processing, Big Data Applications (Healthcare, Finance, Social Media, E-commerce), Big Data Analytics Lifecycle, Challenges in Big Data Management.

Case Study: Social Media Sentiment Analysis for Product Reviews.

Unit-II: Hadoop Ecosystem **08 Hours**

Introduction to Hadoop, Hadoop Architecture, Hadoop Distributed File System (HDFS),

HDFS Components: NameNode, DataNode, HDFS Block Structure and Replication, Hadoop Cluster Architecture, Advantages and Limitations of Hadoop.

Case Study: Large-Scale Log Analysis Using Hadoop HDFS.

Unit-III: MapReduce Framework **08 Hours**

Introduction to MapReduce, MapReduce Architecture, Working of Map and Reduce Functions, Data Flow in MapReduce, Input Splits and Record Readers, Shuffle and Sort Phase, Reduce Programs, Combiner and Partitioner, Applications of MapReduce.

Case Study: Word Count Analysis of Large Document Collections.

Unit-IV: Big Data Tools and Technologies **08 Hours**

Introduction to Apache Hive, Hive Architecture and HiveQL, Introduction to Apache Pig, Pig Latin Programming, NoSQL Databases (Introduction), Types of NoSQL Databases: Key-Value, Column, Document, Graph, Introduction to HBase.

Case Study: E-Commerce Recommendation System Using NoSQL.

Unit-V: Emerging Technologies in Analytics **08 Hours**

Introduction to Apache Spark, Spark Architecture, Resilient Distributed Datasets (RDD), Spark Components: Spark SQL, Spark Streaming, MLlib, Data Processing using Spark, Real-time Big Data Analytics, Case Studies: Big Data Applications.

Case Study: Real-Time Traffic Monitoring Using Apache Spark.

Learning Resources:

Text Books:

1. Seema Acharya, Subhasini Chellappan, "Big Data Analytics," Wiley, 2015.
2. Hadoop: The Definitive Guide – Tom White.

Reference Books:

1. Arvind Sathi, “Big Data Analytics: Disruptive Technologies for Changing the Game”, MC Press, 2012.
2. Jay Liebowitz, “Big Data and Business Analytics,” Auerbach Publications, CRC Press (2013).
3. Michael Mineli, Michele Chambers, Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publications, 2013.
4. Adam Shook and Donald Mine, “MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems” - O'Reilly 2012.
5. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers and Techniques, Pearson India Education Service Pvt. Ltd., 1st Edition, 2016.

Web link for MOOC / NPTEL Links:

1. Data Analytics with Python by Prof. A Ramesh, IIT Roorkee.
   https://nptel.ac.in/courses/106107220
2. Data Analysis and Decision Making - I, Prof. Raghu Nandan Sengupta, IIT Kanpur.
   https://nptel.ac.in/courses/110104094

Suggested Activity-Based Class Learning:

1. Flipped Classroom.
2. Gamification.
3. Online Interactive Tool.
4. Collaborative and Individual Problem-based learning.
5. Quizzes/Assignment.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107604B	Course Name: Cloud Computing	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Operating Systems, Computer Networks.

Course Objectives:

- To provide students with the fundamentals and essentials of cloud computing
- To learn the basics of virtualization and its importance.
- To provide students a sound foundation of the cloud computing so that they are able to start using and adopting cloud computing services and tools in their real-life scenarios
- To acquire knowledge on data storage and various Cloud Application Platform.
- To equip learners with the knowledge and skills to design, implement, and manage secure cloud environments.

Course Outcomes:

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

CO1: Articulate the main concepts, key technologies and fundamentals of cloud computing.

CO2: Understand cloud enabling technologies and virtualization.

CO3: Analyse various cloud programming models and apply them to solve problems on the cloud.

CO4: Develop and deploy applications on Cloud.

CO5: Apply security-providing techniques for cloud applications.

Course Contents:

Unit-I: Introduction to Cloud Computing **08 Hours**

Origins and Influences, Goals and Benefits, Risks and Challenges, Roles and Boundaries, Cloud Characteristics, Migrating into the Cloud, Seven-step model of migration into a Cloud, Cloud Service/Delivery Models: IAAS,PAAS,SAAS, Cloud Deployment Models: Private ,Public, Hybrid, Community, Cloud System Architecture, Federated Cloud/ Intercloud,

Case Studies: Spotify Cloud Transformation, Netflix Cloud Migration.

Unit-II: Cloud Enabling Technology and Virtualization **08 Hours**

Cloud-Enabling Technology: Broadband Networks and Internet Architecture, Data Center

Technology Virtualization Technology, Web Technology, Multitenant Technology, Service Technology.

Virtualization: Definition of Virtualization, Implementation Levels of Virtualization, Types of Hypervisors, Virtualization of CPU, Memory, and I/O Devices, Virtual Clusters and Resource Management, Virtualization for Data-Center Automation

Case Studies: Cloud Infrastructure for an E-Commerce Platform.

Unit-III: Common Standards and Cloud Platforms 08 Hours

Common Standards: The Open Cloud Consortium, Open Virtualization Format, Standards for Application Developers: Browsers (Ajax), Data (XML, JSON), Solution Stacks (LAMP and LAPP), Syndication (Atom, Atom Publishing Protocol, and RSS), and Standards for Security.

Amazon web services: Compute services Storage Services Communication Services Additional services.

Google App Engine: Architecture 47 and core concepts, Application life cycle, Cost model

Microsoft Azure: Azure core concepts, SQL Azure, Windows Azure platform appliance.

Comparison of AWS, Azure and GCP.

Unit-IV: Data Storage and Cloud Computing Applications 08 Hours

Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage,

Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo Cloud data stores: Datastore and Simple DB Gautam Shrauf, Cloud Storage-Overview, Cloud Storage Providers

Cloud Computing Applications: ECG Analysis in the Cloud, Protein Structure Prediction, Satellite Image Processing, CRM and ERP, Social Networking. Overview of OpenStack architecture.

Case Studies: Cloud-Based Healthcare and Scientific Data Processing System.

Unit-V: Security in Cloud 08 Hours

Risks in Cloud Computing: Types of Risks in Cloud Computing, Risk Management, Enterprise-Wide Risk Management,

Data Security in Cloud: Security Issues, Challenges, advantages, disadvantages, Cloud Digital persona and Data security, Content Level Security.

Cloud Security Services: Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements, Secure Cloud Software Testing, Cloud Security Audit, Introducing Business Continuity and Disaster Recovery. Disaster Recovery- Understanding the Threats.

Case Studies: Capital One AWS breach analysis / GitHub Disaster Recovery Case Study.

Learning Resources:

Text Books:

1. A. Srinivasan, J. Suresh, “Cloud Computing: A Practical Approach for Learning and Implementation”, Pearson, ISBN: 978-81-317-7651-3
2. Gautam Shrof “ENTERPRISE CLOUD COMPUTING Technology Architecture, Applications”, Cambridge University Press, ISBN: 9780511778476
3. Thomas Erl, ZaighamMahmood and Ricardo Puttini, Cloud Computing: Concepts, Technology and Architecture, Pearson, ISBN :978 9332535923, 9332535922, 1 st Edition
4. Anthony T. Velte Toby J. Velte, Robert Elsenpeter, “Cloud Computing: A Practical Approach”, 2010, The McGraw-Hill.

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, Mastering Cloud Computing: Foundations and Applications Programming, McGraw Hill, ISBN: 978 1259029950, 1259029956.
2. Jack J. Dongarra, Kai Hwang, Geoffrey C. Fox, Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Elsevier, ISBN :9789381269237, 9381269238, 1st Edition.
3. Brian J.S. Chee and Curtis Franklin, Jr., Cloud Computing: Technologies and Strategies of the Ubiquitous Data Center, CRC Press, ISBN :9781439806128.
4. Dr. Kumar Saurabh, “Cloud Computing, 4ed: Architecting Next-Gen Transformation Paradigms”, Wiley publication, ISBN: 9788126570966
5. Rishabh Sharma, “Cloud Computing: Fundamentals, Industry Approach and Trends”, Wiley publication.

Web link for MOOC / NPTEL Links:

1. Cloud Computing by Prof. Soumya Kanti Ghosh,, IIT Kharagpur
   https://nptel.ac.in/courses/106105167
2. Cloud Infrastructure and Services by Prof. Dr. Nilesh K. Modi.
   https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_cs33

Suggested Activity based Class Learning:

1. Cloud Cost Optimization Game.
2. Deploy a Database on Cloud.
3. Flipped Classroom.
4. Poster presentation.
5. Quizzes.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.
5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 107604C	Course Name: Optimization Algorithms	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Practical :** 2 Hours/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 25 Marks** **PR + OR : 25 Marks**

Expected Prerequisite Courses:

- Discrete Mathematics, Data Structures.

Course Objectives:

- To introduce fundamental concepts of optimization and linear Programming techniques used for solving engineering problems.
- To understand unconstrained optimization methods and their mathematical foundations.
- To analyze constrained optimization problems and heuristic optimization techniques.
- To explore advanced nature-inspired optimization algorithms for complex problem solving.
- To apply multi-objective optimization techniques in machine learning and parallel computing applications.

Course Outcomes:

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

CO1: Apply linear programming techniques for problem solving.

CO2: Analyze and implement unconstrained and constrained non-linear optimization techniques.

CO3: Design and optimize multi-objective problems using a single-objective meta-heuristic optimization algorithm.

CO4: Integrate optimization techniques in machine learning & parallel applications.

CO5: Apply multi-objective optimization techniques to solve real-world problems in machine learning and parallel computing.

Course Contents:

Unit-I: Linear Programming **08 Hours**

Condition for local minimizer, one-dimensional search methods, gradient methods, and Newton's method. Problems with equality constraints, optimization problems, and algorithms for constrained.

Unit-II: Unconstrained Optimization **08 Hours**

Local and Global Minima, Convex Functions, Condition for Local Minimizer, One-Dimensional Search Methods, Gradient Methods, Newton's Method.

Unit-III: Constrained and Heuristic Optimization **08 Hours**

Equality and Inequality Constraints, Large Multiplier Method, Barrier Method, Problems with Equality Constraints, Optimization Problems, Algorithms for Constrained Optimization, and a single-objective heuristic optimization algorithm.

Unit-IV: Advanced Nature-Inspired Algorithms **08 Hours**

Simulated Annealing, Evolutionary Algorithms, Teaching-Learning-Based Optimization (TLBO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC), Grey Wolf Optimizer GWO), Bat Algorithm, Hybrid Optimization Techniques.

Unit-V: Multi-objective & Applied Optimization **08 Hours**

Multi-objective: Non-Elitist, Elitist, and Constrained Multi-Objective Evolutionary Algorithms. Optimization in Machine Learning & Parallel Programs: Continuous/Discrete optimization, Submodular Functions, Load balancing, Data Locality, Synchronization/Communication optimization, Strategy selection.

Learning Resources:

Text Books:

1. Nocedal, Jorge, and Wright, Stephen J. Numerical Optimization. Springer, 2000.
2. Chong, Edwin K. P., and Zak, Stanislaw H. Introduction to Optimization. Wiley, 2013.

Reference Books:

1. Nayak, Sukanta. Fundamentals of Optimization Techniques with Algorithms. Academic Press, 2020.
2. Deb, Kalyanmoy. Multi-Objective Optimization Using Evolutionary Algorithms. Wiley, 2009.
3. Bubeck, Sebastien. Convex Optimization: Algorithms and Complexity. Now Publishers, 2015.

Guidelines for Practicals:

1. The course instructor should design assignments by considering the required background knowledge, relevant technologies, practical applications and current trends related to the course.
2. Preferably, there should be multiple sets of assignments and distributed among batches of students.
3. Giving assignments based on real-life problems can help the students with future projects.
4. Students should be encouraged to use free and open-source software.

5. Instructors can also include an additional assignment that goes beyond the syllabus, but aligns with the course.
6. Instructors should include a course project to be implemented by a group of 2 or 3 students. It should be based on different topics studied in the course. Instructors should frame proper guidelines for the effective implementation of the course project.

Course Code: 170605A	Course Name: Automotive Technology	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Engineering Physics, Engineering Mechanics.

Course Objectives:

- To provide fundamental understanding of construction and working of automobile subsystems.
- To equip students with tools and methods to measure and analyze performance of automobiles.
- To acquaint students with contemporary automotive technologies.

Course Outcomes:

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

CO1: Compare the various chassis and drive-trains of an automobile.

CO2: Analyze axles, wheels, tyres and the steering system of an automobile.

CO3: Select suspension and braking systems of an automobile.

CO4: Measure and analyze the performance of an automobile and describe the safety aspects.

CO5: Discuss electrical systems and assess modern propulsion technologies of an automobile.

Course Contents:

Unit-I: Introduction to Chassis and Drive Train 08 Hours

Introduction: Current scenario in Indian auto/ancillary industries, vehicle specifications and classification.

Chassis and Frames: Types of chassis layout with reference to power plant locations and drive, various types of frames and constructional details.

Drive Trains: Necessity and selection of clutch, necessity of gearbox and different types, overdrive, torque convertor, continuous variable transmission, dual clutch transmission, automated manual transmission, propeller shaft, final drive, and differential.

Unit-II: Axles, Wheels, Tyres and Steering System 08 Hours

Axles: Purpose, requirement and types of front and rear axle, loads acting on rear axles.

Wheels and Tyres: Wheel construction, alloy wheel, wheel balancing and rotation, type of tyres, tyre construction, tyre materials, factors affecting tyre life.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristics, steering linkages and gearbox, power steering, collapsible steering, reversibility of steering, four-wheel steering, wheel alignment.

Unit-III: Suspension and Brake Systems **08 Hours**

Suspension: Types of suspension linkages, types of suspension springs- leaf, coil, air springs, hydrogas, interconnected suspension, self-leveling suspension (active suspension), shock absorbers (hydraulic and air). **Brake Systems:** Drum, disc, mechanical, hydraulic, air brakes, power-assisted brakes, hand brake, ABS, EBD, BA.

Unit-IV: Vehicle Performance and Safety **08 Hours**

Vehicle performance: parameters; vehicle resistances; traction and tractive effort; power requirements for propulsion; road performance curves (numerical examples); vehicle stability; vehicle testing on a chassis dynamometer; NVH in automobiles. **Vehicle safety:** Types of active and passive safety, vehicle interior and ergonomics.

Unit-V: Electrical Systems and Modern Propulsion Technologies **08 Hours**

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, introduction to lithium batteries.

Electrical System and Accessories: Basic electric layout of the vehicle, automotive sensors and actuators, electronic control unit/module.

Modern Propulsion Technologies: Concept and environmental importance of EVs and HEVs, Layout, construction and working, Challenges and future scope of EVs and HEV.

Learning Resources:

Text Books:

1. William H. Crouse., “Automotive Mechanics”, Tata McGraw Hill Publishing House.
2. Narang G. B. S, “Automobile Engineering”, S. Chand and Company Ltd.

Reference Books:

1. Kirpal Singh, “Automobile Engineering”, Volume 1, Standard Publishers distributors.
2. R. K. Rajput, “Automobile Engineering”, Laxmi Publications.

Web link for MOOC / NPTEL Links:

1. Fundamentals of Automotive Systems: https://onlinecourses.nptel.ac.in/noc20_de06/preview
2. Autotronics: https://onlinecourses.nptel.ac.in/noc26_me101/preview
3. Vocational: Automotive Services Technician (Four-Wheeler): https://onlinecourses.swayam2.ac.in/nos24_ge28/preview

4. Automotive Industrial Engineering:
   https://www.coursera.org/learn/automotive-industrial-engineering
5. Automotive Engineering: Automobile Fundamentals:
   https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/

List of Practicals: (Any 6)

1. Identify four vehicles having different chassis layout and compare their performance.
2. Identify four vehicles equipped with different types of automatic transmission and compare their performance.
3. Visit an automobile service centre for demonstration of wheel alignment and write a detailed report on axle, wheels, tyres and wheel alignment of one car.
4. Experimental study of shock absorber.
5. Measurement of noise and vibration in an automobile.
6. Study of requirements of BNCAP test.
7. Demonstration on basic maintenance and checks of an automobile such as doors etting, consumable checking and replacing, brake pad checking &replacing, checking tyre wear etc.

Course Code: 170605B	Course Name: Database Systems	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Fundamentals of Programming.

Course Objectives:

- To understand the fundamental concepts of database management.
- To identify and classify entities, attributes, and relationships in real-world problem domains.
- To understand the principles and structure of the relational data model.
- To demonstrate the use of SQL for secure and efficient database querying and management.
- To understand the basic concepts of transaction processing and concurrency control.

Course Outcomes:

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

CO1: Explain the basic concepts, architecture, and components of database systems.

CO2: Convert ER diagrams into equivalent relational database schemas.

CO3: Normalize relational schemas using functional dependencies.

CO4: Explain the purpose and components of SQL in relational database systems.

CO5: Identify various transaction states and common transaction operations.

Course Contents:

Unit-I: Introduction to Database Systems **08 Hours**

Need of database system, Types of Data, Database System Applications, Database System VS File System, View of Data, Data Abstraction, data independence, Data Models, Structure of Database Management Systems. **Case Study:** Study of Architecture of any Database Management System (DBMS) like Oracle or MySQL.

Unit-II: Entity Relationship Modeling **08 Hours**

Conceptual data modeling: entities, entity types, attributes and its types, relationships, cardinalities on relationship, Entity Relationship diagram extended Features: Specialisation and Generalization on the ER Model. **Case Study:** ER Diagram conversion into Tables for

College Management Systems.

Unit-III: Relational Data Model **08 Hours**

Concept of relations, schema-instance distinction, keys and their types, Codd's Rules, Concept of Anomalies, Normalization, functional dependencies and Normal forms, 1NF, 2NF, 3NF and BCNF decompositions and desirable properties of them. **Case Study:** Library management system to identify different types of keys.

Unit-IV: Structured Query Language (SQL) **08 Hours**

Querying in SQL, DDL to create database and tables, table constraints, update database-update behaviors, DML, aggregation functions group by and having clauses, retrieve data from the database, generate and query views. Different types of Joins. **Case Study:** Design and implementation of Student Course Management System using SQL for effective management of students, courses, and faculty members.

Unit-V: Overview of Transaction Management **08 Hours**

The ACID Properties, Transactions and Schedules, Concurrency Control–The Need for Concurrency Control, Serializability, Locking Methods, Deadlock, Time Stamping Methods, Concurrency Control Protocols. Database Recovery: Need for Recovery, Recovery Techniques. **Case Study:** Design Online Shopping Cart Transaction Management In an e-commerce platform, multiple users simultaneously add, update, and purchase products.

Learning Resources:

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 6th edition
2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education, ISBN 978-81-317-6092-5
3. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Sixth Edition, ISBN-13: 978-0-136-08620-8.

Reference Books:

1. Shio Kumar Singh, Database Systems Concepts Design and Applications, Pearson
2. Mario Piattini, Oscar Diaz - Advanced Database Technology and Design- online book.

Web link for MOOC / NPTEL Links:

1. Introduction to Database Systems By Prof. Sreenivasa Kumar, IIT Madras. https://onlinecourses.nptel.ac.in/noc20_cs03/preview

List of Practicals:

1. Study of installation of various database software like MySQL, MariaDB & Oracle, etc.
2. Draw an ER diagram for any database system with various entities and their attributes on ERWin/ERDPLUS Software.
3. Implement SQL queries to provide students with hands-on experience for studying various commands of DDL.
4. Implement SQL queries to provide students with hands-on experience for studying various commands of DML.
5. Implement SQL queries to provide students with hands-on experience for studying various Logical Operators of SQL.
6. Implement SQL queries to provide students with hands-on experience in implementing various data constraints using SQL commands in MySQL/MariaDB.
7. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing all types of joins.
8. Write at least 10 SQL queries for suitable database applications using SQL DML statements by implementing sub-queries and views.
9. Write at least 10 SQL queries for suitable database applications using SQL DML statements for studying various aggregation functions.
10. ER Modeling and Normalization: a. Consider case studies and formulate.
    a. Problem statement for any application to be developed.
    b. Propose a conceptual design using ER.
    c. Convert ER diagram into relational tables and normalize relational data model.
11. Mini- Project.

Course Code: 170605C	Course Name: Industrial Control Components	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE :** 40 Marks **ESE :** 60 Marks **TW :** 50 Marks

Expected Prerequisite Courses:

- Fundamentals Electronics Engineering.

Course Objectives:

- To understand the basics of process control, including variables, system types, and real-world applications of control loops.
- To learn about transmitters, signal standardization, communication protocols, and converters used for accurate measurement in process control.
- To explore control actions and tuning methods to optimize controller performance and prevent issues like reset windup.
- To understand control valve design, terminology, types, and sizing using Cv calculations in line with industry standards.
- To learn about valve accessories and actuators, focusing on their design and function for optimal control system performance.

Course Outcomes:

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

CO1: Analyze process variables, control system types, and process characteristics, and evaluate examples of process control loops in industry.

CO2: Apply knowledge of transmitters, signal standards, protocols, and converters to evaluate their role in process control systems.

CO3: Design and apply control actions and tuning methods to optimize controller performance and system stability.

CO4: Evaluate control valve selection, sizing, and design based on key characteristics and industry standards.

CO5: Analyze and evaluate valve accessories and actuators for optimal performance in process control systems.

Course Contents:

Unit-I: Introduction to Process Control 08 Hours

Key Concepts in Process Control: Process Variables: Definition and differentiation of manipulated, disturbance, and output variables.

Control System Types: Understanding Open-Loop vs. Closed-Loop systems.

Block Diagram Representation: Structure and components of control loops. Examples of Process Control Loops: Application examples of control loops in industries—temperature, flow, level, and pressure.

Unit-II: Transmitters and Converters 08 Hours

Transmitters and Signal Standardization: Importance of transmitters in process control systems. Standardization of signals: current (4-20 mA), voltage (0-10 V), and pressure signal standards. **Types of Transmitters:** Live zero vs. dead zero, and concept of two-wire. SMART Transmitters. **Differential Pressure Transmitters (DPT):** Types, installation, and calibration of DPTs. Application in level and flow measurement. Zero elevation, suppression.

Converters: Understanding the difference between converters and transmitters. Types: Current-to-pressure and pressure-to-current converters.

Unit-III: Control Actions and Tuning Techniques 08 Hours

Discontinuous Control: On-Off, multi-position, floating control modes. **Continuous Control:** Proportional (P), Integral (I), Derivative (D), PI, PD, and PID control modes.

Reset Windup: Techniques to prevent reset windup, rate before reset, and bumpless transfer.

Controller Tuning Methods: Introduction to process reaction curve. Tuning techniques: Ziegler-Nichols.

Unit-IV: Control Valve: Design, Sizing, and Selection 08 Hours

Control Valve Fundamentals: Key terminology: Rangeability, turndown ratio, cavitation, flashing, noise, viscosity index, valve capacity, AO, AC, and fail-safe actions. **Valve Characteristics:** Linear, equal percentage, and quick-opening characteristics.

Valve Types and Applications: Overview of different valve types: Globe, Ball, Butterfly, Diaphragm, and specialty valves for high-temperature and high-pressure applications.

Valve Sizing and Selection: Cv Calculation.

Unit-V: Control Valve Accessories and Actuator Design 08 Hours

Valve Accessories: Detailed discussion on accessories such as petitioners (pneumatic, electro-pneumatic, and digital), I/P converters, volume boosters, air lock, limit switches, solenoid valves, and hand wheels.

Actuator Types and Design: Understanding different actuator types: Spring and diaphragm, piston cylinder, and smart actuator.

Learning Resources:

Text Books:

1. C. D. Johnson, Process Control and Instrument Technology, Tata McGraw Hill, Publications, 8th Edition.
2. N. A. Anderson, Instrumentation for Process Measurement and Control, CRC Press.

Reference Books:

1. G. Liptak, “Process Control”, Instrument Engineering Handbook CRC Press,

Web link for MOOC / NPTEL Links:

1. Industrial Automation and Control, By Prof. Siddhartha Mukhopadhyay, IIT Kharagpur.
   https://nptel.ac.in/courses/108105062
2. Process Control and Instrumentation, by Dr. P.K. Saha, IIT Guwahati.
   https://nptel.ac.in/courses/103103037

List of Practicals: (Any 8)

1. Identification of industrial control components.
2. Block diagram of an industrial automation system.
3. Comparison of open-loop and closed-loop systems.
4. Direction control valve applications.
5. Control valve sizing basics.
6. Actuator selection.
7. Valve characteristic comparison.
8. PID control exercises.
9. Tuning of PID controller for level/flow control loop.
10. Controller tuning problems.
11. Process reaction curve analysis.
12. Study of the control valve & plot the installed characteristics of the control valve.

Course Code: 170605D	Course Name: Embedded System in IoT	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Basic Electronics Fundamentals, Sensors and Actuators, Basic C Programming.

Course Objectives:

- To understand the fundamentals of embedded systems, IoT architecture, and the role of hardware–software co-design in connected devices.
- To develop the ability to interface sensors, actuators, and communication modules with microcontrollers for IoT applications.
- To analyze and implement embedded programming concepts using platforms such as Arduino, Raspberry Pi, or ARM-based controllers.
- To design and develop IoT-based systems using networking protocols (e.g., MQTT, HTTP) and cloud integration techniques.
- To evaluate security, power management, and real-time constraints in embedded IoT systems for efficient and reliable performance.

Course Outcomes:

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

CO1: Explain fundamentals of embedded systems, including components, classifications, design metrics, and the role of microcontrollers.

CO2: Apply IoT hardware design concepts using microcontroller platforms, interfaces, and communication modules with effective power management.

CO3: Apply IoT communication models, protocols, data transmission, and basic cloud integration concepts.

CO4: Analyze Embedded C programming, real-time processing, RTOS concepts, and low-power design techniques in IoT-based embedded systems.

CO5: Evaluate end-to-end IoT system design, security mechanisms, and real-world IoT applications across domains.

Course Contents:

Unit-I: Introduction to Embedded Systems 08 Hours

Definition, characteristics, and requirements of embedded systems, Embedded system components: hardware, software, processors, peripherals, Classification of embedded systems, Embedded system design metrics: cost, power, performance, memory, reliability, Applications of embedded systems in various domains, Overview of microprocessors vs microcontrollers, Role of 8-bit microcontrollers in embedded development.

Unit-II: IoT Hardware Platforms and Interfacing 08 Hours

Design Considerations for IoT Hardware, Microcontroller Platforms: Arduino, ESP32, NodeMCU, Nucleo (STM32 Overview), ADC, DAC, GPIO Programming, Communication Interfaces: UART, SPI, I2C, Wireless Communication Modules (Wi-Fi, BLE, GSM, LoRa – Basics), Power Management in IoT Devices.

Unit-III: IoT Communication Protocols and Networking 08 Hours

IoT Communication Models, IP Addressing Basics, Application Layer Protocols: MQTT, HTTP, CoAP (Overview), Client-Server vs Publish-Subscribe Model, Data Acquisition and Transmission, Introduction to Cloud Platforms (ThingsBoard / AWS IoT – Conceptual), REST API Basics.

Unit-IV: Embedded Software and Real-Time Concepts for IoT 08 Hours

Embedded C for IoT Applications, Interrupt Handling and Timer-Based Programming, Real-Time Data Monitoring, Introduction to RTOS for IoT Devices, Task Scheduling Basics, Data Logging and Local Storage, Edge Computing Concept, Low Power IoT Design Techniques.

Unit-V: IoT System Design, Security and Applications 08 Hours

End-to-End IoT System Design Methodology, IoT Security: Authentication, Encryption Basics, Secure Communication (TLS Concept), Data Analytics Basics for IoT, Industrial IoT (IIoT) Overview, Smart City Applications, Smart Energy Monitoring System, IoT-Based Environmental Monitoring, Smart Irrigation System, Remote Health Monitoring System.

Learning Resources:

Text Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi & Rolin D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Pearson Education.
2. Zdravko Karakehayov, “Embedded Systems Design with 8051 Microcontrollers: Hardware and Software”, CRC Press / Taylor & Francis.
3. Raj Kamal, “Embedded Systems: Architecture, Programming & Design”, Tata McGraw-Hill.

4. David E. Simon, “An Embedded Software Primer”, Pearson Education.

Reference Books:

1. Daniel D. Gajski, Samar Abdi, “Embedded System Design: Modeling, Synthesis and Verification”, Springer, 2021.
2. Peter Marwedel, “Embedded System Design: Foundations of Cyber-Physical Systems and the Internet of Things”, Springer
3. Qing Li & Caroline Yao, “Real-Time Concepts for Embedded Systems”, CRC Press (Taylor & Francis)
4. Marilyn Wolf, “Computers as Components: Principles of Embedded Computing System Design”, Elsevier
5. Catherine H. Gebotys, “Security in Embedded Devices”, Springer.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.nptel.ac.in/noc24_ee68/preview
2. https://onlinecourses-archive.nptel.ac.in/noc19_cs32/course
3. https://www.coursera.org/learn/iot

List of Practicals: (Any 8)

1. Draw and explain 3-layer and 5-layer IoT architecture. Map real-world application to architecture layers.
2. Comparison of IoT Development Boards. Compare Arduino, ESP32, Raspberry Pi based on: Processing speed, Memory, Connectivity, Power consumption, Application suitability.
3. Sensor & Actuator Selection. Select appropriate sensors for:
    a. Smart irrigation system
    b. Health monitoring system
    c. Smart energy meter

    Justify selection with technical reasoning.
4. Protocol Comparison. Compare MQTT, HTTP, CoAP. Identify best protocol for given IoT scenario.
5. IoT Communication Model Analysis. Device-to-Device. Device-to-Cloud. Device-to-Gateway. Draw block diagrams and explain.
6. Embedded C Programming Problems. Write logic for:
    a. Sensor threshold detection
    b. PWM-based motor control
    c. Interrupt-based event detection.
7. IoT Security Case Study. Identify security threats in smart home system. Suggest countermeasures.
8. Design complete IoT solution for Smart parking.

9. Design complete IoT solution for Weather monitoring.
10. Industrial IIoT Monitoring Plan. Design a predictive maintenance node with: Vibration analysis, Data transmission, Dashboard planning.
11. Smart Campus IoT Design. Complete architecture including: Sensors, Networking, Cloud, Security, Cost estimation.
12. Sensor Signal Conditioning Design. Design amplifier gain for low-voltage sensor. Select filter type for noise removal.

Course Code: 170605E	Course Name: Governing Policies	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Business Economics.

Course Objectives:

- To explain the principles of infrastructure systems, governance frameworks, and policy implementation in urban and rural contexts.
- To examine economic evaluation tools, including demand forecasting, cost–benefit analysis, financing options, and PPP models.
- To interpret national infrastructure programs, policies, and regulations for effective development planning.
- To apply sustainable, inclusive, and technology-driven approaches to plan and manage urban and rural infrastructure.

Course Outcomes:

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

CO1: Understand infrastructure, governance, and policy implementation in urban and rural development.

CO2: Analyze economic aspects of infrastructure, apply demand forecasting, cost–benefit analysis, financing mechanisms, and PPP models.

CO3: Apply national infrastructure programs, policies, and regulations to plan and assess urban and rural development projects.

CO4: Implement planning and management tools for urban and rural infrastructure projects.

CO5: Apply concepts of sustainable and inclusive infrastructure by integrating climate resilience, risk reduction, resource efficiency, digital governance, and global case insights.

Course Contents:

Unit-I: Infrastructure Governance **08 Hours**

Concept, scope, and components of urban & rural infrastructure, Infrastructure lifecycle and asset management, Principles of good governance, Role of central, state, and local governments, Urban Local Bodies (ULBs), Panchayati Raj Institutions (PRIs), National

policies on housing, transport, water, sanitation, energy, rural development, Policy formulation, implementation, monitoring.

Unit-II: Economics of Urban and Rural Infrastructure 08 Hours

Economic characteristics of infrastructure (public goods, externalities, natural monopoly), Demand forecasting & cost–benefit analysis (CBA), Budgetary allocations, grants, and intergovernmental transfers, Municipal finance and rural development financing, PPP models, Case studies, Life-cycle costing, Economic impact assessment, social cost–benefit analysis.

Unit-III: Policies, Acts and Regulatory Frameworks 08 Hours

AMRUT, Smart Cities Mission, Swachh Bharat Mission, National Urban Housing Policy, PMAY, National Transport Policies, PMGSY, NRLM, MGNREGA, Rural drinking water, sanitation, electrification programs, Environmental regulations (EIA, Water/Air Acts, Waste Management Rules), Land acquisition and R&R policies, Infrastructure concession frameworks.

Unit-IV: Planning, Implementation and Monitoring of Infra. Projects 08 Hours

Master planning, regional planning, Integrated urban/rural planning approaches, GIS-based infrastructure planning, DPR preparation, feasibility studies, Procurement methods, contract management, Risk management, KPIs for urban and rural services, Service level benchmarks (SLBs), Digital governance & monitoring systems.

Unit-V: Sustainable, Inclusive and Resilient Infrastructure Governance 08 Hours

Green and climate-resilient infrastructure, Disaster risk reduction, Energy efficiency, circular economy, Infrastructure for marginalized groups, Rural–urban linkages for balanced development, E-governance tools IoT, AI, and data analytics, UN SDGs and infrastructure governance, international case studies.

Learning Resources:

Text Books:

1. Town Planning, G. K. Hiraskar, Dhanpat Rai Publications
2. Town Planning, S. C. Rangwala, Charotar Publishing House Pvt. Ltd.
3. Rural Development: Planning Strategy & Policy Imperatives — Vivek Saurath & Manoj Agarwal.

Reference Books:

1. Urban Planning by Chris Couch.
2. Urban Infrastructure and Governance by G. Ramesh, Vishnu Prasad Nagadevara, Gopal Naik, Anil Suraj.
3. Urban and Regional Planning Education: Learning for India (edited by Ashok Kumar, Diwakar S. Meshram, Krishne Gowda.

4. Swachh Bharat Mission Guidelines.
5. MRTP Act 1966: The director, government printing, stationary and publications, Maharashtra state, Mumbai
6. URDPFI & AMRUT Guidelines: Ministry of housing and urban affairs, Government of India.
7. Natural Infrastructure and Resilient Cities: Role of Green Infrastructure in Urban Planning for Adaptation to Climate Change in India (2025, by National Institute of Disaster Management, Delhi).
8. Role of Edge Analytics on Sustainable Smart City Development: Challenges and Solutions by G. R. Kanagachidambaresan.
9. Sustainable Smart Cities in India: Challenges and Future Perspectives (The Urban Book Series) by Poonam Sharma and Swati Rajput.
10. Rural Development: Principles, Policies and Development by Katar Singh and Anil Shishodia. Atlantic Publications.

Web link for MOOC / NPTEL Links:

1. https://onlinecourses.swayam2.ac.in/imb21_mg02/preview
2. https://onlinecourses.swayam2.ac.in/ugc23_ge04/preview
3. https://onl inecourses.nptel.ac.in/noc23_ce52/preview
4. https://onlinecourses.swayam2.ac.in/cec20_ar01/preview
5. https://www.coursera.org/learn/smart-cities
6. https://onlinecourses.nptel.ac.in/noc25_ar27/preview
7. https://onlinecourses.nptel.ac.in/noc26_ar08/preview
8. https://onlinecourses.nptel.ac.in/noc25_ar25/preview
9. https://onlinecourses.nptel.ac.in/noc26_ce48/preview

List of Practicals (Any 8):

1. Presentation on any national policy for housing and transport. (Group Activity)
2. Analyze the latest central/state government budget allocations for infrastructure sectors. (Individual Activity)
3. Comparison of Public-Private Partnership (PPP) models in infrastructure project (Individual Activity)
4. Conduct a sanitation or waste management study under Swachh Bharat guidelines with case study. (Individual Activity)
5. Prepare a compliance checklist for industries under Water Act, Air Act, and Waste Management Rules. (Group Activity)
6. Prepare a land use map and zoning proposal for a neighborhood. (Group work)

7. Conduct a basic energy audit of a building (college, hostel, home) and propose energy-saving measures. (Group Activity)
8. Suggest a small-scale circular economy project for rural or urban ward. (Group Activity)
9. Map how infrastructure projects (roads, water supply, housing, digital systems) contribute to SDGs 6, 7, 9, 11, and 13. (Individual Activity)
10. Identify and explain components of a tender document by referring to any online tender document related to infrastructure project.

Course Code: 170605F	Course Name: Application Development	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE** : 40 Marks **ESE** : 60 Marks **TW** : 50 Marks

Expected Prerequisite Courses:

- Web Development, Database Management Systems.

Course Objectives:

- To familiarize students with client-side scripting concepts.
- To provide knowledge of server-side development and backend processing in web applications.
- To enable students to understand basic database concepts.
- To understand and learn Web application deployment.

Course Outcomes:

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

CO1: Apply the client-side technologies for web development.

CO2: Develop user interfaces using component-based design approaches.

CO3: Apply the server-side technologies for web development.

CO4: Create effective web applications for business functionalities using the latest web development platforms.

CO5: Deploy web applications in collaborative environments.

Course Contents:

Unit-I: Basics of Web Application Interactivity **08 Hours**

Introduction to JavaScript, JS Variables and Constants, JS Variable Scopes, JS Data Types, JS Functions, JS Array, JS Object, JS Events.

Unit-II: ReactJS **08 Hours**

Introduction to ReactJS, ReactJS Components Styling, Routing, Redux- Architecture, Hooks-Basic hooks, useState() hook, useEffect() hook, useContext() hook.

Unit-III: Backend Development Using NodeJS **08 Hours**

Role of backend in web applications, Introduction to NodeJS, Environment Setup, Node.JS Events, Node.JS Functions, Node.JS Built-in Modules, File System, Handling Data I/O in Node.JS, Create HTTP Server, Create Socket Server.

Unit-IV: Database Integration Using MongoDB 08 Hours

Introduction to databases, Need for databases in web applications, Types of databases: SQL vs NoSQL, MongoDB fundamentals, Data models and schemas, Basic CRUD operations.

Unit-V: Managing and Deploying Web Applications: GitHub 08 Hours

Deployment strategies, Overview of Git, Git Repositories: Public vs private repositories, Basic Git Workflow & commands, collaboration using GitHub.

Learning Resources:

Text Books:

1. Jeffrey C.Jackson, "Web Technologies: A Computer Science Perspective", Second Edition, Pearson Education, 2007, ISBN 978-0131856035.
2. Kogent Learning Solutions Inc, Web Technologies: HTML, JAVASCRIPT, PHP, JAVA, JSP, XML and AJAX, Blackbook, Dreamtech Press, ISBN: 9788177228496.

Reference Books:

1. Shama Hoque, Full-Stack React Projects: Learn MERN Stack Development by Building Modern Web Apps, Packt Publishing.
2. Dr. Hiren Joshi, Web Technology and Application Development, DreamTech, 1st Ed.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/programming-with-javascript
2. https://www.coursera.org/specializations/build-dynamic-website

List of Practicals:

1. Design responsive user registration and login which will do the following actions: Register user, login user functionality.
2. Create a To-Do List application where users can add tasks, mark tasks as completed, and delete tasks.
3. Develop a frontend using React JS which includes forms and navigation.
4. Create a Node.JS Application which serves a static website.
5. Develop a Node.js application with MongoDB to perform CRUD Operations.
6. Create version control account on GitHub and implement basic git commands and repository handling.
7. Mini Project: Develop a web application using front end and backend technologies in any of the domains: Social Media, E-commerce, Finance, Education, Any other.

Course Code: 170605G	Course Name: Data Visualization	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Programming and Problem Solving.

Course Objectives:

- To introduce the fundamental concepts and importance of data visualization.
- To develop the ability to create basic graphical representations such as bar charts, line charts, etc.
- To enable students to explore and summarize datasets using filtering, aggregation, and basic statistical measures.
- To apply visualization techniques to analyze time-series and geospatial data commonly used in engineering applications.
- To develop skills for creating dashboards and communicating insights through visual storytelling and business analytics tools.

Course Outcomes:

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

CO1: Explain the importance, principles, and techniques of data visualization and perform basic data exploration using filtering and aggregation methods.

CO2: Apply appropriate visualization techniques to create basic and advanced charts.

CO3: Analyze time-series datasets to identify trends, seasonality, and noise using suitable visualization techniques.

CO4: Analyze geospatial data using mapping techniques to derive meaningful insights.

CO5: Develop interactive dashboards and visual reports using visualization tools to communicate data insights effectively.

Course Contents:

Unit-I: Overview of Data Visualization 08 Hours

Importance and benefits of good data visualization– Design principles. Statistical Measures, Introduction to python libraries for visualization, Exploring Data – Reduce Items and Attributes: Filter and Aggregate.

Unit-II: Creation of Basic Visualization 08 Hours

Histogram, Bar (Vertical and Horizontal) and Line Chart, Box plot, Scatter plot (Examples and Exercises to be given for practice). Color palettes – Creation of 3D Charts. Creation of Advanced Visualization: Heat Map– Facet Grid – Interaction Techniques: Manipulate View – Creation of interactive Network topologies and Trees.

Unit-III: Visualization of Time Series Data **08 Hours**

Summary statistics and plotting aggregated views - Visualization of seasonality, trends and noise– working with multiple time series data such as Power load variation, Machine temperature monitoring, Rainfall and water level data, Signal variation in electronics.

Unit-IV: Visualization of Geospatial Data **08 Hours**

Spatial join - overlapping geospatial data to maps and adding special cues – Case Study-Visualization of multimodal data and analysis-case study sensor data and health care, genome and biomedical data.

Unit-V: Business Analytics and Visualization Tools **08 Hours**

Tableau, PowerBI, Creating Interactive Dashboards and charts to organize data using visualization principles and Data Storytelling.

Learning Resources:

Text Books:

1. Python Data Visualization: An Easy Introduction to Data Visualization in Python, ISBN: 9780070087705, Tata McGraw-Hill Education, 2009.
2. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.

Reference Books:

1. Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code Jack Dougherty and Ilya Ilyankou 1st Edition, O'Reilly Media, 2021.
2. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012.

Web link for MOOC / NPTEL Links:

1. https://www.coursera.org/learn/advanced-data-visualization-with-tableau-public

List of Practicals:

1. Load a dataset and perform basic data exploration by identifying attributes, data types, and displaying summary statistics.
2. Using a dataset, compute statistical measures (mean, median, standard deviation) and perform filtering and aggregation

3. Create Histogram, Bar Chart (vertical and horizontal), and Line Chart using a suitable dataset.
4. Using a dataset, create Box Plot and Scatter Plot to analyze data distribution and relationships between variables.
5. Using a dataset, generate advanced visualizations such as Heat Map and Facet Grid with appropriate color palettes.
6. Using a time-series dataset, create visualizations to identify trends, seasonality, and patterns.
7. Using a geospatial dataset, plot location-based data on a map and analyze spatial distribution.
8. Create an interactive dashboard using Tableau or Power BI and present insights using data storytelling.

Course Code: 170605H	Course Name: Drives and Controls	
Teaching Scheme	**Credit**	**Evaluation Scheme**
Theory : 3 Hours/Week **Tutorial :** 1 Hour/Week	**3** **1**	**CCE : 40 Marks** **ESE : 60 Marks** **TW : 50 Marks**

Expected Prerequisite Courses:

- Power Electronics, Electric Machines.

Course Objectives:

- To understand the fundamentals, components, and control principles of electric drive systems.
- To analyze thermal models and select appropriate motor power ratings for different duty cycles.
- To study performance, speed control, and braking methods of DC motor drives.
- To understand operation, control techniques, and speed control methods of induction motor drives
- To understand the types, operation, and control of synchronous and special motor drives for fixed and variable speed applications.

Course Outcomes:

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

CO1: Explain the fundamentals, components, selection criteria, and control techniques of electric drives, including closed-loop and PLL control.

CO2: Analyze the thermal characteristics of motors to determine suitable motor power ratings under different duty cycles and load conditions.

CO3: Analyze performance, speed control, multi-quadrant operation, and closed-loop control of DC motor drives.

CO4: Explain starting, speed control methods, slip power recovery techniques, and closed-loop control of induction motor drives.

CO5: Analyze the operation and control of synchronous, Permanent Magnet Synchronous Motor, BLDC, stepper, and switched reluctance motor drives.

Course Contents:

Unit-I: Basics of Electric Drives and Control **08 Hours**

Definition, Advantages of electrical drives, Components of Electric drive system, Selection Factors, status of Electrical Drives (DC & AC), speed control and drive classifications, close

loop control of drives, phase locked loop (PLL) control.

Unit-II: Selection of Motor Power Rating 08 Hours

Thermal model of motor for heating and cooling-Relationship between temperature rise and time, Heating time constant, Cooling time constant. classes of motor duty- continuous duty, short time duty, intermittent periodic duty, intermittent periodic duty with starting, intermittent periodic duty with starting & braking, continuous duty with intermittent periodic loading, continuous duty with starting & braking, Continuous duty with periodic speed changes. Determination of motor ratings, Selection of power ratings of motor -continuous duty and constant load, continuous duty and variable load, Short time rating of motor.

Unit-III: DC Motor Drives 08 Hours

DC motors and their performance starting, transient analysis, speed control, Controlled rectifier fed drives, full controlled 3 phase rectifier control of dc separately excited motor, Multi quadrant operation, Chopper controlled drives closed loop speed control of DC motor.

Unit-IV: Induction Motor Drives 08 Hours

Induction motor analysis, starting and speed control methods- voltage and frequency control, current control, closed loop control of induction motor drives, rotor resistance control, Slip power recovery: Static Kramer and Scherbius Drive, Single phase induction motor starting, braking and speed control.

Unit-V: Special Purpose Motor Drives 08 Hours

Synchronous motor types, operation with fixed frequency, variable speed drives, Permanent Magnet Synchronous Motor and BLDC motor drives, Stepper motor drives, switch reluctance motor drives.

Learning Resources:

Text Books:

1. G. K. Dubey, Fundamentals of Electrical Drives, 2nd Edition (sixth reprint), Narosa Publishing House, 2001.
2. M. L. Soni, P.V. Gupta, U. S. Bhatnagar, “A course in Electrical Power”, 1999, Dhanpat Rai & Sons.

Reference Books:

1. M. H. Rashid, Power Electronics -Circuits, devices and Applications, 3rd Edition, PHI Pub. 2004.
2. B. K. Bose, Modern Power Electronics and AC Drives, Pearson Education, Asia, 2003.

Web link for MOOC / NPTEL Links:

1. http://nptel.ac.in/courses/108104140

List of Practicals:

1. Based on Basics of Electric Drives and Control.
2. Based on Selection of Motor Power Rating.
3. Based on DC Motor Drives.
4. Based on Induction Motor Drives.
5. Based on Special Purpose Motor Drives.
6. Mini project/case study on Electrical drives.
7. Seminar on Electrical drives.
8. Industrial Visit to electrical drive and control industry and prepare report.

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