VIVEKANAND EDUCATION SOCIETY

INSTITUTE OF TECHNOLOGY (AUTONOMOUS)

Hashu Advani Memorial Complex, Collector's Colony,
Chembur, Mumbai, 400074, Maharashtra, India
www.vesit.ac.in

Syllabus Approved By:

Academic Council of V.E.S. Institute of Technology

Effective from: 2023-24

Preamble

Engineering education forms the cornerstone of technological innovation, industrial advancement, and societal transformation. As the world navigates an era of rapid change driven by automation, artificial intelligence, sustainable technologies, and global connectivity, VESIT positions itself as a catalyst for cultivating a dynamic learning ecosystem.

At VESIT, we strive to foster critical thinking, technical expertise, academic excellence, and holistic development among aspiring engineers. We are committed to shaping professionals who are adaptable, collaborative and are also deeply conscious of their social and environmental responsibilities.

Leveraging its autonomous status and affiliation with the University of Mumbai, VESIT designs a forward-thinking, outcome-based curriculum that emphasizes industry relevance and experiential learning.

The syllabus at VESIT has been structured in alignment with the principles of the National Education Policy (NEP) 2020, focusing on flexibility and multidisciplinary learning. The key thrust areas of education at VESIT include :-

Student-Centric Approach:

The programme is designed to offer students greater autonomy in shaping their academic journey. The syllabus comprises of **Core (Major) and Minor courses** from Diverse Disciplines as well as a wide range of **Open Electives**. Students can tailor their learning paths based on their interests and career aspirations. The curriculum also integrates mentored field projects and on the job training, providing valuable hands-on experience. Additionally, students with a research inclination can also explore **research-based projects** or pursue **Honours by Research.**

Multidisciplinary Approach:

VESIT's curriculum reflects a strong interdisciplinary focus,incorporating emerging fields and cutting-edge technologies. Courses are designed to bridge various domains with offerings such as **Machine learning, Artificial Intelligence & Data Science, Cyber Security, Geographic Information Systems (GIS), Internet of Things (IoT), Register transfer level VLSI, Robotics, Quantum Technologies, Mobile application development, Industrial Automation, Edge Computing and Embedded Intelligence and Information Security.**

This approach encourages broader thinking and prepares students for diverse career paths.

Emphasis on Conceptual Clarity:

The curriculum lays stress also on a strong theoretical foundation, ensuring that students gain deep conceptual understanding, which is essential for mastering advanced topics and solving real-world problems.

Fostering Creativity and Critical Thinking:

Courses are designed to nurture a critical and creative mindset, promoting analytical reasoning, problem-solving, and innovation. Students are encouraged to question, explore, and think beyond conventional solutions.

Comprehensive Evaluation and Assessment:

Student performance is assessed through a number of assessment tools that includes the Mid-term Tests, Continuous Assessments, End-Semester Examinations. These evaluation tools are designed to measure the knowledge retention of students as well as their ability to apply concepts effectively in practical situations.

Guided by a vision of excellence and inclusivity, and supported by a passionate faculty, VESIT aspires to be a hub where ideas flourish, startups emerge, and industry-academia partnerships thrive. Our goal is to transform students into innovators, entrepreneurs, researchers and responsible leaders poised to drive sustainable growth and meaningful change in society.

Dr. J M Nair	Dr. M Vijayalakshmi	Dr. Mrs. Gresha S Bhatia
Principal, VESIT	Vice Principal, VESIT	Academic Coordinator, VESIT

Preamble Department of Computer Engineering

The programme under the Department of Computer Engineering is committed to nurturing innovation-driven, technically competent, and industry-ready professionals. The schema and syllabus is designed in sync with the mission of the department and adhering programme objectives(POs) and structured through course objectives(COs). The core curriculum emphasizes computational thinking, algorithmic precision, and software-hardware integration through foundational courses such as Data Structures, Operating Systems, Design and Analysis of Algorithms, and Computer Networks. To stay ahead in a competitive technological environment, the department integrates **Multidisciplinary Minor Courses (MDM)** in Artificial Intelligence, Machine Learning, and Deep Learning, enabling students to master data-driven decision-making and intelligent system design. This solid groundwork is complemented by advanced topics in Cryptography, Blockchain Development, and Software Engineering to cultivate system-level understanding and problem-solving acumen. The emphasis on **industry readiness** is exemplified through **Vocational and Skill Development** tracks in Full Stack Web Development, Cloud and Distributed Computing, and Mobile App Development, which prepare students for real-world software development environments and DevOps culture. Furthermore, **Program Electives** in NLP, Embedded Systems, Data Engineering, and GeoInformatics allow learners to tailor their expertise to specific industry domains. The department also champions sustainability and ethical innovation through **Open Electives** in Green Technologies, Cyber Laws & Digital Forensics, and Smart Systems, encouraging responsible technological advancement. Emerging areas such as Quantum Technologies, Edge Computing, Robotics, and VLSI are woven into the **Minor in Emerging Areas (MEA)** to ensure forward compatibility and academic agility. Through a strategic blend of theory, practice, and emerging tech, the Department empowers students to lead in next-generation computing and intelligent systems with clarity, competence, and conscience.

Dr. Nupur Giri — HOD, CMPN, VESIT

Dr. Mrs. Gresha S Bhatia — DHOD, CMPN, VESIT

T.E. NEP 2025-26

Department of Computer Engineering

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*In online mode

Semester V Teaching Scheme								
Course Type	**Course Code**	**Course name**	**Teaching scheme (Contact Hours)**			**Credits assigned**		**Total**
			Th	**Pr**	**Tut**	**Th**	**Pr/Tut**	
PCC	NCMPC51	Theory of Computer Science	3	-	-	3	-	3
PCC	NCMPC52/ NCMPCL52	Data Warehousing & Mining	3	2	-	3	1	4
PCC	NCMPC53/ NCMPCL53	Cryptography and System Security	3	2	-	3	1	4
PEC	NCMPE5X/ NCMPEL5X	Program Elective 1	3	2	-	3	1	4
MDM	NCMMM51/ NCMMML51	Course 3 Machine Learning	3	2	-	3	1	4
OE	NOE50X	Open Elective 2	3	-	1	4	-	4
PCC	NCMPCL51	Cloud Computing Lab	-	2	-	-	1	1
			18	**10**	**1**	**19**	**5**	**-**
		Total Hours	**29**			**Total Credits**		**24**

Program Elective 1		
Sr. No	Course Code	Course Name
1	NCMPE51	Data Engineering
2	NCMPEL51	Data Engineering Lab
3	NCMPE52	Design Thinking
4	NCMPEL52	Design Thinking Lab
5	NCMPE53	Internet of Everything
6	NCMPEL53	Internet of Everything Lab

Semester V Examination Scheme

Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
PCC	NCMPC51	Theory of Computer Science	20	20	60	2	-	-	**100**
PCC	NCMPC52/ NCMPCL52	Data Warehousing & Mining	20	20	60	2	25	-	**125**
PCC	NCMPC53/ NCMPCL53	Cryptography and System Security	20	20	60	2	25	-	**125**
PEC	NCMPE5X/ NCMPEL5X	Program Elective 1	20	20	60	2	25	-	**125**
MDM	NCMMM51/ NCMMML51	Course 3 Machine Learning	20	20	60	2	25	25	**150**
OE	NOE50X	Open Elective 2	20	20	60	2	-	-	**100**
PCC	NCMPCL51	Cloud Computing Lab	-	-	-	-	25	25	**50**
								Total marks	**775**

Open Elective 2

Sr. No.	Course Code	Course names
For Departments of AI&DS, CMPN, IT		
1	NOE506	Solid and Hazardous waste management
2	NOE507	Fundamentals of Sustainability Engineering
3	NOE508	Energy Audit and Management
4	NOE509	Electric Vehicles
5	NOE510	Industrial Automation
6	NOE511	Fundamentals of Robotics

Semester VI Teaching Scheme

Course Type	Course Code	Course name	Teaching scheme (Contact Hours)			Credits assigned		Total
			Th	Pr	Tu	Th	Pr/Tut	
PCC	NCMPC61/ NCMPCL61	Software Engineering and Architecture	3	2	-	3	1	4
PCC	NCMPC62/ NCMPCL62	Cryptocurrency & Blockchain Development	3	2	-	3	1	4
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 2**	3	2	-	3	1-	4
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 3**	3	2	-	3	1	4
MDM	NCMMM61	Course 4 Deep Learning	1	2	-	-	2	2
VSEC	NCMVS61	Mobile App Development	1	2	-	-	2	2
PCC	NCMCP61	Capstone Project I	**-**	**4**	**-**	**-**	**2**	**2**
			15	**14**	**0**	**14**	**8**	**22**
		Total Hours	**29**			**Total Credits**		**22**

Program Elective 2			Program Elective 3	
Sr. No	**Course Code**	**Course Name**	**Course Code**	**Course Name**
1	**NCMPE61**	Applied Data Science	**NCMPE64**	Natural Language Processing and Generative AI
2	**NCMPEL61**	Applied Data Science Lab	**NCMPEL64**	Natural Language Processing and Generative AI Lab
3	**NCMPE62**	Graphics & Animation	**NCMPE65**	GeoInformatics
4	**NCMPEL62**	Graphics & Animation Lab	**NCMPEL65**	GeoInformatics Lab
5	**NCMPE63**	System Software	**NCMPE66**	Embedded Systems and RTOS
6	**NCMPEL63**	System Software Lab	**NCMPEL66**	Embedded Systems and RTOS Lab

Semester VI Examination Scheme

Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
PCC	NCMPC61/ NCMPCL61	Software Engineering and Architecture	20	20	60	2	25	-	**125**
PCC	NCMPC62/ NCMPCL62	Cryptocurrency & Blockchain Development	20	20	60	2	25	-	**125**
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 2**	20	20	60	2	25	-	**125**
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 3**	20	20	60	2	25	-	**125**
MDM	NCMMM61	Course 4 Deep Learning	-	-	-	-	50	25	**75**
VSEC	NCMVS61	Mobile App Development	-	-	-	-	50	25	**75**
PCC	NCMCP61	Capstone Project I	-	-	-	-	25	25	**50**
								TOTAL MARKS	**700**

SEM V SYLLABUS

Department of Computer Engineering

COURSE NAME: THEORY OF COMPUTER SCIENCE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC51	Theory of Computer Science	3	-	-	3	-	-	3

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC51	Theory of Computer Science	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory						
		Internal Assessment		End Sem Exam	Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Mid-Term Test	Continuous Assessment					
NCMPC51	Theory of Computer Science	20	20	60	2	-	-	100

Prerequisite: Discrete Structures	
Course Objectives:	
1	Acquire conceptual understanding of fundamentals of grammars and languages.
2	Build concepts of theoretical design of deterministic and non-deterministic finite automata and push down automata.
3	Develop understanding of different types of Turing machines and applications.
4	Understand the concept of Undecidability.
Course Outcomes:	
1	Identify the central concepts in theory of computation and differentiate between deterministic and nondeterministic automata, also obtain equivalence of NFA and DFA.

2	Acquire conceptual understanding of fundamentals of grammars and languages.
3	Devise regular, context free grammars while recognizing the strings and tokens.
4	Build concepts of theoretical design of deterministic and non-deterministic push down automata.
5	Develop understanding of different types of Turing machines and applications.
6	Understand the concept of Undecidability.

Module		Topics	CO	Hours
1		**Basic Concepts and Finite Automata**	CO1	**09**
	1.1	Importance of TCS, Alphabets, Strings, Languages, Closure properties, Finite Automata (FA) and Finite State machine (FSM).		
	1.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, Equivalence between NFA with and without ε-transitions, NFA to DFA Conversion, Minimization of DFA, FSM with output: Moore and Mealy machines, Applications and limitations of FA.		
2		**Regular Expressions and Languages**	CO2	**07**
	2.1	Regular Expression (RE), Equivalence of RE and FA, Arden's Theorem, RE Applications		
	2.2	Regular Language (RL), Closure properties of RLs, Decision properties of RLs, Pumping lemma for RLs.		
3		**Grammars**	CO2 CO3	**08**
	3.1	Grammars and Chomsky hierarchy		
	3.2	Regular Grammar (RG), Equivalence of Left and Right linear grammar, Equivalence of RG and FA.		
	3.3	**Context Free Grammars (CFG)** Definition, Sentential forms, Leftmost and Rightmost derivations, Parse tree, Ambiguity, Simplification and Applications, Normal Forms: Chomsky Normal Forms (CNF) and Greibach Normal Forms (GNF), Context Free language (CFL) - Pumping lemma,		

		Closure properties.		
4		**Pushdown Automata(PDA)**	CO4	**04**
	4.1	Definition, Language of PDA,PDA as generator, decider and acceptor of CFG, Deterministic PDA , Non-Deterministic PDA, Application of PDA.		
5		**Turing Machine (TM)**	CO5	**09**
	5.1	Definition, Design of TM as generator, decider and acceptor, Variants of TM: Multitrack, Multitape, Universal TM, Applications, Power and Limitations of TMs		
6		**Undecidability**	CO6	**02**
	6.1	Decidability and Undecidability, Recursive and Recursively Enumerable Languages, Halting Problem, Rice's Theorem, Post Correspondence Problem.		
			Total	**39**

Text Books:	
1	John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, **"Introduction to Automata Theory, Languages and Computation"**, 3rd Edition, Pearson Education, 2008.
2	Michael Sipser, **"Theory of Computation"**, 3rd Edition, Cengage learning. 2013.
3	Vivek Kulkarni, **"Theory of Computation",** Illustrated Edition, Oxford University Press, (12 April 2013) India.
Reference Books:	
1	J. C. Martin, **"Introduction to Languages and the Theory of Computation",** 4th Edition, Tata McGraw Hill Publication, 2013.
2	N. Chandrashekhar & K.L.P. Mishra, "**Theory of Computer Science, Automata Languages & Computations**", PHI publications.

Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.		
Sr. No	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Gate Based Assignment Test/ Tutorials	10 marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		

1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

COURSE NAME: DATA WAREHOUSING AND MINING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC52	Data Warehousing and Mining	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC52	Data Warehousing and Mining (Theory)	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPC52	Data Warehousing and Mining (Theory)	20	20	60	2	-	-	100

Prerequisite: Database Concepts	
Course Objectives:	
1	To identify the significance of Data Warehousing and Mining
2	To understand ETL process and OLAP models
3	To perform data cleaning and data visualization
4	To select suitable data models and mining algorithms for specific applications.
5	To promote research in cutting-edge data mining techniques and applications.
6	To study web and spatial data mining.

Course Outcomes: The students will be able to :	
1	Understand data warehouse fundamentals and design data warehouse with dimensional modeling.
2	Perform ETL process to create the data warehouse and apply OLAP operations
3	Understand data mining principles and perform data preprocessing and visualization..
4	Identify appropriate data mining algorithms to solve real world problems
5	Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
6	Explore various aspects and methods with respect to spatial & web mining.

Module		Content	CO	Hours
1		**Data Warehousing Fundamentals**	CO1	5
	1.1	Introduction to Data Warehouse, Data warehouse architecture, Data warehouse versus Data Marts, Top-down versus Bottom-up approach, E-R Modeling versus Dimensional Modeling		
	1.2	Information Package Diagram, Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Constellation Schema. Factless Fact Table, Slowly Changing and Rapidly Changing Dimensions		
2		**ETL & OLAP**	CO2	6
	2.1	Major steps in ETL process, Data extraction: Techniques, Data transformation: Basic tasks, Major transformation types, Data Loading: Applying Data,		
	2.2	OLTP Vs OLAP, OLAP definition, Dimensional Analysis, Hypercubes, OLAP operations: Drill down, Roll up, Slice, Dice and Rotation, OLAP models: MOLAP, ROLAP		
3		**Introduction to Data Mining, Data Exploration and Data Pre-processing**	CO3	9
	3.1	Data Mining Task Primitives, Architecture, KDD process, Issues in Data Mining, Applications of Data Mining in cybersecurity, healthcare, finance, marketing, education, law & government, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization		

	3.2	Data Preprocessing: Descriptive data summarization, Cleaning, Integration & transformation, Data reduction, Data Discretization and Concept hierarchy generation.		
4		**Data Mining Algorithms : Mining frequent patterns and associations**	CO4, CO5	6
	4.1	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori		
	4.2	Mining Frequent Itemsets without candidate generation, Introduction to Mining Multilevel Association Rules and Mining, Multidimensional Association Rules		
5		**Data Mining Algorithms : Classification and Clustering**	CO4, CO5	10
	5.1	Basic Concepts, Decision Tree Induction - ID3, Naive Bayesian Classification, Accuracy and Error measures, Evaluating the Accuracy of a Classifier: Holdout & Random Subsampling, Cross Validation, Bootstrap.		
	5.2	Types of data in Cluster analysis, Partitioning Methods (k-Means, k-Medoids), Hierarchical Methods (Agglomerative, Divisive)		
6		**Spatial and Web Mining**	CO6	3
	6.1	Spatial Data, Spatial Vs. Classical Data Mining, Spatial Data Structures, Spatial mining in urban planning, public health, transportation planning and emergency response.		
	6.2	Web Mining: Web Content Mining, Web Structure Mining, Web Usage mining, Applications of Web Mining in business and banking.		
			Total	**39**

Textbooks:	
1	Paulraj Ponniah, " Data Warehousing: Fundamentals for IT Professionals ", Wiley India
2	Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 2nd Edition
3	M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education
References:	
1	Reema Thareja "Data warehousing", Oxford University Press 2009.

2	Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher 2nd Edition
3	Ian H. Witten, Eibe Frank and Mark A. Hall " Data Mining ", 3rd Edition Morgan Kaufmann publisher.

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks

*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Useful Digital Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
AI Tools	
1	https://www.coursera.org/specializations/data-mining
2	https://topai.tools/usecases/data-warehousing
3	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
Case Studies	
1	https://www.trianz.com/experiences/enterprise-data-warehouse-case-studies-collection
2	https://estuary.dev/real-time-data-warehouse-examples/
3	https://www.bizprospex.com/understanding-data-mining-with-the-help-of-case-studies-on-data-mini
4	https://dataforest.ai/blog/practical-data-warehousing-successful-cases
5	https://www.datamation.com/big-data/data-mining-use-cases/

DATA WAREHOUSING AND MINING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW&PR	Tut	Total
NCMPCL52	Data Warehousing and Mining Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPCL52	Data Warehousing and Mining Lab	-	-	-	-	25	-	25

Lab Objectives:	
1	Understand how to build a data warehouse.
2	Learn about the data sets and data preprocessing.
3	Demonstrate the working of algorithms for data mining tasks such Classification, clustering, Association rule mining & Web mining
4	Explore open source software (like Orange / Tableau etc.) to perform data mining tasks.
Lab Outcomes: At the end of the course, the students will be able to	
1	Design data warehouses and perform various OLAP operations.
2	Apply relevant preprocessing techniques on datasets and implement data mining approaches like classification.
3	Explore and apply clustering algorithms to datasets, and utilize open-source software for executing data mining tasks.

4	Implement Association rule & web mining algorithm.

Sr No.	List of Experiments	LO
1	Case study on building Data warehouse/ Data Mart : Write Detailed Problem statement and design dimensional modeling (creation of star and snowflake schema)	LO1
2	Design the dimension and fact tables for the chosen case study	LO1
3	Implementation of OLAP operations: Slice, Dice, Rollup, Drill down and Pivot based on chosen case study.	LO1
4	Execution of Bayesian algorithm for binary classification	LO2
5	Implementation of Data Discretization (any one) - Apply techniques like Z-score normalization, Min-Max scaling before clustering.	LO2, LO3
6	Implementation of Data Visualization (using Tableau) - Use the Hopkins statistic or visual methods (e.g., pairplots) to assess whether the data has a natural clustering tendency	LO2, LO3
7	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (Python Matplotlib)	LO2, LO3
8	Consider raw data, apply preprocessing and classify using ID3	LO2
9	Implementation of Clustering algorithm (K-means/K-medoids)	LO3
10	Implementation of Association Rule Mining algorithm (Apriori / FP Growth)	LO4

Term Work	
1	Term work should consist of at least 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15 Marks, Assignment / Case Study: 10 Marks)

COURSE NAME: CRYPTOGRAPHY AND SYSTEM SECURITY

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC53	Cryptography and System Security	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NCMPC53	Cryptography and System Security	03	-	-	03	-	-	03

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPC53	Cryptography and System Security	20	20	60	02	-	-	100

Prerequisite: Computer Network**s,** Knowledge on number systems.	
Course Objectives	
1	To introduce system security goals, system security concepts and to explore classical encryption techniques.
2	To explore the working principles and utilities of various cryptographic algorithms including secret key cryptography, hashes and message digests, and public key algorithms.
3	To explore the design issues and working principles of various authentication protocols, PKI standards and various secure communication standards including PGP, IPsec, and SSL.
4	To develop the ability to use existing cryptographic utilities to build programs for secure communication.
5	To understand software vulnerabilities and cyber security concepts.

Course Outcomes: Students will be able	
1	Understand system security goals, Security services, classical encryption techniques, and apply system security concepts.
2	Understand symmetric and asymmetric cryptography, compare and apply different encryption and decryption techniques to solve problems related to confidentiality and authentication.
3	Understand and analyze the symmetric public-key cryptography, RSA and other public-key cryptosystems ,the key distribution and management schemes.
4	Apply different message digest techniques to verify integrity , design secure applications and the key distribution and management schemes.
5	Understand network security basics, analyze different attacks on networks and evaluate the performance of firewalls and security protocols like SSL, IPSec, and PGP.
6	Understand various software vulnerabilities, cyber crimes and cyber security.

Module		Content	CO	Hours
1	**Basics of Cryptography**		CO1	08
	1.1	**Introduction to cryptography** Security Goals, Attacks, Services and Mechanisms, Types of Cryptography-Symmetric Key, Asymmetric Key		
	1.2	**Mathematics for Cryptography** Integer Arithmetic, Euclidean Algorithm,Modular Arithmetic,Modular Inverses,Fermat's and Euler's theorem		
	1.3	**Classical Encryption techniques** Symmetric cipher model, mono-alphabetic and polyalphabetic substitution techniques: Vigenere cipher, playfair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers		
2	**Symmetric and Asymmetric key Cryptography**		CO2	08
	2.1	Block cipher principles, block cipher modes of operation, DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Introduction to Stream Ciphers		

	2.2	**Public key cryptography:** Principles of public key cryptosystems- The RSA Cryptosystem.		
3	**Cryptographic Hash Functions and Key Distribution**		CO3	06
	3.1	Cryptographic hash functions, Properties of secure hash function, MD5, SHA-1, MAC, HMAC, CMAC.		
	3.2	**Key Distribution Techniques**: Symmetric Key Distribution: KDC, Needham-schroeder protocol. Kerberos: Kerberos Authentication protocol, Symmetric key agreement: Diffie Hellman, Public key Distribution: Digital Certificate: X.509		
4	**Authentication Protocols & Digital Signature Schemes**		CO4	04
	4.1	User Authentication, Entity Authentication: Password Base, Challenge Response Based		
	4.2	Digital Signature, Attacks on Digital Signature, Digital Signature Scheme: RSA		
5	**Network Security and Applications**		CO5	08
	5.1	Network security basics: TCP/IP vulnerabilities (Layer wise), Network Attacks: Packet Sniffing, ARP spoofing, port scanning, IP spoofing		
	5.2	Denial of Service: DOS attacks, ICMP flood, SYN flood, UDP flood, Distributed Denial of Service		
	5.3	Internet Security Protocols: PGP, SSL, IPSEC. Network security: IDS, Firewalls		
6	**Information and System Security**		CO6	05
	6.1	**Software Vulnerabilities:** Buffer Overflow, Format string, cross-site scripting, SQL injection, Malware: Viruses, Worms, Trojans, Logic Bomb, Bots, Rootkits.		
	6.2	**Cyber Security** Classifications of Cyber Crimes, Tools and Methods –Password Cracking, Keyloggers, Spywares,SQL Injection ,Network Access Control.		
			Total	**39**

Textbooks	
1	William Stallings, "Cryptography and Network Security, Principles and Practice", 6th Edition Pearson Education, March 2013
2	Behrouz A. Ferouzan, "Cryptography & Network Security", Tata McGraw Hill
3	Behrouz A. Forouzan & Debdeep Mukhopadhyay, "Cryptography and Network Security" 3rd Edition, McGraw Hill
4	Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal Perspectives", First Edition, Wiley India, 2011.
5	Open Source Intelligence Methods and Tools: A Practical Guide to Online Intelligence by Nihad A. Hassan (Author), Rami Hijazi (Author)
Reference Books	
1	Bruce Schneier, "Applied Cryptography, Protocols Algorithms and Source Code in C", Second Edition, Wiley.
2	Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill Education, 2003.
3	Charles Pfleeger, Shari Pfleeger, Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, New Delhi, 2015.
4	Eric Cole, "Network Security Bible", Second Edition, Wiley, 2011.
5	OSINT Techniques - Resources for Uncovering Online Information - 10th Edition (2023) by Michael Bazzell
Useful Links	
Resources	
1	https://onlinecourses.nptel.ac.in/noc22_cs90/preview
2	https://onlinecourses.nptel.ac.in/noc22_cs03/preview
3	https://cse29-iiith.vlabs.ac.in/
4	https://threema.ch/press-files/2_documentation/cryptography_whitepaper.pdf
5	http://surl.li/uhndp
6	https://netleon.com/blog/cryptography-real-world-application/
AI Tools	
1	https://www.maltego.com/

2	https://www.recordedfuture.com/threat-intelligence-101/tools-and-technologies/osint-tools
3	https://www.kali.org/tools/spiderfoot/
Case Studies	
1	https://www.kroll.com/en/insights/publications/cyber/case-studies

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table		
Sr. No.	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5
2	Literature review of papers/journals	5
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	GATE Based on Assignment tests/Tutorials etc	10
12	Peer Review and participation	5/10
*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Quiz	

2	Skill Enhancement Lecture
3	Extra Assignments/lecture
End Semester Theory Examination	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

CRYPTOGRAPHY AND SYSTEM SECURITY (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPCL53	Cryptography and System Security Lab	-	02	-	-	01	-	01

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPCL53	Cryptography and System Security Lab	-	-	-	-	25	-	25

Prerequisite: Computer Network, Number Theory	
Lab Objectives:	
1	To apply various encryption techniques
2	To study and implement various security mechanism
3	To explore the network security concept and tools
4	To incorporate ethical usage of OSINT tools
Lab Outcomes: At the end of the course, the students will be able to	
1	To apply traditional and advanced encryption techniques

2	To study and implement various security mechanisms
3	To study and analyze cryptographic algorithms
4	To analyse images and data using forensic tools
5	To study file recovery, carving, log, and timeline analysis
6	To explore network forensic analysis

Suggested Experiments: Students are required to complete at least 10 experiments.

Sr. No.	List of Experiment	LOs
1	Design and Implementation using Substitution ciphers: Caesar Cipher, Auto Key Cipher, PlayFair Cipher	LO1
2	Design and Implementation using Transposition Ciphers: Keyed Transposition Cipher, Keyless Transposition Cipher	LO1
3	(i) Implementation and analysis of the RSA cryptosystem. (ii) Implementation of the Diffie-Hellman key exchange algorithm	LO2
4	For varying message sizes, test the integrity of the message using MD-5, SHA-1, and analyze the performance of the two protocols. Use crypt APIs.	LO3
5	Analysis of forensic images using open source tools: FTK Imager, Autopsy, Sleuth Kit(TSK) , Volatility	LO4
6	Explore forensics tools in Kali Linux for acquiring, analyzing, and duplicating data. dd- For bit-by-bit disk imaging and dcfldd	LO4
7	Perform file recovery and carving using Foremost, Scalpel, and Photorec	LO5
8	a. Perform Log and timeline analysis using Plaso and Timesketch b. Generate a Timeline Report Using Autopsy	LO5
9	Perform Network forensics using Network Miner and Wireshark	LO6

10	Explore USB Device Forensics using USBDeview and USB Detective	LO6

Useful Links	
1	**https://www.kali.org/tools/theharvester/**
2	**https://www.kali.org/tools/spiderfoot/**
3	**https://www.kali.org/tools/gospider/**
4	**https://seon.io/try-for-free/**
5	**https://help.shodan.io/command-line-interface/0-installation**
6	**https://www.kali.org/tools/recon-ng/**
7	**https://www.kali.org/tools/metagoofil/**
Virtual Lab	
1	https://cse29-iiith.vlabs.ac.in/List%20of%20experiments.html
AI Tools	
1	Deep Exploit https://www.oreilly.com/library/view/mastering-machine-learning/9781788997409/5b2c984f-788d-49e8-817f-40973dc992e0.xhtml
2	GyoiThon-https://github.com/gyoisamurai
3	Sn1per (Community Edition)-https://sn1persecurity.com/wordpress/
4	Cuckoo Sandbox (AI-enhanced setups) -https://github.com/cuckoosandbox/cuckoo

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Cryptography and System Security"
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

Programme
ELECTIVE-1
TE NEP Sem V
2025-26

COURSE NAME: DATA ENGINEERING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE51	Data Engineering	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE51	Data Engineering	3		-	3		-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE51	Data Engineering	20	20	60	2	-	-	100

Prerequisite: Discrete Structures, DBMS, Java/Python	
Course Objectives	
1	Understand the core concepts and principles of Data Engineering.
2	Understand various data storage and retrieval technologies.
3	Learn to design and implement stream and batch data processing pipelines.
4	Design applications using Apache Spark for big data processing and machine learning.
5	Design data pipeline orchestration and cloud-based data engineering applications.
6	Understand the importance of data quality, security, and compliance in data engineering.
Course Outcomes: Students will be able to	
1	Understand the principles of a Data Engineering
	Work with various data sources and storage systems.

2	
3	Design, build, and deploy both batch and stream data processing pipelines
4	Design and implement algorithms using Apache Spark for big data analysis and machine Learning tasks
5	Understand cloud-based data engineering services and their applications
6	Apply Data engineering principles to design and implement real world application

Module	Content		CO	Hours
1	**Foundations of Data Engineering**		CO1	03
	1.1	Introduction to Data Engineering: Role, importance, and challenges.Data Engineering vs. Data Science vs. Data Analytics.		
	1.2	Data Lifecycle: Ingestion, storage, processing, analysis, and visualization.		
	1.3	Python for Data Engineering: Fundamentals, libraries (Pandas, NumPy)		
2	**Data Storage & Retrieval**		CO2	08
	2,1	Data Scraping and Storage techniques (text, audio, video, image data). Data Visualization fundamentals: PowerBI, Tableau .		
	2,2	Relational Databases: SQL, Database Design.NoSQL databases: Types (Document, Key-Value, Graph), MongoDB ,.Graph Databases: Neo4j, Cypher query language, graph algorithms		
3	**Stream Data Processing**		CO3	08
	3.1	Introduction to Stream Data Processing: Concepts, Algorithms.		
	3.2	Stream Processing with Apache Flink: Data Streams, Windowing, Transformations.		
	3.3	Distributed Data Processing Fundamentals: MapReduce, Hadoop Ecosystem.		

4	**Big Data with Spark**		CO4	06
	4.1	Distributed Data Processing with Spark: RDDs (Resilient Distributed Datasets)		
	4.2	Functional Programming in Spark: Transformations, Actions.SparkSQL and DataFrames: Data Manipulation, SQL on Spark.		
	4.3	Machine Learning with MLlib: Common Algorithms, Model Training.Developing and Deploying Spark Applications.		
5	**Data Pipelines & Orchestration**		CO5	04
	5.1	Data Pipeline Orchestration: Concepts, Tools (Airflow ,Luigi, Prefect).		
	5.2	Building a basic data pipeline: Ingestion, Transformation, Loading,Monitoring and Logging		
	5.3	Cloud Services for Data Engineering: AWS, Azure, GCP (overview). Snowflake: Data Warehousing, Data Lakes, Data Engineering. , Case Study		
6	Data Governance and Security		CO6	10
	6.1	Data Governance Frameworks		
	6.2	Data Security Best Practices,Encryption, Access Control Compliance (GDPR, HIPAA)		
			Total	**39**

Textbooks	
1	"Designing Data-Intensive Applications" by Martin Kleppmann
2	"Data Engineering Cookbook" by Andreas Kretz
3	"Fundamentals of Data Engineering" by Joe Reis and Matt Housley
4	"Spark: The Definitive Guide 'by Matei Zaharia, Bill Chambers, and Tathagata Das
References	
1	"Graph Algorithms: Practical Examples in Apache Spark & Neo4j", by Aleksa Vukotic , Nicki Watt , Tareq Abedrabbo
2	"Data Pipelines with Apache Airflow" by Bas P. Harenslak and Julian Rutger de Ruiter
3	"Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud ", Mark Wilkins
4	"Advanced Analytics with Spark" by Sandy Ryza, Uri Laserson, Sean Owen, and Josh Wills

Useful Links	
Resources	
1	https://kafka.apache.org/
2	https://airflow.apache.org/
3	https://nifi.apache.org/
4	https://spark.apache.org/
5	https://hadoop.apache.org/
6	https://flink.apache.org/
7	https://azure.microsoft.com/
AI Tools	
1	DeepCode AI | AI Code Review | AI Security for SAST | Snyk AI | Snyk
2	GitHub Copilot · Your AI pair programmer
3	TFX | ML Production Pipelines | TensorFlow
4	Dataiku | The Universal AI Platform™
Industry Articles	
1	https://www.datacamp.com/blog/category/data-engineering
2	https://www.dataengineeringdigest.com/
Case Studies	
1	https://indatalabs.com/resource/data-engineering-case-studies
2	https://cookbook.learndataengineering.com/docs/05-CaseStudies/

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table		
Sr. No.	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5

2	Literature review of papers/journals	5
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5
4	Wins in the event/competition/hackathon pertaining to the course	10
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10
8	Content beyond syllabus presentation	10
9	Creating Proof of Concept	10
10	Mini Project / Extra Experiments/ Virtual Lab	10
11	GATE Based on Assignment tests/Tutorials etc	10
12	Peer Review and participation	5/10
*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Quiz	
2	Skill Enhancement Lecture	
3	Extra Assignments/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

DATA ENGINEERING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL51	Data Engineering Lab	--	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL51	Data Engineering Lab	-	-	-	-	25	-	25

Prerequisite: Discrete Structures, DBMS, Java/Python	
Lab Objectives:	
1	Understand the fundamental concepts and principles of Data Engineering, including data models, data governance, and the data lifecycle.
2	Gain practical experience with diverse data storage and retrieval technologies like RDBMS, NOSQL Databases etc.
3	Develop the ability to design, implement batch and real-time data processing pipelines
4	Understand various Apache Spark concepts for scalable data processing
5	Understand data pipeline orchestration and cloud-based data engineering
6	Acquire knowledge of data quality, security, and compliance in building robust data engineering solutions
Lab Outcomes: At the end of the course, the students will be able to	

Prerequisite: Discrete Structures, DBMS, Java/Python	
1	Explain the core principles and concepts of Data Engineering and the data lifecycle.
2	Effectively interact with and manage data from various sources and storage systems
3	Design and implement stream and batch data processing pipelines.
4	Utilize Apache Spark for efficient processing and analysis of large-scale datasets
5	Use data pipeline orchestration and cloud-based data engineering tools.
6	Apply data engineering principles to design and implement solutions for real-world data challenges, considering data quality, security, and compliance.

Suggested Experiments: Students are required to complete at least 10 experiments.

Star (*) marked experiments are compulsory.

Sr. No.	Title of Experiment	LO's
1*	Data Acquisition and Initial Processing with Python: Extract data from diverse sources (CSV, JSON, REST APIs, relational databases). Perform basic data cleaning, transformation (e.g., filtering, renaming, type casting), and loading into a suitable data structure (Pandas DataFrame).	LO 1
2*	Interactive Data Visualization with PowerBI/Tableau: Connect to various data sources, create interactive charts and dashboards to explore data patterns, and derive insights.	LO2
3*	NoSQL Database (MongoDB): Data Modeling and CRUD Operations: Design document schemas, perform CRUD operations, and explore querying techniques in MongoDB.	LO 2
4*	Graph Database (Neo4j): Network Data Modeling and Analysis: Model relationships using nodes and edges, load data into Neo4j, and perform graph traversals and analysis using Cypher queries.	LO2
5*	Real-time Stream Processing with Apache Flink (or Kafka Streams): Develop a simple application to ingest, process, and analyze a simulated real-time data stream (e.g., sensor data, clickstream data).	LO3
6*	Scalable Data Processing with Spark RDDs: Implement fundamental Spark RDD operations (map, filter, reduce, aggregate) on a large synthetic or publicly available dataset.	LO4

7	Data Manipulation and Querying with Spark SQL and DataFrames: Perform SQL-like queries and data transformations using Spark SQL and DataFrames for efficient data analysis.	LO4
8*	Machine Learning with Spark MLlib: Train and evaluate a basic machine learning model (e.g., linear regression, logistic regression, decision tree) using Spark MLlib on a relevant dataset.	LO 4
9*	Building a Data Pipeline with Apache Airflow: Design and implement a simple data pipeline to automate a data extraction, transformation, and loading (ETL) process.	LO 3L O5
10*	Build a Conversational BI application for (retail, healthcare, finance etc)	LO 6
11	Implementing Data Quality Checks: Design and implement data quality checks within a data pipeline to identify and handle inconsistencies, errors, and missing values.	LO6

Useful Links	
1	https://kafka.apache.org/
2	https://airflow.apache.org/
3	https://nifi.apache.org/
4	https://spark.apache.org/
5	https://hadoop.apache.org/
6	https://flink.apache.org/
Virtual Lab	
1	https://www.snowflake.com/en/resources/webinar/virtual-hands-on-lab/?tags=region%2Fapj
2	https://nebulacloud.ai/connect/blogs/introducing-bi-and-data-analytics-lab-as-a-service
AI Tools	
1	https://github.com/features/copilot
2	https://www.dataiku.com/

3	https://snyk.io/platform/deepcode-ai/

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: DESIGN THINKING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE52	Design Thinking	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE52	Design Thinking (Theory)	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE52	Design thinking (Theory)	20	20	60	2	25	-	100

Course Prerequisite: Analytical Skills and Reasoning Skills	
Course Objectives	
1	To make Learner aware about systematic Design Process
2	To understand various phases of Design Thinking
3	To nurture Creative skills
4	To effectively apply the design Techniques towards Product Development
Course Outcomes	
1	To understand Design Thinking and its need
2	To adopt Design Thinking for Innovation
3	To study and analyse various phases in Design Thinking
4	To understand Challenges in Design
5	Test and Implement Design

6	To document the Design Process

Module	Content		CO	Hours
1	**Introduction to Design thinking**		CO1	08
	1.1	Various Tools used since ancient Years, Stoneage, Wooden age, iron age etc, Invention of Liver, wheel. Need for Design. Various Design methodologies: Documentation, Free hand Sketching,Engineering Drawing principles, Geometrical Parameters. Various Tools and Techniques. Design principles for Software, User Interface. Market Research, Goal Oriented Design.		
	1.2	Need for Design Thinking. Case Study of Problems that can be solved by Design Thinking. Benefits of Design Thinking To Society, Benefits of Design Thinking to Organization to Benefits of Design Thinking to Technology. Design		
	1.3	Overview of Design Thinking: History, Importance, and Applications.Design Thinking Mindset: Empathy, Curiosity, and Creativity.Phases of Design Thinking: Empathize, Define, Ideate, Prototype, Test.Real-life Case Studies (Tech Industry Examples). Activities: Brainstorming exercises using Miro or MURAL. Empathy mapping activity for user understanding.		
2	**Design Thinking and Innovation**		CO2	10
	2.1	Designing products and Services. Product Design, Service Design, product V/s Services. Design Thinking v/s Traditional Thinking. Design Thinking a Non linear process. StoryBoard Template and Paper Templates.		
	2.2	Innovation Definition. The newness Matrix, Product Innovation process Innovation, Service Innovation , Paradigm Innovation, Business Model, Frugal and Open innovation, Relation between Design Thinking, Business, innovation and Innovation management.		
	2.3	Innovation V/s Invention. Continuous v/s Discontinuous Innovation. Reasons for Discontinuity. Innovation Cycle. Various Innovative Ideas for Day to Day Business: Documentation, Survey, Marketing.		
3	**Design Thinking process: Phase 1 Empathize**		CO3	06

	3.1	Don Norman's Design principles. Research your users' needs. (User Interview Techniques). Personna Identification. Human Centered approach. Human properties to be considered in Design. Personna, Stakeholder analysis, Type of Users; Bell Curve.		
	3.2	Design Thinking process **Phase 2 Ideation** Problem Definition: How to Frame a Problem Statement. Define: state your users' needs and problems.Problem Definition, Multi stakeholder and Multidisciplinary Approach. Mistakes made by designers. Pain Point identification. Stakeholder Mapping. Preparing Questionnaire. Case study of Customer care services and Successful Stories. ● Brainstorming, SCAMPER, and Mind Mapping. ● Prioritization Frameworks: MoSCoW, Impact-Effort Matrix.		
	3.3	Design Use Cases: Application Software, Tickets and Bills, Home Appliances Designs, Other Innovative schemes adopted in various Applications		
4	Design Thinking Process Phase 3 Ideate:		CO4	06
	4.1	Challenge assumptions and create ideas.Pillars of Ideation : Creativity and Abductive Logic.		
	4.2	Skills for Ideation Creative Skills and Questioning Skill Ideation method. Divergent Phase		
	4.3	Brainstorming and Brainwriting, Conceptual Modelling Convergent phase : Why and How Technique, Prioritise.		
5	Design Thinking Phase 4 Prototype:		CO5	05
	5.1	Start to create solutions.Why Prototype is mandatory. Visual Communication, Aesthetics, Iterative Method.		
	5.2	Skills required in prototyping Sketching Drawing, paper model, tool handling.		
	5.3	Show Test and feedback. Storyboard Technique. Problems discussion using Storyboard, Solution using Storyboard.Redesigning of Process.		
6	**Testing and Implementation**		CO6	04

	6.1	Test: try your solutions out., Test Phase , Pillars of Testing Experimentation, Agility, Agile Methodology . Skills . Testing Methodology. Testing Tools and Techniques. Experiment Grid, Feedback Capturing , assumptions canvas. User acceptance Testing.		
	6.2	Implementation: Implementation Functions, System Thinking. Business Logic or Business Plan, Techniques that assure security and Confidentiality. Designs with environmental and economic sustainability.		
	6.3	Design Thinking for Emerging Technologies: AI, IoT, and Sustainable Solutions. Industry Use Cases and Success Stories. Integrating Design Thinking into Agile Processes. Ethical Considerations in Design Thinking.		
	6.4	Prototyping and Visualization Low-Fidelity vs. High-Fidelity Prototyping, Tools for Prototyping: Sketching, Wireframing, and Digital Prototyping, Rapid Prototyping Techniques, Project Documents, Project Diary. CaseStudies on various Successful Projects.		
		Total		**39**

Textbooks	
1	Design Thinking: A Framework for Applying Design Thinking in Problem Solving, First Edition, Author(s): Anuja Agarwal Cengage Group
2	Design Thinking, Beginner's Perspective by E Balgurusammy , Bindu Vijayakumar McgrawHill Publication
3	Galitz's Human Machine Interaction adapted by Dhananjay R. Kalbande, Prashant Kanade, Sridari Iyer wiley Publications
References	
1	Human Computer Interaction by Alan Dix, Janet Finlay, Gregory D Abowd, Russel Beale 3e Paerson
2	Design of Everyday Things, Don Norman , Basic Books
Resources	
1	Design Thinking Study Guide

	https://www.nngroup.com/articles/design-thinking-study-guide/
2	Design Thinking and Product Innovation https://www.pvpsiddhartha.ac.in/dep_it/lecture%20notes/DT/unit-i.pdf
3	Design Thinking V/s Human Centered Design https://www.pvpsiddhartha.ac.in/dep_it/lecture%20notes/DT/unit-ii.pdf
AI Tools	
1	http://www.uizard.io Turn product ideas into concepts instantly with GenAI
2	https://www.devlinpeck.com/content/ai-in-design devlinpeck
3	Use Generative AI to create Images, Videos and More. Harness the power of Artificial Intelligence to up your Social Media Marketing game. https://designs.ai/
Industry articles	
1	TCS Design Thinking Creativity and Innovation https://www.tcs.com/who-we-are/tcs-way/article/design-thinking-center-of-excellence-improve-experiences
2	Get closer to your customers with design thinking Capgemini White Paper. https://www.capgemini.com/us-en/news/client-stories/embrace-new-ways-of-working/
Case Studies	
1	https://www.frog.co/work CaseStudies by Capgemini
2	https://www.capgemini.com/insights/research-library/rethink-series/ ReThink A series of whitepapers on how we need to rethink sustainability

Internal Assessment
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.
Continuous Assessment
Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

DESIGN THINKING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL52	Design Thinking Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL52	Design Thinking lab	-	-	-	-	25	-	25

Prerequisite: C programming, Digital Logic and Computer Architecture, Microprocessor, Computer Networks.	
Lab Objectives:	
1	To make students eligible to apply Design Thinking Skills in actual Practice
2	To design system as per Users Requirements
3	To apply various Traditional as well as Advance Tools (AI) for creative and innovative designs
Lab Outcomes: Students will be able to:	
1	To apply Design thinking to provide solution
2	Provide User centric Designs
3	To foster innovation and Creativity
4	Systematic adoption of Advanced Tools and Techniques
5	Evaluate and enhance the the design
6	To use design skills in day to day practice as a system developer.

Sr. No.	List of Experiments	LOs
1	Prepare the detailed Document for any Tool or product that you use in day to Day practice, Try to get its evolution (Eg. Adjustable Spanner, Drill Machine, Chopper, Cutter, Punching Machine, Steppler, Grater, Grinder, Peelar etc)	LO1
2	To provide a prototype for any product selected as per the users Requirement. The requirements can be identified from peers and utilize all possible Materials for design. The expected content is personna, Questionnaire and storyboard template (Prerequisite sem 2 I & E)	LO1, LO2
3	Prepare a marketing material for the Product under consideration using any Modern Design Tool or Application and description of the Product	LO1, LO2, LO3
4	Design a GUI for a Web Application and Considering Recent trends in Technology	LO4
5	Propose a Business Model for the Product or Utility under Consideration	LO4
6	Refinement of Existing Design of a Product or a Service or Facility options : Web page, Product Interface, Product Design, Office or Living room Arena etc.	LO4, LO5
7	Formulate the Plan for Registering the Product or Service or Facility for IPR (Copyright or Patent)	LO3, LO4
8	Evaluation of Design with peers and suggest the Possible Changes.	LO3, LO4, LO5
9	Technology adoption in Design to provide feasibility to User. (CaseStudy Presentation)	LO1, LO5
10	Survey of Various Products and/or Services which are popular or trending.	LO6

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: INTERNET OF EVERYTHING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE53	Internet of Everything	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE53	Internet of Everything	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE53	Internet of Everything	20	20	60	2	-	-	100

Prerequisite: C programming, Digital Logic and Computer Architecture, Computer Networks.	
Course Objectives	
1	To equip students with the fundamental knowledge and basic technical competence in the field of the Internet of Everything (IoE).
2	To emphasize learning the core IoT functional stack and application layer protocols.
3	To study and understand the different sensors, actuators, and IoT-enabling technologies and apply this knowledge to build projects.
4	To understand data handling in IoT.
5	To examine prototyping boards like Arduino and Raspberry Pi to develop useful projects or products.
Course Outcomes: After successful completion of the course, students will be able to:	

1	Explain the concept, architecture, and ecosystem of IoE and differentiate it from IoT.
2	Describe sensors, actuators, communication models, and data transmission protocols in IoE.
3	Illustrate the role of smart objects, communication protocols, and cloud-based integration with edge computing and security in IoE.
4	Apply data preprocessing, analytics, and visualization techniques to extract insights from IoE data using suitable tools and platforms.
5	Understand the IoT design methodology to apply to various use cases.
6	Explore the latest trends in IoE.

Module	Content		CO	Hours
1	**Introduction to Internet of Everything (IoE)**		CO1	06
	1.1	Concept of IoE: Definition, evolution, and significance, IoT vs. IoE: Key differences and integration		
	1.2	IoE Architecture: People, Process, Data, and Things		
	1.3	IoE Ecosystem: Devices, sensors, networks, and data flow.		
2	**Sensors, Actuators, and Connectivity**		CO2	07
	2.1	Types of Sensors in IoE: Temperature, motion, proximity, etc.		
	2.2	Actuators in IoE: Motors, valves, and smart control systems etc.		
	2.3	Communication Models: M2M (Machine to Machine), M2P (Machine to People), P2P (People to People)		
	2.4	Protocols for Data Transmission: MQTT, CoAP, HTTP/HTTPS		
	2.5	Overview of sensor networks (WSN)		
3	**IoE Enabling Technologies**		CO3	
	3.1	Smart Objects: A Definition, Trends in Smart Objects.		

	3.2	Wireless Communication Protocols: Wi-Fi, Bluetooth, Zigbee, LoRaWAN.		07
	3.3	IoT Platforms and Tools: AWS IoT, Azure IoT, Google Cloud IoT.		
	3.4	Edge Computing and Fog Computing in IoE, Cloud Integration for IoE Data Management.		
	3.5	IoE Security Protocols: Encryption, authentication, and secure gateways.		
4	**Data Analytics and Visualization in IoE**		CO4	07
	4.1	IoE Data Flow and Pipeline: The end-to-end journey of data from sensors/devices to the cloud, Gateways and Aggregators, Real-Time vs. Batch Data Handling.		
	4.2	Applications and Analytics Layer: Role and significance in the IoE architecture, Analytics vs. Control Applications, Data Analytics vs. Network Analytics.		
	4.3	IoT Data Management and Compute Stack: Key design considerations for managing IoT data, Common data-related challenges in IoE, Compute models: Fog Computing and Edge Computing, Understanding the hierarchy of Edge, Fog, and Cloud layers		
5	**IoE Design Methodology and Use Cases**		CO5	06
	5.1	IoE System Design Phases: Requirements gathering, architecture design, and implementation		
	5.2	Design Considerations: Scalability, security, and interoperability		
	5.3	Hardware and Software Selection for IoE Systems		
	5.4	Integration of Sensors, Actuators, and Cloud Platforms.		
	5.5	Use cases: Smart Agriculture, Environmental Monitoring, Retail and Supply Chain Management.		
6	**Latest Trends in IoE**		CO6	06
	6.1	Industrial IoT (IIoT): Concept of IIoT and its role in smart manufacturing, Applications in predictive maintenance, asset tracking, and process automation.		

	6.2	AI in IoE (AIoT): Integration of Artificial Intelligence with IoT for intelligent decision-making, AI-driven automation in healthcare, smart homes, and industry.		
	6.3	5G and Edge Computing in IoE: Enhancing low latency and high-speed data transmission, Edge AI for faster processing and improved security.		
	6.4	Digital Twins in IoE**:** Virtual representation of physical assets for monitoring and simulation, Applications in healthcare, manufacturing, and energy systems.		
Total				**39**

Textbooks:	
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.
2	Dr Prateek Jain, Dr Archana Sharma, "Transitioning to Internet of Everything (IoE) Key Technology Applications and Recent Trends", BFC Publications, 2024.
3	Hakima Chaouchi, "The Internet of Things - Connecting Objects to the Web", 1st Edition, Wiley, 2010.
4	Perry Lea, "Internet of things For Architects", 1st Edition, Packt Publication, 2018
5	Arshdeep Bahga, Vijay Madisetti, "Internet of Things – Hands-On Approach", 2nd Edition, Universities Press, 2016.

References:	
1	Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", 1st Edition, Wiley, 2014.
2	Donald Norris, "Raspberry Pi – Projects for the Evil Genius", 2nd Edition, McGraw Hill, 2014.
3	Anand Tamboli ,"Build Your Own IoT Platform", 1st Edition, Apress, 2019.

Assessment		
Internal Assessment:		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment:		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table		
No.	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.		

Indirect Assessment:	
1	Skill Enhancement Lecture
2	Extra Assignments/lab/lecture
End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105166/
2	Introduction to Internet of Things and Cloud Udemy
3	https://nptel.ac.in/courses/108/108/108108098/
4	https://nptel.ac.in/courses/106/105/106105195/
5	https://www.mygreatlearning.com/iot/free-courses
6	https://www.coursera.org/courses?query=iot
7	https://www.edx.org/learn/iot-internet-of-things

AI Tools	
1	AWS Management Console
2	coral.ai

INTERNET OF EVERYTHING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL53	Internet of Everything Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL53	Internet of Everything Lab	-	-	-	-	25	-	25

Prerequisite: C programming, Digital Logic and Computer Architecture, Computer Networks.	
Lab Objectives:	
1	To equip students with practical experience in working with IoE devices, sensors, actuators and communication protocols
2	To teach students how to send data from IoE devices to the cloud and use it for monitoring or analysis.
3	To foster the development of IoE-based solutions for everyday problems, with a focus on testing and troubleshooting.
Lab Outcomes: Students will be able to:	
1	Understand the working principles and interfacing of various sensors for data acquisition.
2	Learn to control actuators for implementing actions in IoE systems.
3	Develop skills to program and interface Arduino with sensors and actuators.
4	Transmit IoT data to the cloud for monitoring, analysis, and visualization.

5	Combine sensors, actuators, Arduino, and Raspberry Pi to create functional IoT systems.
6	Test, debug, and evaluate the performance of IoT systems built with Arduino and Raspberry Pi.

Suggested Experiments: Students are required to complete at least 10 experiments.		
Sr. No.	**Title of Experiment**	**LOs**
1	To interface LED/Buzzer with Arduino/Raspberry Pi i)To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to 'turn ON' LED for 1 sec after every 2 seconds. ii) To interface Push button/Digital sensor (IR/LDR) with arduino/ Raspberry Pi and write a program to 'turn ON' LED when push button is pressed or at sensor detection.	LO1, LO2
2	To interface temperature and humidity sensor To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.	LO1, LO2
3	To interface Bluetooth with Arduino/Raspberry Pi i) write a program to send sensor data to a smartphone using Bluetooth. ii) write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth	LO1, LO2, LO3
4	Implement Edge to cloud Protocols (MQTT and COAP) using a dummy data set.	LO3, LO4
5	Implement MQTT Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.	LO3 LO4
6	Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.	LO3, LO4
7	Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud	LO3, LO4
8	IoT Platform Integration Connect an IoE device to AWS IoT, Azure IoT, or Google Cloud IoT for data monitoring.	LO1, LO4
9	Data Visualization using Grafana/Power BI Develop dashboards to visualize and analyze IoE data trends	LO3
10	Mini project	All LOs

Textbooks:	
1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals – Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1st Edition, Published by Pearson Education, Inc, publishing as Cisco Press, 2017.
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3	Perry Lea, "Internet of things For Architects", 1st Edition, Packt Publication, 2018
4	Arshdeep Bahga, Vijay Madisetti, "Internet of Things – Hands-On Approach", 2nd Edition, Universities Press, 2016.
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1	Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", 1st Edition, Wiley, 2014.
2	Donald Norris, "Raspberry Pi – Projects for the Evil Genius", 2nd Edition, McGraw Hill, 2014.
3	Anand Tamboli ,"Build Your Own IoT Platform", 1st Edition, Apress, 2019.

Useful Links	
1	https://nptel.ac.in/courses/106/105/106105166/
2	https://www.udemy.com/course/a4iot-intro-iot-cloud/?srsltid=AfmBOopAuXxLHyO-ElqezwJkqR_JMpQE_TwW-32ka9VdLO7Bwe3RdjjK
3	https://nptel.ac.in/courses/108/108/108108098/
4	https://nptel.ac.in/courses/106/105/106105195/
5	https://www.mygreatlearning.com/iot/free-courses
6	https://www.coursera.org/courses?query=iot
7	https://www.edx.org/learn/iot-internet-of-things
AI Tools	
1	AWS Management Console
2	coral.ai

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: MACHINE LEARNING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM51	Machine Learning	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM51	Machine Learning	3	-	-	3	1	-	4

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM51	Machine Learning (Theory)	20	20	60	2	25	25	100

Prerequisite: Data Warehousing and Mining	
Course Objectives:	
1	Understand the fundamental concepts, types, and applications of Machine Learning.
2	Apply dimensionality reduction techniques and assess model performance using appropriate metrics
3	Implement supervised learning algorithms for regression and classification problems
4	Apply unsupervised learning methods for clustering and association rule mining.
5	Utilize ensemble learning strategies and model validation techniques.
6	Gain familiarity with MLOps practices for deploying, monitoring, and maintaining machine learning models.
Course Outcomes:	
1	Understand the basics of Machine Learning, its types, and essential concepts.
2	Apply dimensionality reduction techniques and evaluate performance metrics for ML algorithms.
3	Implement supervised learning models for regression and classification problems.

4	Implement unsupervised learning techniques and evaluate clustering models.
5	Apply ensemble learning techniques and model validation strategies.
6	Understand and apply MLOps concepts for deploying, monitoring, and maintaining ML models.

Module		Content	CO	Hours
1	**Introduction to Machine Learning**		CO1	05
	1.1	Introduction to Machine Learning, Data Formats, ML Workflow: Data Preparation, Model Training, Model Evaluation, Train-Test-Validation Splits Data Formats in ML, Structured vs. Unstructured data, Applications of types of Machine Learning across various industries (e.g., Healthcare, Finance, Marketing, Robotics etc.)		
	1.2	Overfitting and Underfitting, Bias-Variance Tradeoff, Model Generalization and Model Overfitting		
2	**Dimensionality Reduction & Performance Measures**		CO2	06
	2.1	Importance of feature selection in improving model performance, PCA, LDA, Difference between PCA and LDA (Supervised vs Unsupervised), SVD		
	2.2	Performance Measures: Classification Metrics (Accuracy, Precision, Recall, F1-Score, ROC-AUC), Regression Metrics (MSE, RMSE, MAE)		
3	**Supervised Learning**		CO3	09
	3.1	Regression: Linear, Polynomial, Ridge, Lasso, Regularization: L1 Regularization (Lasso), L2 Regularization (Ridge), Elastic Net, Decision Tree Regression.		
	3.2	Classification: Numericals on Decision Tree (ID3, CART), Logistic Regression		
	3.3	Classification: Introduction to SVM, Support Vectors, Hyperplane, Margin, Linear SVM: Maximizing margin, Hard and Soft Margin SVM, Non-linear SVM and Kernel Trick		
4	**Unsupervised Learning**		CO4	06
	4.1	Clustering types: Graph-based,:Minimum Spanning Tree (MST) Clustering, Model-based: Expectation-Maximization (EM), Density-based: DBSCAN		
	4.2	Basics of Clustering Evaluation: Silhouette Score, Davies-Bouldin Index, Adjusted Rand Index (ARI)		

5	**Ensemble Learning**			
	5.1	Concepts of Ensemble Learning, Advantages and challenges, Bias-Variance trade-off in ensembles, K-Fold Cross-validation	CO5	07
	5.2	Basics of Bagging and Boosting, Random Forest algorithm, Use cases and benefits, AdaBoost, Gradient Boosting, XGBoost overview and comparison, Stacking: layered models and meta-learners, Voting Classifier: hard vs. soft voting		
6	**MLOps & Deployment**			
	6.1	Introduction to MLOps: Concept and workflow, Model serving basics, Batch vs. Online (real-time) deployment		
	6.2	Model performance monitoring, Data drift and concept drift detection, Introduction to model retraining strategies, Updating deployed models.	CO6	06
			Total	**39**

Textbooks:	
1	Peter Harrington, ―Machine Learning n Action‖, DreamTech Press
2	Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press
3	Tom M. Mitchell, ―Machine Learning‖ McGraw Hill
4	Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖, CRC Press
5	Noah Gift & Alfredo Deza, Practical MLOps: Operationalizing Machine Learning, OREILLY
References:	
1	Han Kamber, ―Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2	Dr. Deepali Vora, Dr. Gresha Bhatia, Python for Machine Learning projects
3	Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education
4	Kevin P. Murphy , Machine Learning ― A Probabilistic Perspective‖
5	Machine Learning For Absolute Beginners: A Plain English Introduction (Second Edition), Oliver Theobald

6	Richard Duda, Peter Hart, David G. Stork, ―Pattern Classification‖, Second Edition, Wiley Publications.
7	Approaching (Almost) Any Machine Learning Problem, Abhishek Thakur

Useful Digital Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
AI Tools	
1	https://onlinecourses.nptel.ac.in/noc25_cs46/preview
2	https://onlinecourses.nptel.ac.in/noc25_cs50/preview
3	https://nptel.ac.in/courses/106106198?utm_source
4	https://www.coursera.org/specializations/machine-learning
Case Studies	
1	https://mobidev.biz/blog/machine-learning-application-use-cases-manufacturing-industry?utm_source
2	https://www.businessinsider.com/ai-for-worker-site-safety-in-construction-2025-4?utm_source
3	https://www.coherentsolutions.com/insights/role-of-ml-and-ai-in-clinical-trials-design-use-cases-benefits.
4	https://dataforest.ai/blog/practical-data-warehousing-successful-cases
5	https://www.datamation.com/big-data/data-mining-use-cases/

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
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5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
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8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complet the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

MACHINE LEARNING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW&PR	Tut	Total
NCMMML51	Machine Learning Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMML51	Machine Learning Lab	-	-	-	-	25	25	50

Lab Objectives	
1	Understand and apply core ML algorithms on real-world datasets.
2	Implement dimensionality reduction and supervised/unsupervised techniques.
3	Evaluate ML models for classification, regression and clustering using performance metrics and validation methods.
4	Apply ensemble learning strategies to improve model performance.
5	Engage in case study-based analysis and propose and deploy simple ML models as solutions for real life problems.

Lab Outcomes	
1	Implement and demonstrate fundamental ML algorithms.
2	Perform dimensionality reduction and assess its impact on model performance.
3	Apply regression and classification models and analyze results.
4	Execute clustering techniques and evaluate clustering outcomes.
5	Utilize ensemble methods and cross-validation techniques.

6	Deploy a simple ML model and monitor it post-deployment.

Exp No.	List of Experiments	LOS
1	Apply dimensionality reduction using PCA and LDA on a high-dimensional dataset and analyze feature importance and evaluate reduced feature set impact	LO2
2	Implementation of Linear, Polynomial or Ridge Regression and compare different regression techniques for prediction accuracy	LO3
3	Implement classification model using Logistic regression and evaluate performance measures	LO3
4	Build classification models using Decision Tree(CART) and compare performance metrics with logistic regression	LO3
5	Implement classification models using linear / nonlinear or kernelized SVM and compare their performance metrics	LO3
6	Implement ensemble models : Bagging, Random Forest and evaluate performance measures	LO5
7	Implement ensemble models : and Boosting: XG boost and compare the results	LO5
8	Apply cross-validation (K-Fold, Stratified) and compare ROC-AUC of models	LO5
9	Perform clustering using DBSCAN and evaluate using Silhouette Score	LO4
10	Deploy an ML model using Flask or Streamlit for basic web-based inference to build and deploy a simple interactive ML application	LO1

Term Work	
1	Term work should consist of at least 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks) Pract/oral : 25 marks

CLOUD COMPUTING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPCL51	Cloud Computing Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPCL51	Cloud Computing Lab	-	-	-	-	25	25	50

Prerequisite: Discrete Structures

Lab Objectives:

1	To provide hands-on experience in setting up and managing cloud infrastructure using AWS and Azure platforms.
2	To enable students to deploy, configure, and troubleshoot core cloud services such as compute, storage, networking, and databases.
3	To develop practical skills in leveraging serverless computing, monitoring tools, and cloud automation through CLI and SDKs.
4	To ensure students can implement secure, scalable, and cost-effective cloud solutions with disaster recovery and load balancing capabilities.

Lab Outcomes: At the end of the course, the students will be able to

1	Create and configure cloud accounts, virtual machines, and storage solutions on AWS and Azure platforms.
2	Deploy and manage cloud resources such as VPCs, load balancers, and auto-scaling groups for optimized application performance.
3	Implement identity and access management (IAM) policies to secure cloud resources.
4	Monitor cloud resource usage, set up alarms, and generate performance reports for proactive management.

5	Use serverless computing solutions like AWS Lambda and Azure Functions to build event-driven applications.
6	Demonstrate proficiency in using CLI and SDKs for cloud resource automation and workflow management.

Suggested Experiments: Students are required to complete at least 10 experiments.		
Star (*) marked experiments are compulsory.		
Sr. No.	**Title of Experiment**	**LOs**
1*	Setting Up AWS and Azure Accounts • **Objective**: Create and configure free-tier accounts on AWS and Azure. • **Description**: Students will register, explore the dashboards, and set up billing alerts to manage usage.	LO1
2*	Launching Virtual Machines • **Objective**: Deploy virtual machines (VMs) on AWS EC2 and Azure Virtual Machines. • **Description**: Configure OS, choose instance types, and set up secure remote access (SSH/RDP) for the VMs.	LO1
3*	Working with Storage Services • **Objective**: Explore storage solutions in AWS S3 and Azure Blob Storage. • **Description**: Create storage buckets, upload/download files, and set access permissions for data sharing.	LO2
4*	Deploying Serverless Functions • **Objective**: Create and test serverless functions using AWS Lambda and Azure Functions. • **Description**: Write and deploy simple functions (e.g., a REST API or data processing task) triggered by events.	LO3
5*	Setting Up and Managing Databases • **Objective**: Work with managed database services like AWS RDS and Azure SQL Database. • **Description**: Create databases, connect using client tools, and perform basic CRUD operations.	LO4
6*	Load Balancing and Auto-Scaling • **Objective**: Implement load balancing and auto-scaling for web applications. • **Description**: Use AWS Elastic Load Balancer (ELB) and Azure Load Balancer to distribute traffic and configure scaling rules.	LO2

7*	Configuring IAM and Access Control • **Objective**: Explore identity and access management (IAM) in AWS and Azure. • **Description**: Create users, roles, and policies to restrict access to cloud resources.	LO3
8*	Monitoring Cloud Resources • **Objective**: Use monitoring tools like AWS CloudWatch and Azure Monitor. • **Description**: Configure alarms, monitor resource utilization, and generate performance reports.	LO2
9*	Deploying a Web Application • **Objective**: Host a web application using cloud services. • **Description**: Deploy a static or dynamic website on AWS Elastic Beanstalk and Azure App Service.	LO5
10	Configuring Backups and Disaster Recovery • **Objective**: Set up automated backups and disaster recovery plans. • **Description**: Use AWS Backup and Azure Recovery Services to ensure data protection.	LO5
11	Integrating CLI and SDK for Cloud Operations • **Objective**: Automate cloud tasks using AWS CLI, Azure CLI, and SDKs. • **Description:** Use command-line tools and SDKs to provision resources and perform basic automation.	LO6

Useful Links	
1	**AWS Free Tier and Getting Started** – Create and explore AWS services with free-tier usage.
2	**Microsoft Azure Free Account** – Set up Azure cloud resources with a free $200 credit.
3	**AWS Documentation Portal** – Official AWS documentation and service guides.
4	**Azure Documentation Portal** – Microsoft Learn for Azure concepts and tutorials.
5	**Cloud Skills Challenge by Microsoft** – Hands-on challenges to practice Azure skills.
Virtual Lab	
1	**AWS Cloud Quest (Free Tier Labs)** – Interactive learning through gamified AWS labs.
2	**Microsoft Azure Hands-on Labs** – Free, browser-based sandbox for Azure with real services.
AI Tools	
1	**AWS Trusted Advisor** – AI-powered best practice checker for performance, cost, and security.
2	**Azure Advisor** – Personalized AI-driven cloud optimization recommendations.

3	CAST Highlight – AI-based cloud readiness assessment and migration analysis tool.
4	CloudZero – AI-powered cost intelligence tool for cloud resource tracking and budgeting.

Term Work:	
1	Journal must include at least 2 assignments on content of theory and practical of "CLOUD COMPUTING AWS/AZURE"
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Mini Project
	Total 25 Marks (Experiments: 10-marks, Mini Project: 10-marks, Assignment: 5-marks)

SEM VI SYLLABUS

Department of Computer Engineering

Semester VI Teaching Scheme								
Course Type	**Course Code**	**Course name**	**Teaching scheme (Contact Hours)**			**Credits assigned**		**Total**
			Th	**Pr**	**Tu**	**Th**	**Pr/Tut**	
PCC	NCMPC61/ NCMPCL61	Software Engineering and Architecture	3	2	-	3	1	4
PCC	NCMPC62/ NCMPCL62	Cryptocurrency & Blockchain Development	3	2	-	3	1	4
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 2**	3	2	-	3	1-	4
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 3**	3	2	-	3	1	4
MDM	NCMMM61	Deep Learning	1	2	-	-	2	2
VSEC	NCMVS61	Mobile App Development	1	2	-	-	2	2
PCC	NCMCP61	Capstone Project I	**-**	**4**	**-**	**-**	**2**	**2**
			15	**14**	**0**	**14**	**8**	**22**
		Total Hours	**29**			**Total Credits**		**22**

Program Elective 2			**Program Elective 3**	
Sr. No	**Course Code**	**Course Name**	**Course Code**	**Course Name**
1	**NCMPE61**	Applied Data Science	**NCMPE64**	Natural Language Processing and Generative AI
2	**NCMPEL61**	Applied Data Science Lab	**NCMPEL64**	Natural Language Processing and Generative AII Lab
3	**NCMPE62**	Graphics & Animation	**NCMPE65**	GeoInformatics
4	**NCMPEL62**	Graphics & Animation Lab	**NCMPEL65**	GeoInformatics Lab
5	**NCMPE63**	System Software	**NCMPE66**	Embedded Systems and RTOS
6	**NCMPEL63**	System Software Lab	**NCMPEL66**	Embedded Systems and RTOS Lab

Semester VI Examination Scheme									
Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
PCC	NCMPC61/ NCMPCL61	Software Engineering and Architecture	20	20	60	2	25	-	**125**
PCC	NCMPC62/ NCMPCL62	Cryptocurrency & Blockchain Development	20	20	60	2	25	-	**125**
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 2**	20	20	60	2	25	-	**125**
PEC	NCMPE6X/ NCMPEL6X	**Program Elective 3**	20	20	60	2	25	-	**125**
MDM	NCMMM61	Deep Learning	-	-	-	-	50	25	**75**
VSEC	NCMVS61	Mobile App Development	-	-	-	-	50	25	**75**
PCC	NCMCP61	Capstone Project I	-	-	-	-	25	25	**50**
								TOTAL MARKS	**700**

COURSE NAME: SOFTWARE ENGINEERING AND ARCHITECTURE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC61	Software Engineering and Architecture	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC61	Software Engineering and Architecture (Theory)	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPC61	Software Engineering and Architecture (Theory)	20	20	60	2	-	-	100

Prerequisite: Object Oriented Programming with Java , Python Programming	
Course Objectives: Students should be able to	
1	Understand software engineering principles, processes, and methodologies.
2	Learn to design, model, and evaluate software architectures.
3	Develop skills for managing software projects efficiently.
4	Explore modern software development practices, tools, and frameworks
5	Understand the foundational concepts of intelligent and agentic systems in software engineering.
6	Analyze and design agent-based solutions for real world problems by applying agentic frameworks and tools
Course Outcomes: Students should be able to	

1	Identify requirements, apply modeling techniques & assess the process models.
2	Plan, schedule and track the progress of the projects using agile tools.
3	Create software architecture styles and design patterns for the software projects.
4	Develop test cases and perform manual and automated testing tools of software projects using various approaches.
5	Design and implement intelligent software agents that can perceive, decide, and act.
6	Manage the lifecycle (deployment, monitoring, scaling) of agentic applications by Using state-of-the-art libraries, frameworks and tools.

Module		Content	CO	Hours
1	**Introduction to Software Engineering and Architecture**		CO1, CO2	07
	1.1	**Software Engineering and Architecture Overview:** Introduction to Software Engineering, Software architecture vs. software design, Software development lifecycle (SDLC) models: Waterfall, Incremental Process Models, Evolutionary Process Models: Spiral, Introduction to Agile process model: Overview of JIRA, Asana		
	1.2	**Requirement Engineering:** **Requirement gathering techniques** - Open ended and close ended questionnaires, Survey, Joint Application Design, Functional and non-functional requirements, user requirements, system requirements, interface specification, **Requirement modeling** — Use cases, user stories and **Requirements validation**		
2	**Software Modeling and Design**		CO3	06
	2.1	**Software Design Principles:** Modularity, Abstraction, Coupling, Cohesion, SOLID principles, Design Patterns - Singleton and Factory Methods (Creational Patterns), Bridge and Composite Methods (Structural Patterns), Blackboard Method (Behavioural Patterns)		
	2.2	**Structured and Object Oriented Modeling :** Use case Diagram, Data flow diagram, Class diagrams, Sequence Diagram, Component diagrams, Deployment diagrams.		
	Software Architecture		CO3	07
	3.1	**Architectural Patterns & Styles**		

3		Architectural / Enterprise Patterns: State Logic Controller, Sense-Logic-Actuator,Model-View-Controller,Service-Oriented Architecture (SOA), Architectural Styles: Layered architecture, Client-server, Microservices, Event-driven architecture, Pipe and Filter.		
4	**Software Estimation and Project Scheduling**		CO2	04
	4.1	Software Metrics: LOC, Function Points, Introduction to Basic COCOMO model and COCOMO II Model		
	4.2	Project Scheduling & Tracking : Work breakdown structure – Gantt Chart – CPM / PERT		
5	**Software Testing and Introduction to Agentic Software Engineering**		CO4, CO5	08
	5.1	Unit testing, Integration testing,Validation testing, System testing		
	5.2	Testing Techniques: white-box testing - Basis path, Control structure testing. Black-box testing - Graph based, Equivalence, Boundary Value, Introduction to automated industrial software testing tools (Selenium)		
	5.3	Introduction to Autonomous Agents, Characteristics of Agentic Software, Differences between Traditional AI and Agentic AI		
6	**Foundations of Intelligent Agents, Agentic Frameworks and Tools**		CO6	07
	6.1	Agent Architectures: Reactive, Deliberative, Hybrid, Cognitive Models of Agents, Communication between Agents (Protocols, Languages)		
	6.2	Introduction to OpenAI Agents SDK, LangGraph, CrewAI, AutoGen, Hands-on: Building Simple Agents		
	6.3	Emerging Trends in Software development: DevOp Architecture, DevOps Toolchain.		
			Total	**39**

Textbooks	
1	Roger Pressman, "**Software Engineering: A Practitioner's Approach"**, 9th edition , McGraw-Hill Publications, 2019
2	Ian Sommerville, **"Software Engineering"**, 10th edition, Pearson Education, 2016
3	"**Software Architecture: Foundations, Theory , and Practice**" by Richard N. Taylor, Nenad Medvidovic, Eric Dashofy, ISBN:978-0-470-16774

4	Grady Booch, James Rambaugh, Ivar Jacobson, **"The Unified Modeling Language user guide"**, 2nd edition, Pearson Education, 2005
5	**Multiagent Systems and Applications: Volume 1 Practice and Experience** by Maria Ganzha and Lakhmi C. Jain, Springer Publisher, October 2012, ISBN:978-3-642-33322-4

References	
1	**Clean Code: A Handbook of Agile Software Craftsmanship** by Robert C. Martin, 2015
2	Rajib Mall, **"Fundamentals of Software Engineering"**, 5th edition, Prentice Hall India, 2014
3	Jibitesh Mishra and Ashok Mohanty, **"Software Engineering"**, Pearson , 2011
4	Ugrasen Suman, **"Software Engineering – Concepts and Practices"**, Cengage Learning, 2013
5	Fundamentals of Software Architecture by Mark Richards & Neal Ford, 2020
Useful Links	
Resources	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx
4	Software Engineering Specialization by University of Minnesota
5	Software Design and Architecture Specialization by University of Alberta
6	Software Design and Architecture Roadmap
7	OpenAI Agents SDK Documentation
8	CrewAI Tutorials
9	LangGraph for Python Developers

AI Tools	
1	Project Planning and Management: Jira, Microsoft Project, Asana
2	Development: GitHub Copilot, Tabnine
3	Testing: DeepCode, Snyk
4	Deployment: Harness, Spinnaker
5	Monitoring and Maintenance: Datadog, New Relic
6	Documentation and Knowledge Management: Confluence, Slite
Industry articles	
1	https://clickup.com/blog/
Case Studies	
1	https://www.bugraptors.com/case-study
Virtual Lab	
1	**http://vlabs.iitkgp.ernet.in/se/**

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr.No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks

5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based Assignment test/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
End Semester Theory Examination	
1	Question Paper will comprise a total of six questions
2	All Question carries equal Marks
3	Questions will be mixed in nature(For Ex.-Suppose question 2 has part (a) from module 3 then part (b) will be from any other module other than module 3
4	Only Four Questions need to be solved
5	In the question paper, the weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

SOFTWARE ENGINEERING AND ARCHITECTURE (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPCL61	Software Engineering and Architecture Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPCL61	Software Engineering and Architecture (Theory)	-	-	-	-	25	-	25

Prerequisite: Object Oriented Programming with Java , Python Programming

Lab Objectives:

1	Understand and implement software engineering principles, process models and design patterns.
2	Apply architectural styles and patterns in software projects.
3	Perform structured and object-oriented modeling using UML diagrams
4	Gain hands-on experience with agile project management and estimation tools
5	Build and test software components using manual and automated tools.
6	Design and manage lifecycle activities for any agent-based systems to build intelligent software agents using agentic frameworks and tools.

Lab Outcomes:

1	Apply modeling techniques to document software requirements and design.
2	Plan, schedule, and track software projects using modern agile tools.
3	Design and implement software architecture and design patterns.

4	Perform unit and integration testing, including automation using Selenium
5	Develop simple autonomous software agents using frameworks like OpenAI Agents SDK and LangGraph.
6	Integrate DevOps practices for building and managing scalable systems.

Suggested Experiments: Students are required to complete at least 8 experiments.

Sr.No.	List of Experiments	LOs
1	Create Software Requirement Specification (SRS) using functional, non-functional requirements, use cases, and user stories for a real-world application.	LO1
2	Draw Use Case Diagrams and Level 1 & Level 2 Data Flow Diagrams (DFD) for the chosen problem statement (Eg., E-Commerce, Banking Systems, etc.)	LO1
3	Model Class Diagrams and Sequence Diagrams for a chosen system (e.g., Library Management, Online Shopping).	LO1, LO3
4	Design architecture using MVC and appropriate design patterns for a chosen problem statement and document it.	LO3
5	Create and manage a small software project using Agile methodology with tools like Jira or Asana (including creating user stories, sprints, backlogs).	LO1, LO2
6	Estimate software effort, cost, and schedule using COCOMO II models and Gantt chart respectively using SE tools.	LO2
7	Perform black-box (equivalence partitioning / boundary value analysis) and white-box testing (basis path) and automate test cases using Selenium.	LO4
8	Implement basic DevOps pipeline: GitHub actions for CI/CD pipeline for a simple Java / Python app	LO6
9	Create a simple agent (e.g., chatbot agent) using OpenAI Agents SDK or LangGraph. Demonstrate agent's perception, decision, and action.	LO5
10	Build a simple multi-agent system where two agents communicate (example:	LO5

	buyer and seller agents) and demonstrate coordination.	

Useful Links	
Resources	
1	https://nptel.ac.in/courses/106/105/106105182/
2	https://onlinecourses.nptel.ac.in/noc19_cs69/preview
3	https://www.mooc-list.com/course/software-engineering-introduction-edx
4	Software Engineering Specialization by University of Minnesota
5	Software Design and Architecture Specialization by University of Alberta
6	Software Design and Architecture Roadmap
7	OpenAI Agents SDK Documentation
8	CrewAI Tutorials
9	LangGraph for Python Developers
AI Tools	
1	Project Planning and Management: Jira, Microsoft Project, Asana
2	Development: GitHub Copilot, Tabnine
3	Testing: DeepCode, Snyk
4	Deployment: Harness, Spinnaker
5	Monitoring and Maintenance: Datadog, New Relic
6	Documentation and Knowledge Management: Confluence, Slite
Industry articles	
1	https://clickup.com/blog/
Case Studies	
1	https://www.bugraptors.com/case-study
Virtual Lab	
1	**http://vlabs.iitkgp.ernet.in/se/**

Term Work:	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Attendance: 5-marks, Assignment: 5-marks)

COURSE NAME: CRYPTOCURRENCY AND BLOCKCHAIN DEVELOPMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC62	Cryptocurrency & Blockchain Development	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPC62	Cryptocurrency & Blockchain Development	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPC62	Cryptocurrency & Blockchain Development	20	20	60	2	-	-	100

Prerequisite: Knowledge on number systems.	
Course Objectives	
1	To provide an in-depth understanding of blockchain technology and cryptocurrency ecosystems, including their applications and limitations.
2	To equip students with the skills needed to design, develop, and deploy secure blockchain solutions and smart contracts.
3	To explore the ecosystem of decentralized applications, focusing on their architecture, development, and integration with blockchain networks.
4	To introduce advanced topics like DeFi, NFTs, scalability, and blockchain's role in emerging technologies for industry-oriented learning.
Course Outcomes: Students will be able	
1	Understand the principles, architecture, and applications of blockchain and cryptocurrencies.
2	Analyze and evaluate the features of major blockchain platforms and their use cases.
3	Design and implement secure cryptocurrency wallets and manage transactions effectively.

4	Develop and deploy smart contracts using Solidity and integrate them with blockchain networks.
5	Build and optimize decentralized applications (DApps) with cryptocurrency payment integration.
6	Assess and implement advanced blockchain solutions like DeFi, NFTs, and layer-2 scalability techniques.

Module		Content	CO	Hours
1	**Introduction to Cryptocurrency and Blockchain**		CO1	07
	1.1	History and Evolution of Money and Digital Currencies, Understanding Cryptocurrencies: Concepts, Types, and Benefits, Blockchain Technology Fundamentals: Distributed Ledgers and Immutability,		
	1.2	Consensus Mechanisms: Proof of Work (PoW), Proof of Stake (PoS), and Alternatives, Key Components of Blockchain: Cryptography, Hashing, and Mining, Applications of Blockchain Beyond Cryptocurrencies (Supply Chain, Healthcare, etc.), Blockchain's Role in Decentralization and the Future of Web3		
2	**Blockchain Architecture and Platforms**		CO2	06
	2.1	Anatomy of a Blockchain: Blocks, Transactions, and Nodes, Types of Blockchains: Public, Private, Consortium, and Hybrid, Exploring Key Blockchain Platforms: Bitcoin, Ethereum, Hyperledger, and Binance Smart Chain.		
	2.2	Smart Contracts: Concept, Structure, and Applications, Overview of Decentralized Applications (DApps) and Token Standards (ERC-20, ERC-721, etc.), Security Aspects of Blockchain: Attacks, Challenges, and Mitigation Techniques		
3	Cryptocurrency Ecosystem and Wallets		CO3	06
	3.1	Popular Cryptocurrencies: Bitcoin, Ethereum, Ripple, and Altcoins, Cryptocurrency Mining: Mechanisms, Challenges, and Rewards, Cryptocurrency Wallets: Hot vs. Cold Wallets, Multi-Signature Wallets.		
	3.2	Securing Wallets: Threats, Recovery Methods, and Best Practices, Cryptocurrency Exchanges: Types, Trading Mechanisms, and Risks, Regulatory and Legal Frameworks for Cryptocurrencies Globally		
4	Smart Contracts and Development		CO4	07
	4.1	Introduction to Solidity Programming Language, Setting Up Development Environments: Truffle, Ganache, and Remix IDE, Writing and Deploying Basic Smart Contracts, Smart Contract Lifecycle, Gas Optimization, and Fees		

	4.2	Advanced Solidity Concepts: Libraries, Modifiers, and Events, Debugging, Testing, and Security Best Practices for Smart Contracts, Integration of Smart Contracts with Blockchain Networks		
5	Building Decentralized Applications (DApps)		CO5	07
	5.1	Architecture of Decentralized Applications, Interaction Between Smart Contracts and Frontend Using Web3.js, Tools for DApp Development: Web3.js, Ethers.js, and Metamask		
	5.2	Building and Deploying a Simple DApp on Ethereum Testnet, Integrating Cryptocurrency Payments in DApps Using Payment Gateways, Performance Optimization and Scaling Solutions for DApps, Testing and Deploying DApps to Production Environments		
6	Advanced Topics and Trends in Blockchain		CO6	06
	6.1	Layer-2 Scaling Solutions: Polygon, Lightning Network, and Optimistic Rollups, Decentralized Finance (DeFi): Protocols, Platforms, and Applications, Non-Fungible Tokens (NFTs): Standards, Creation, and Marketplace Integration		
		Blockchain Interoperability: Bridging Between Different Networks, Blockchain's Role in Emerging Technologies: AI, IoT, and Metaverse		
	6.2	Case Study: End-to-End Development and Deployment of a Blockchain-Based Solution for any domain		
		Total		**39**

Textbooks	
1	"Mastering Blockchain: Unlocking the Power of Cryptocurrencies, Smart Contracts, and Decentralized Applications" by Imran Bashir
2	"Blockchain Basics: A Non-Technical Introduction in 25 Steps" by Daniel Drescher
3	"Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain" by Ritesh Modi
References	
1	"Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies is Changing the World" by Don Tapscott and Alex Tapscott
2	"Cryptocurrency: How Bitcoin and Digital Money are Challenging the Global Economic Order" by Paul Vigna and Michael J. Casey
3	"The Basics of Bitcoins and Blockchains" by Antony Lewis

4	"Building Ethereum DApps: Decentralized Applications on the Ethereum Blockchain" by Roberto Infante
Useful Links	
Resources	
1	https://github.com/frankiefab100/Blockchain-Development-Resources
2	https://tech.seas.harvard.edu/free-blockchain
AI Tools	
1	https://www.chaingpt.org
2	https://www.anchain.ai/ciso
3	https://workik.com/blockchain-code-generator
Industry articles	
1	https://www.ft.com/content/5acb33a2-4690-4f56-add3-7e2b01530a21
Case Studies	
1	https://www.wired.com/story/user-owned-ai-illia-polosukhin-open-source-web3
2	https://coingeek.com/blockchain101/a-guide-to-ai-driven-solutions-for-strengthening-blockchain-security/?utm_source=chatgpt.com

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks

4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

CRYPTOCURRENCY & BLOCKCHAIN DEVELOPMENT (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPCL62	Cryptocurrency & Blockchain Development Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPCL62	Cryptocurrency & Blockchain Development Lab	-	-	-	-	25	-	25

Prerequisite:	
Lab Objectives	
1	To provide hands-on experience in blockchain and cryptocurrency development environments.
2	To enable students to design and deploy blockchain networks, smart contracts, and decentralized applications (DApps).
3	To enhance skills in integrating cryptocurrency wallets and exchanges into applications securely.
4	To foster problem-solving and innovation in blockchain technology applications through practical experimentation.
Lab Outcomes	
1	Configure and manage blockchain networks using popular platforms.
2	Design and implement smart contracts for various use cases.
3	Develop and deploy decentralized applications (DApps) on blockchain platforms.
4	Integrate cryptocurrency wallets and secure transactions effectively.
5	Analyze and optimize blockchain-based systems for performance and scalability.
6	Evaluate the practical implications of blockchain security and compliance requirements.

Suggested Experiments: Students are required to complete at least 10 experiments.		
Star (*) marked experiments are compulsory.		
Sr. No	**List the Experiment**	**LOs**
1*	Explore the Cryptocurrency Landscape	LO5
2*	Cryptography in Blockchain, Merkle root tree hash	LO6
3*	Create a Blockchain using Python	LO1
4*	Create a Crypto Currency using Python for the blockchain implemented in Experiment No. 3 and create a network of nodes.	LO1, LO4
5*	Hands on Solidity Programming Assignments for creating Smart Contracts	LO2
6	Deploying a Voting/Ballot Smart Contract in Remix IDE	LO2, LO3
7*	Creating a Token (ERC-20) in Remix IDE	LO2
8*	Building a web based Decentralized Application (DApp) using Truffle suite	LO3
9*	Configuring a Cryptocurrency Wallet using Metamask and integrating it with a DApp.	LO4
10*	Simulating Blockchain Transactions using Ganache to simulate transactions and observe block creation.	LO1, LO5
11	Implement a Private Ethereum Blockchain using Geth	LO1, LO5

Useful Links	
1	https://www.lfdecentralizedtrust.org/
2	https://ethereum.org/en/
3	https://coinmarketcap.com/coins/
Tools and Articles	
1	https://archive.trufflesuite.com/
2	https://remix.ethereum.org/
3	https://metamask.io/

4	https://archive.trufflesuite.com/ganache/

Term Work	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Attendance: 5-marks, Assignment: 5-marks)

Programme
ELECTIVE-2
TE NEP Sem VI
2025-26

COURSE NAME: APPLIED DATA SCIENCE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE61	Applied Data Science	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE61	Applied Data Science	3		-	3	-		3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE61	Applied Data Science	20	20	60	2	-		100

Prerequisite: Engineering Mathematics, Machine Learning, Data Structures & Algorithms	
Course Objectives	
1	To introduce students to the basic concepts of data science.
2	To acquire an in-depth understanding of data exploration and data visualization.
3	To be familiar with various anomaly detection techniques**.**
4	To understand the data science techniques for different applications.
Course Outcomes	
1	To gain fundamental knowledge of the data science process.
2	Apply different methodologies and evaluation strategies.
3	To apply data exploration and visualization techniques
4	To apply anomaly detection techniques.
5	To gain an in-depth understanding of time-series forecasting.

6	To apply Optimization Techniques and explore data science techniques to real world applications.

Module		Content	CO	Hours
1		**Introduction to Data Science**	CO1	05
	1.1	Introduction to Data Science, Data Science Process		
	1.2	Motivation to use Data Science Techniques: Volume, Dimensions and Complexity, Data Science Tasks and Examples		
	1.3	Overview of Data Preparation, Modeling, Difference between data science and data analytics		
2		**Data Exploration**	CO2	10
	2.1	Descriptive Statistics: Univariate Exploration: Measure of Central Tendency(Methods to calculate Arithmetic Mean,Weighted Mean,Median,Mode) Measure of Dispersion(Range,Quartile Deviation,IQR),Measures of Skewness (Karl Pearson Coeff.of skewness, Bowley's Coefficient of skewness), Measures of Kurtosis Multivariate Exploration:Correlation Analysis, Concept of Correlation,Bivariate Distribution,Covariance Types of correlation, Karl Pearson's Coefficient of Correlation		
	2.2	Inferential Statistics: Overview of Various forms of distributions: Normal, Poisson Statistical Inference-Tests of Significance: Procedure for testing a Hypothesis,Significance tests in Attributes,Test of significance of a single Mean, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors,F-Distribution and Analysis of Variance(ANOVA)		
3		**Methodology and Data Visualization**	CO3	06
	3.1	Methodology: Overview of model building, Cross Validation, K-fold cross validation, leave-1 out, Bootstrapping		
	3.2	Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart, Roadmap for Data Exploration		
4		**Anomaly Detection**	CO4	06
	4.1	Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics		

	4.2	Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE		
5		**Time Series Forecasting**	CO5	08
	5.1	Taxonomy of Time Series Forecasting methods, Time Series Decomposition		
	5.2	Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error		
6		**Optimization Techniques and Applications of Data Science**	CO6	04
	6.1	Optimization: Global and local optima; Unconstrained and constrained optimization; Introduction to least-squares optimization		
	6.2	Predictive Modeling: House price prediction, Fraud Detection Clustering: Customer Segmentation,Use cases for Health care, Time series forecasting: Weather Forecasting, Recommendation engines: Product recommendation		
		Total		**39**

Textbooks	
1	Vijay Kotu, Bala Deshpande. "Data Science Concepts and Practice", Elsevier, M.K. Publishers.
2	Steven Skiena, "Data Science Design Manual", Springer International Publishing AG
3	Samir Madhavan. "Mastering Python for Data Science", PACKT Publishing
4	Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, "Comprehensive Statistical Methods", S.Chand Publications, New Delhi.
References	
1	Jake VanderPlas. "Python Data Science Handbook", O'reilly Publications.
2	Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, "Recommender Systems Handbook", Springer.
3	S.C. Gupta, V. K. Kapoor "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi.

4	B .L .Agrawal. "Basic Statistics", New Age Publications, Delhi.
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs69/preview
3	https://www.coursera.org/specializations/applied-data-science
4	www.IntroDataScience.com.
5	https://rapidminer.com/
6	https://julialang.org/
7	https://towardsdatascience.com/machine-learning/home
AI Tools	
1	https://h2o.ai/
2	https://datasquirrel.ai/
3	https://flourish.studio/
Case Studies	
1	https://www.analyticsvidhya.com/blog/2021/05/data-science-in-healthcare/
2	https://neptune.ai/blog
3	https://towardsdatascience.com/
Datasets	
1	https://www.kaggle.com/datasets
2	https://archive.ics.uci.edu/
3	https://data.gov/

Internal Assessment
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.
Continuous Assessment
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table

Sr. No.	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical/Quiz	
2	Skill Enhancement Lecture	
3	Extra Assignments/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

APPLIED DATA SCIENCE (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL61	Applied data Science Lab	-	2	-	-	1		1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL61	Applied Data Science Lab	-	-	-	-	25	-	**25**

Prerequisite: Engineering Mathematics, Machine Learning, Programming fundamentals	
Lab Objectives	
1	To explore various stages in the data science lifecycle.
2	To understand data preparation, exploration and visualization techniques.
3	To model and evaluate different supervised/unsupervised learning techniques
Lab Outcomes	
1	Apply various stages of the data science lifecycle for the selected case study.
2	Apply inferential statistics, predictive analytics, and data mining to informatics-related field
3	Demonstrate data preparation, exploration and visualization techniques.
4	Implement and evaluate different supervised and unsupervised techniques.

Suggested Experiments: Students are required to complete at least 8 experiments.		
Sr.No.	**List of Experiment**	**LO Mapped**
1	Explore the descriptive and inferential statistics on the given dataset.	LO1,LO2
2	Apply data cleaning techniques (e.g. Data Imputation)	LO1,LO3
3	Explore data visualization techniques.	LO3
4	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)	LO4
5	Use SMOTE technique to generate synthetic data.(to solve the problem of class imbalance)	LO1,LO3
6	Outlier detection using distance based/density based method.	LO3
7	Implement time series forecasting for Healthcare diagnosis	LO2,LO4
8	Illustrate data science lifecycle for selected case study. (Prepare case study document for the selected case study) Suggested Case Studies: 1. Customer Segmentation 2. Fraud Detection 3. House Price prediction 4. Product Recommendation 5. Stock price prediction 6. Weather prediction	LO1-LO4

Useful Links:	
1	https://www.microsoft.com/en-in/download/details.aspx?id=45331
2	https://rapidminer.com/
3	https://www.knime.com/

Term Work:	
1	Term work should consist of at least 8 experiments.
2	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks: (Minimum 10 Experiments - 15 marks, Assignment - 5 marks, Attendance - 5 marks (Theory+Lab)

Oral & Practical exam
Based on the entire syllabus of Applied Data Science course and Lab

COURSE NAME: GRAPHICS AND ANIMATION

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE62	Graphics and Animations	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE62	Graphics and Animations	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE62	Graphics and Animations	20	20	60	2	-	-	100

Prerequisite: Knowledge of C Programming and Basic Mathematics

Course Objectives

1	To equip students with the fundamental knowledge and basic technical competence in the field of computer graphics and animations.
2	To emphasize on the implementation aspect of computer graphics algorithms.
3	To prepare the student for advanced areas and professional avenues in the field of computer graphics and animations.
4	To introduce the basics of graphics and animations in game development.

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

1	Describe the basic concepts of computer graphics and animations.
2	Demonstrate various algorithms for basic graphics primitives and curve representation techniques.
3	Apply 2D and 3D geometric transformations on graphical objects and demonstrate projection methods.
4	Use various clipping algorithms on graphical objects and demonstrate visible surface detection techniques.
5	Demonstrate the concept of Animation, its techniques and applications.

6	Understand the role of graphics and animation in game development.

Module	Content		CO	Hours
1	**Introduction to Computer Graphics and Animations**		CO1	04
	1.1	Introduction to computer graphics: Overview of coordinate system, pixel, screen resolution, aspect ratio, definition of scan conversion, rasterization, applications of graphics. Concept aliasing and anti-aliasing.		
	1.2	Introduction to Animation : Definition, Need, and Importance of Animation, Applications of Animation, Principles of Animation, Types of Animation: 2D Animation, 3D Animation.		
2	**Output Primitives**		CO2	08
	2.1	Scan conversions of point, line, circle: DDA algorithm and Bresenham algorithm for line drawing, midpoint algorithm for circle		
	2.2	Curves Generation: Bezier Curve, B-Spline Curve, Fractal-Geometry: Fractal Dimension, Koch Curve.		
	2.3	Filled Area Primitive: Inside outside tests, Boundary Fill and Flood fill algorithm.		
3	**2D and 3D Geometric Transformations**		CO3	09
	3.1	Basic transformations: 2D Transformations: Translation, Scaling, Rotation, Reflection and Shear, Matrix representation and Homogeneous Coordinates (2D)		
	3.2	3D Transformations: Translation, Scaling, Rotation, Rotation about an arbitrary axis (3D), Matrix representation and Homogeneous Coordinates (3D)		
	3.3	Composite Transformations (2D and 3D)		
	3.4	Viewing transformation pipeline and Window to Viewport coordinate transformation, Introduction to parallel and perspective projections		
4	**Two-Dimensional Clipping and Visible Surface Detection**		CO4	08
	4.1	Clipping operations: Point clipping, Line clipping algorithms: Cohen-Sutherland, Liang: Barsky.		
	4.2	Polygon Clipping Algorithms: Sutherland- Hodgeman, Weiler-Atherton.		

	4.3	Visible Surface Detection: Introduction, classification of visible surface detection algorithm Hidden Surface Removal , Application of Coherence , Back Face Elimination , Depth (Z) Buffer Algorithm, A-Buffer Algorithm, Depth Sorting (Painter's) Algorithm		
5	**Animation: Concepts, Techniques, and Applications**		CO5	05
	5.1	2D & 3D Animation Concepts : 2D animation, definition of 2D, characteristics of 2D, authoring tools for 2D animation, SWF, FLA, FLV, keyframe, editing keyframes, track views, trajectories, animation modifiers, hierarchies, animation helps and controls, morphing and wrapping.		
	5.2	Basics of 3D Animation: Modeling, Skeleton & Kinetic Animation Concepts, 3D Camera Tracking and Special Effects, Motion Capture Methods, Formats, and Applications		
6	**Introduction to Graphics and Animation in Game Development**		CO6	05
	6.1	Fundamentals of graphics in game development: Introduction to game graphics, importance of graphics in gaming, evolution of game graphics (2D, 3D, HD, Ray Tracing), role of graphics in player immersion.		
	6.2	Game Art and Visual Design: Game assets: Sprites, textures, models, backgrounds, 2D vs. 3D graphics: Differences and use cases, Color theory and visual aesthetics in gaming.		
	6.3	Animation Principles in Gaming: Fundamentals of Game Animation: Importance of animation in gameplay and storytelling, Keyframe animation vs. procedural animation Motion capture and physics-based animation, Character and Object Animation: Character rigging and skeletal animation, Animation techniques for game objects (particles, effects), Real-time vs. pre-rendered animation		
			Total	**39**

Textbooks	
1	Hearn & Baker,"Computer Graphics C version", 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2 ndEdition, Pearson Publication
3	Samit Bhattacharya,"Computer Graphics",Oxford Publication
4	R. K Maurya, "Computer Graphics with Virtual Reality", Wiley India.

5	Jeannie Novak, Game Development Essentials: An Introduction, Cengage Learning
References	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-Hill Education
3	Rajesh K. Maurya,"Computer Graphics",Wiley India Publication.
4	F.S.Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.
5	Steve Marschner & Peter Shirley, Fundamentals of Computer Graphics, A K Peters/CRC Press
Useful Links	
	Resources
1	Computer Graphics - NPTEL Course
2	ANIMATIONs - NPTEL Course
3	Rigging with Animation Industry´s Techniques | Udemy
4	https://www.coursera.org/learn/interactive-computer-graphics
5	Game Development Fundamentals Courses Udemy
	AI Tools
1	https://www.blender.org/
2	https://www.freecadweb.org/
3	Generative AI – Adobe Sensei
4	Runway | Tools for human imagination.
5	Home | prometheanai

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table

No.	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks

*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment:

1	Skill Enhancement Lecture
2	Extra Assignments/lab/lecture

End Semester Theory Examination:

1	Question paper will be of 60 marks
2	Question paper will have a total of five questions

3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

GRAPHICS AND ANIMATION (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL62	Graphics and Animations lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL62	Graphics and Animations Lab	-	-	-	-	25	-	25

Prerequisite: Knowledge of C Programming.	
Lab Objectives:	
1	Understand the need of developing graphics and animation applications.
2	Learn algorithmic development of graphic primitives.
3	Learn the representation of graphical images and animate them.
Lab Outcomes: Students will be able to	
1	Develop an understanding of fundamental graphics concepts and their implementation in programming.
2	Implement various algorithms for rendering output primitives in computer graphics.
3	Apply transformation matrices to manipulate objects and create complex graphical scenes.
4	Implement clipping algorithms and generate smooth curves for efficient and visually appealing graphics.
5	Develop skills in basic animation techniques
6	Utilize programming skills to develop interactive graphics applications using appropriate tools and algorithms.

Suggested Experiments: Students are required to complete at least 10 experiments.		
Star (*) marked experiments are compulsory.		
Sr. No.	**List of Experiment**	**LOs**
1	Drawing basic primitives using C Functions.	LO1
2	Implement DDA Line Drawing algorithm and Bresenham's Line algorithm.	LO2
3	Implement the midpoint Circle algorithm.	
4	Implement Area Filling Algorithm: Boundary Fill, Flood Fill.	LO2
5	Implement 2D Transformations: Translation, Scaling, Rotation, Reflection, and shear.	LO3
6	Implement Line Clipping Algorithm: Cohen Sutherland / Liang Barsky.	LO4
7	Implement Curve : Bezier for n control points	LO4
8	Program to perform animation (such as Rising Sun, Moving Vehicle, Smileys, Screen Saver, etc.) (Using C)	LO5, LO6
9	Program to perform animation of a ball bouncing while applying squash and stretch to show motion dynamics. (Unity, C#)	LO5
10	Create a simple animated character that walks or jumps using sprite sheets. Using Unity (with C#), Godot (GDScript), or Pygame (Python)	LO5, LO6
11	Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. (Use C#)	LO2
12*	Experiments can be conducted using virtual labs.	LO1-LO6

Textbooks:	
1	Hearn & Baker,"Computer Graphics C version", 2nd Edition, Pearson Publication
2	James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, "Computer Graphics Principles and Practice in C", 2 ndEdition, Pearson Publication
3	Samit Bhattacharya,"Computer Graphics",Oxford Publication
4	R. K Maurya, "Computer Graphics with Virtual Reality", Wiley India.

5	Jeannie Novak, Game Development Essentials: An Introduction, Cengage Learning
References:	
1	D. Rogers, "Procedural Elements for Computer Graphics", Tata McGraw-Hill Publications
2	Zhigang Xiang, Roy Plastock, "Computer Graphics", Schaum"s Outlines McGraw-Hill Education
3	Rajesh K. Maurya,"Computer Graphics",Wiley India Publication.
4	F.S.Hill, "Computer Graphics using OpenGL", Third edition, Pearson Publications.
5	Steve Marschner & Peter Shirley, Fundamentals of Computer Graphics, A K Peters/CRC Press
Indirect Assessment: Quiz	

Useful Links:	
Resources:	
1	Computer Graphics - NPTEL Course
2	ANIMATIONs - NPTEL Course
3	Rigging with Animation Industry´s Techniques | Udemy
4	https://www.coursera.org/learn/interactive-computer-graphics
5	Game Development Fundamentals Courses Udemy
6	**Virtual Lab :** https://cse18-iiith.vlabs.ac.in/
AI Tools	
1	https://www.blender.org/
2	https://www.freecadweb.org/
3	Generative AI – Adobe Sensei
4	Runway | Tools for human imagination.

5	Home | prometheanai

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks: (Minimum 10 Experiments - 10 marks, Mini project- 5 marks, Assignment -5 marks, Attendance- 5 marks (Theory+Lab)

COURSE NAME: SYSTEM SOFTWARE

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE63	System Software	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE63	System Software	3	-	–	3	–	–	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE63	System Software	20	20	60	2	2-		100

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture	
Course Objectives	
1	To impart knowledge on roles and functionalities of system programs in contrast to application programs.
2	To acquire foundational understanding of the structure, design, and working principles of assemblers, macro processors, linkers, and loaders.
3	To comprehend the core concepts of compiler design, including its major components, essential algorithms, and the data structures involved.
4	To recognize the importance of syntactic correctness in application programming and understand how the compiler's analysis phase interprets code to accurately capture the programmer's intent.
5	To integrate the outcomes of the analysis phase for generating optimized object code, focusing on space efficiency and execution performance.
Course Outcomes: Students will be able	
1	Recognize the need of various system programs within the software development environment.
2	Apply the data structures in the design and implementation of assemblers.
3	Identify the data structures utilized in the design of macro processors.

4	Compare different loaders and linkers and their contribution in developing efficient user applications.
5	Illustrate the foundational concepts and processes involved in the analysis phase of compiler design.
6	Interpret the working of techniques for intermediate code generation and machine code optimization in the synthesis phase of compiler design.

Module		Content	CO	Hours
1	**Introduction to System Software**		CO1	02
	1.1	Concept of System Software, Goals of system software, system program and system programming, Introduction to various system programs such as Assembler, Macro processor, Loader, Linker, Compiler, Interpreter, Device Drivers, Operating system, Editors, Debuggers.		
2	**Assemblers**		CO2	07
	2.1	Elements of Assembly Language programming, Assembly scheme, pass structure of assembler, Assembler Design: Two pass assembler Design and single pass Assembler Design for X86 processor, data structures used.		
3	**Macros and Macro Processor**		CO3	06
	3.1	Introduction, Macro definition and call, Features of Macro facility: Simple, parameterized, conditional and nested. Design of Two pass macro processor, data structures		
4	**Loaders and Linkers**		CO4	04
	4.1	Introduction, functions of loaders, Relocation and Linking concept, Different loading schemes,Design of Absolute loader, Introduction of Direct Linking Loader.		
5	**Compilers: Analysis Phase**		CO5	10
	5.1	Introduction to compilers, Phases of compilers:Lexical Analysis- Role of Finite State Automata in Lexical Analysis,Design of Lexical analyzer, data structures used.		
	5.2	Syntax Analysis- Role of Context Free Grammar in Syntax analysis, Types of Parsers: Top down parser- LL(1), Bottom up parser- SR Parser, Operator precedence parser, SLR. Semantic Analysis, Syntax directed definitions.		

6	**Compilers:Synthetic phase**			
	6.1	Intermediate Code Generation: Types of Intermediate codes: Syntax tree, Postfix notation, three address codes: Triples and Quadruples, indirect triple. Code Optimization: Need and sources of optimization, Code optimization techniques: Machine Dependent and Machine Independent. Code Generation: Issues in the design of code generator, code generation algorithm. Basic block and flow graph.	CO6	10
			Total	**39**

Textbooks	
1	D. M Dhamdhere: Systems programming and Operating Systems, Tata McGraw Hill, Revised Second Edition.
2	A. V. Aho, R. Shethi, Monica Lam, J.D. Ulman: Compilers Principles, Techniques and Tools, Pearson Education, Second Edition.
3	J. J. Donovan: Systems Programming Tata McGraw Hill, Edition 1991

References	
1	John R. Levine, Tony Mason & Doug Brown, Lex & YACC, O 'Reilly publication, second Edition
2	D, M .Dhamdhere, Compiler construction 2e, Macmillan publication, second edition .
3	Kenneth C. Louden, Compiler construction: principles and practices, Cengage Learning
4	Leland L. Beck, System software: An introduction to system programming, Pearson publication, Third Edition

Useful Links	
1	https://nptel.ac.in/courses/106108052
2	https://www.coursera.org/lecture/nand2tetris2/unit-4-1-syntax-analysis-5pC2Z
Industry Articles	
1	https://www.researchgate.net/publication/262296881_Truffle_A_self-optimizing_runtime_system
2	https://llvm.org/devmtg/2017-02-04/
3	https://godbolt.org/

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks

11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	QUIZ	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

SYSTEM SOFTWARE (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL63	System Software Lab	—	02	–	–	1	–	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL63	System Software Lab					25	-	25

Prerequisite: Theoretical computer science, Operating system. Computer Organization and Architecture	
Lab Objectives:	
1	To understand the basic concepts and designing of assembler and macro processor.
2	To Explore the analysis and synthesis phase of the compiler.
3	To understand the role of compiler generation tools like LEx and YACC.
Lab Outcomes: At the end of the course, the students will be able to	
1	Generate machine code by implementing two pass assemblers.
2	Implement a two pass macro processor.
3	Parse the given input string by constructing Top down/Bottom-up parser.
4	Identify and Validate tokens for given high level language and Implement synthesis phase of compiler.
5	Demonstrate implementation phases of the compiler using LEX & YACC tools.

Suggested Experiments: Students are required to complete at least 10 experiments.		
Sr. No.	**Name of the Experiment**	**LOs**
1	Implementation of Lexical Analyzer in C / Java / Python.	LO4
2	Implement Lexical Analyzer using FLEX a. Count no of Vowels & Consonants. b. Count no of Words, characters & lines c. Count no of keywords,identifiers & operators. d. Identify Even & odd integers. e. Count of printf & scanf statements in C program. f. Classify English words as verbs, adverbs, adjectives etc..	LO4, LO5
3	Implementation of Left Recursion Removal.	LO3
4	Write a program to find FIRST & FOLLOW Symbols for the given grammar.	LO3
5	Implement Syntax Analyzer(LL1) using C / Java / Python a. Generate the Predictive Parsing Table (take FIRST and FOLLOW as input for any grammar). b. Perform Parsing action for valid & invalid inputs based on the Parsing Table Generated.	LO3
6	Implement programs using parser generator tool : YACC a. Implement Simple Calculator. b. Recognize nested 'If' statements and display levels. c. Write a program to recognize a valid variable in C language.	LO3
7	Implement Operator Precedence Parser.	LO3
8	Implement Intermediate Code Generation using LEX and YACC.	LO4, LO5
9	Implement data structure for Pass-1 of Two Pass Assembler.	LO1
10	Implement Pass-2 of Two Pass Assembler taking required data structure as input.	LO1
11	Implement data structure for two Pass Macro-Processor.	LO2

Useful Links:	
1	https://gnuwin32.sourceforge.net/packages/flex.htm
2	https://gnuwin32.sourceforge.net/packages/bison.htm

3	https://compiler-lab.web.app/docs

Term Work:	
1	Term work should consist of 10 experiments.
2	The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Attendance: 5-marks, Assignment: 5-marks)
Oral & Practical exam Based on the entire syllabus of System Software and System Software Lab	

Programme
ELECTIVE-3
TE NEP Sem VI
2025-26

COURSE NAME: NATURAL LANGUAGE PROCESSING AND GENERATIVE AI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE64	Natural Language Processing and Generative AI	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE64	Natural Language Processing and Generative AI	3	-	-	3		-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE64	Natural Language Processing and Generative AI	20	20	60	2	-	-	100

Prerequisite: Python programming,data structures and algorithms,machine learning concepts,probability and statistics,TCS

Course Objectives

1	To define natural language processing and to learn various stages of natural language processing.
2	To describe basic concepts and algorithmic description of the main language levels: Morphology, Syntax, Semantics, and Pragmatics & Discourse analysis.
3	Learn and apply both classical statistical and modern neural approaches to NLP, including sequence models and transformer architectures
4	Design, implement, and evaluate NLP and generative AI systems for real-world applications
5	Analyze and address ethical, social, and technical challenges in NLP and generative AI, including bias, fairness, privacy
6	To learn advanced NLP techniques for developing real world NLP applications using LLM to solve real-world language processing problems

Course Outcomes: Students will be able to

1	Have a broad understanding of the field of natural language processing.
2	Apply NLP techniques like preprocessing, POS tagging, parsing, and semantic analysis.
3	Implement and fine-tune statistical and neural models (RNNs, LSTMs, transformers) for NLP tasks.
4	Design ,implement and evaluate LLMs for text generation, summarization, translation, and chatbots
5	Design prompts and apply prompt engineering to optimize LLM outputs.
6	Design prompts and apply prompt engineering to optimize LLM outputs to solve real-world language processing challenges.

Module		Content	CO	Hours
1	**Introduction to NLP**		CO1	03
	1.1	Origin & History of NLP; Language, Knowledge and Grammar in language processing,Stages in NLP;Ambiguities and its types in English and Indian Regional Languages; Challenges of NLP;Applications of NLP		
	1.2	Basic Terms: Preprocessing, Tokenization, stemming, lemmatization		
2	**Levels of NLP Processing**		CO2	08
	2.1	Morphological Analysis - English Morphology, Derivational and Inflectional Morphology , FST		
	2.2	Syntax Analysis - POS tagging,Tagset for English ,Generative Models, HMM, CRF, Parsers		
	2.3	Semantic Analysis :Lexical Semantics, WordNet Relations among lexemes & their senses –Homonymy, Polysemy, Synonymy, Hyponymy;Semantic Ambiguity; Word Sense Disambiguation (WSD);Knowledge based approach(Lesk's Algorithm)		
3	**Pragmatic & Discourse Processing**		CO3	04
	3.1	Pragmatic Analysis, Discourse processing, Reference Resolution, Reference Phenomena,		
	3.2	Syntactic & Semantic constraint on coherence, Anaphora		
4	**Statistical and Neural NLP Models**		CO4	06
	4.1	Statistical Language Models: N-grams, Smoothing, Perplexity Neural Networks for NLP: RNNs, LSTMs, GRUs		

	4.2	Word Embeddings: Word2Vec, GloVe, FastText		
5	**Transformers and Large Language Models (LLMs)**		CO5	08
	5.1	Transformer Architecture and Attention Mechanism, Popular LLMs: BERT, GPT-4, RoBERTa, Meta LLaMA2, Google PaLM2		
	5.2	Pretraining, Fine-tuning, and Transfer Learning,Dialogue Systems and Chatbots,Retrieval-Augmented Generation (RAG),Multilingual NLP|		
	5.3	Introduction to LangChain and LLM Environment Setup, Model Evaluation Metrics,Safety, Bias, Fairness, Privacy in LLMs, LLM applications.		
6	**Generative AI, Prompt Engineering and Agentic AI**		CO6	10
	6.1	Introduction to Generative AI , Types of Generative AI Models (Variational AutoEncoders, Generative Adversarial Networks), Advantages and limitations of Generative AI,ChatGPTand Conversational AI		
	6.2	Prompt Engineering prompts for LLM interaction, Prompt Templates,Techniques for crafting clear, concise, and informative prompts, Exploring advanced prompt engineering strategies (zero-shot learning, few-shot learning) , and case studies: successful applications of prompt engineering.		
	6.3	Introduction to Agentic AI,Distinction between traditional AI, LLMs, and agentic AI,Role of NLP in enabling agentic AI,Use cases: conversational agents, task-oriented agents, and collaborative agents in domains like hospitality, education, and customer service.		
			Total	**39**

Textbooks	
1	Daniel Jurafsky, James H. Martin "Speech and Language Processing" Second Edition, Prentice Hall, 2008.
2	Christopher D.Manning and Hinrich Schutze, " Foundations of Statistical Natural Language Processing ", MIT Press, 1999.
3	Julien Chaumond, Hamza Tahir, Antania Guli," LLM Engineer's Handbook", Packt Publication.
4	Natural Language Processing with Transformers: Revised Edition by Lewis Tunstall, Leandro von Werra, and Thomas Wolf
5	Prompt Engineering and ChatGPT , Russel Grant (Author), Jeremy Diener

6	Karthikeyan Sabesan , Sivagamisundari , Nilip Dutta ,"Generative AI for Everyone: Deep learning, NLP, and LLMs for creative and practical applications"
References	
1	Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press, 2008.
2	Daniel M Bikel and ImedZitouni — Multilingual natural language processing applications: from theory to practice, IBM Press, 2013.
3	Alexander Clark, Chris Fox, Shalom Lappin — The Handbook of Computational Linguistics and Natural Language Processing, John Wiley and Sons, 2012.
4	Nitin Indurkhya and Fred J. Damerau, —Handbook of Natural Language Processing,Second Edition, Chapman and Hall/CRC Press, 2010.
5	Anjanava Biswas , Wrick Talukdar ,'Building Agentic AI Systems: Create intelligent, autonomous AI agents that can reason, plan, and adapt".
6	Steven Bird, Ewan Klein and Edward Loper, Natural language processing with Python: analyzing text with the natural language toolkit, O Reilly Media, 2009.
Resources	
1	http://www.cse.iitb.ac.in/~cs626-449
2	http://cse24-iiith.virtual-labs.ac.in/#
3	https://nptel.ac.in/courses/106105158
4	https://promptengineering.org/
AI Tools	
1	https://www.crewai.com/
2	https://bolt.new/
3	https://aistudio.google.com/prompts/new_chat
Industry Articles	
1	https://arxiv.org/list/cs.AI/recent
2	https://www.accelirate.com/agentic-ai-use-cases/
Case Studies	
1	https://www.moveworks.com/us/en/resources/blog/agentic-ai-examples-use-cases
2	https://cloud.google.com/transform/101-real-world-generative-ai-use-cases-from-industry-leaders

Internal Assessment		
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.		
Continuous Assessment		
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table		
Sr. No.	**Rubrics**	**Marks**
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Quiz	
2	Skill Enhancement Lecture	
3	Extra Assignments/lecture	
End Semester Theory Examination		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	

3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

NATURAL LANGUAGE PROCESSING AND GENERATIVE AI (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL64	Natural Language Processing And Genetic AI Lab		2			1		1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL64	Natural Language Processing And Genetic AI Lab					25		25

Prerequisite: Java/Python	
Lab Objectives:	
1	To understand the key concepts of NLP.
2	To learn various phases of NLP.
3	To design and implement various language models and POS tagging techniques
4	To understand various NLP Algorithms.
5	To learn NLP applications such as Information Extraction, Sentiment Analysis, Question answering, Machine translation etc
6	To design and implement applications based on natural language processing using LLM
Lab Outcomes: At the end of the course, the students will be able to	
1	Apply various text processing techniques.
2	Design a language model for word-level analysis.
3	Model linguistic phenomena with formal grammar and pos tagging.
4	Design, implement, and analyze NLP algorithms.

5	To apply NLP techniques to design real-world NLP applications such as machine translation, sentiment analysis, text summarization, Information extraction, Question Answering systems etc.
6	Implement a proper experimental methodology for training and evaluating empirical NLP systems using LLM

Suggested Experiments: Students are required to complete at least 10 experiments.

Star (*) marked experiments are compulsory.

Sr. No.	Title of Experiment	LOs
1	Study various applications of NLP in NLP in cybersecurity, healthcare, finance,social media and marketing , education , law and government Formulate the Problem Statement for Mini Project based on chosen real world NLP applications: [Machine Translation, Text Categorization, Text summarization, chat Bot, Plagiarism, Spelling & Grammar checkers, Sentiment / opinion analysis, Question answering, Personal Assistant, Tutoring Systems, etc.]	LO1
2	**Text Preprocessing and Normalization** - Preprocess,Clean and prepare raw text for NLP tasks.:Tokenization, lowercasing, stopword removal, stemming, lemmatization	LO2
3	Morphological Analysis ,POS Tagging and EDA: Implement the N-Gram model for the given text input. Perform POS tagging on the given text, Perform exploratory data analysis of a given text (Word Cloud)/ topic modeling/chunking	LO3
4	Named Entity Recognition (NER) Extract entities (names, places, organizations) from text using spaCy, Hugging Face Transformers	LO4
5	Sentiment Analysis Using Neural Networks Classify text sentiment using deep learning. use PyTorch or TensorFlow, Hugging Face Transformers,RNN/LSTM/GRU for sentiment classification	LO5
6	Fine Tuning Transformer models: Fine-tuning Transformer Models for Text Classification/Topic modeling /Paraphrase Detection with BERT	LO5,LO6
7	Prompt Engineering and Output Evaluation with LLMs Design and test prompts for generative AI tasks.Design, test, and compare different prompt strategies (zero-shot, few-shot, chain-of-thought) to optimize LLM responses for a specific task, such as summarization or question answering.	LO5,LO6

8	**Build a custom Chabot** Build a custom chatbot for documents /website using LLM /MCQ generation using Lang Chain and LLM.	LO5,LO6
9	**Agentic AI:** Develop an agentic AI system using LangChain agents that autonomously plans and executes multi-step tasks (e.g., research, data extraction, report generation) by chaining LLM calls and tool use.	LO5, LO6
10	**Implementation of mini projects using LLM** e.g. multilingual Chabot, music lyrics translation in regional language, news summarizer, chatbot assistance , sentiment analysis of mixed case languages etc for selected domains.	LO1 -LO6

Useful Links	
1	https://nptel.ac.in/courses/106105158
2	https://promptengineering.org/
3	https://huggingface.co/
Virtual Lab	
1	http://www.cse.iitb.ac.in/~cs626-449
2	http://cse24-iiith.virtual-labs.ac.in/#
AI Tools	
1	https://www.microsoft.com/en-us/microsoft-copilot/microsoft-copilot-studio
2	https://www.mindstudio.ai/
3	https://manus.im/app
4	https://relevanceai.com/

Term Work:	
1	Term work should consist of a minimum of 7 experiments and a Mini Project.
2	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work.

4	Total 25 Marks (Experiments + Mini Project: 15-marks, Term work Assessment: 10-marks)

COURSE NAME: GEOINFORMATICS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE65	GeoInformatics	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE65	GeoInformatics (Theory)	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE65	Geoinformatics (Theory)	20	20	60	2	-	-	100

Prerequisite: Basic understanding of geography ,computer applications,Programming (Python/Java), and Data Structures

Course Objectives:

1	To understand the fundamentals and applications of geospatial technologies.
2	To develop proficiency in handling GIS and Remote Sensing tools.
3	To introduce GPS and data modeling techniques.
4	To analyze spatial data for various real-world problems.
5	To implement geospatial programming techniques for automating GIS workflows

Course Outcomes: Students will be able to **:**

1	Understand basic concepts of Geoinformatics and its components.
2	Apply GIS concepts to manage and analyze spatial data

3	Explain Remote Sensing principles, satellite sensors and data
4	Use GPS for data acquisition and integration.
5	Develop proficiency in geospatial programming using Python libraries
6	Understand and analyze the diverse applications and emerging technologies in Geoinformatics

Module		Content	CO	Hours
1	Fundamentals of Geoinformatics		CO1	05
	1.1	Introduction to Geoinformatics,Issues,scope, and importance of Geoinformatics.Evolution of Geoinformatics,		
	1.2	Core technologies under GeoInformatics(GIS,Remote Sensing ,Global navigation and satellite navigation,Photogrammetry,Cartography etc.) Spatial databases.Open-source vs. proprietary tools (QGIS, ArcGIS, Google Earth Engine).		
2	**GIS Fundamentals and Spatial Analysis**		CO2	06
	2.1	GIS Data Types, Sources and Models/Vector (points, lines, polygons) and Raster, Spatial & Attribute Data		
	2.2	Map Projections & Georeferencing,GIS Analysis – Overlay, Buffer, Network, Terrain		
3	**Remote Sensing and Image Processing**		CO3	06
	3.1	Basics of Remote Sensing – EMR, Platforms, Sensors,Satellite Systems (IRS, LANDSAT, MODIS)		
	3.2	Image Interpretation Techniques,Digital Image Processing – Preprocessing, Classification		
4	**Global Positioning System and GIS-Integration**		CO4	07
	4.1	Introduction to GPS,Segments & Working Principles,GPS Data Acquisition, Error Sources and accuracy,GPS data formats.		
	4.2	Integration of GPS data into GIS,Quality Control and Error checking.Applications of GPS-GIS Integration.		

5	**Spatial Data Management and Programming Techniques**		CO5	09
	5.1	Data Sources:Satellite data,Survey data,Field data.Shapefile,GeoJSON, KML.Meta data and standards.Cartography thematic mapping and visualization techniques		
	5.2	Automating GIS workflows,Python libraries (Geopandas, Folium, PyProj),File I/O (reading/writing geospatial data: GeoJSON, Shapefiles),APIs for spatial data (e.g., OSMnx, Google Maps API).Geopandas: Vector data manipulation (buffers, overlays).		
6	**Applications and Emerging trends**		CO6	06
	6.1	Applications: Agriculture and Precision Farming, Forestry, Urban and Regional Planning,Disaster Risk Reduction and Management, Environmental Monitoring,Transportation, Water Resources ,Smart Cities and Infrastructure development etc,		
	6.2	Emerging Trends:Web GIS, Mobile GIS, Integration of AI and ML in Geoinformatics,Cloud GIS,Big data and GeoSpatial Analysis,UAV(Drones) in data collection,IOT with GIS.3D and 4D GIS.Blockchain in Geospatial data Management.		
		Total		**39**

Textbooks:

1	Lillesand, T. M., Kiefer, R. W., & Chipman, J. W. – Remote Sensing and Image Interpretation, Wiley
2	Burrough, P.A., & McDonnell, R.A. – Principles of Geographical Information Systems, Oxford University Press
3	Chang, Kang-tsung – Introduction to Geographic Information Systems, McGraw-Hill

References:

1	Jensen, J.R. – Introductory Digital Image Processing, Pearson
2	Bolstad, Paul – GIS Fundamentals: A First Text on Geographic Information Systems
3	Gorr, Wilpen L., and Kurland, Kristen S. – GIS Tutorial: Workbook for ArcGIS

Useful Digital Links	
1	https://onlinecourses.nptel.ac.in/noc22_ce26/preview
AI Tools	
1	https://www.sentinel-hub.com/
2	https://www.ibm.com/docs/en/environmental-intel-suite?topic=components-geospatial-analytics\
3	https://descarteslabs.com/products/deforestation
Case Studies	
1	https://earthengine.google.com/
2	https://learn.arcgis.com/en/gallery/
3	https://www.iirs.gov.in/edusat-education
4	https://docs.mapbox.com/help/glossary/turf/

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

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5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks

6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complete th certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

GEOINFORMATICS (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW&PR	Tut	Total
NCMPEL65	Geoinformatics Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL65	Geoinformatics Lab	-	-	-	-	25	25	50

Prerequisite: Programming (Python/Java), and Data Structures	
Lab Objectives:	
1	To familiarize with GIS, Remote Sensing, and GPS tools.
2	To practice image processing, spatial analysis, and data integration.
3	To apply geospatial techniques for solving real-world problems.
Lab Outcomes: At the end of the course, the students will be able to	
1	Understand and apply the fundamentals of GIS software and spatial data types.
2	Acquire and import GPS data into GIS systems using mobile apps or GPS devices.
3	Visualize and interpret spatial data using satellite images and mapping techniques.
4	Perform basic spatial analysis operations using GIS tools.
5	Conduct preprocessing and georeferencing of remote sensing data for improved accuracy.
6	Apply GIS/RS/GPS tools for real-world applications through a mini project

Suggested Experiments: Students are required to complete at least 10 experiments.
Star (*) marked experiments are compulsory.

Sr. No.	List of THE Experiments	LOs
1	Introduction to GIS Software (QGIS/ArcGIS) and Data Types (Vector/Raster)	LO1
2	Map Projection and Coordinate system	LO1
3	GPS Data Collection and import into GIS using Mobile Apps/Handheld GPS and Import into GIS	LO2
4	Spatial data Visualization and Interpretation of Satellite Images	LO3
5	GIS Spatial Analysis: Buffer, Overlay, and Query Operations	LO4
6	Image Preprocessing of satellite data: Radiometric and Geometric Corrections	LO5
7	GPS based survey and Mapping	LO2
8	3D Visualization in GIS	LO8
9	Georeferencing of Maps and Images: Topographic Maps or Satellite Images	LO5
10	Cartography :Thematic Map design and layout	LO4
11	Mini Project: Application of GIS/RS/GPS for a Local Area Study (e.g., Urban Mapping) Mini Project Examples ● Flood-prone area mapping ● Vegetation mapping ● School/clinic site selection ● Urban green cover assessment	LO6

Term Work:	
1	Term work should consist of 10 experiments.
2	Journal must include at least 2 assignments on content of theory and practical of "Geoinformatics"
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)
Practical & Oral Exam	
	Based on the entire Syllabus of PEC Geoinformatics and Geoinformatics Lab , Total 25 Marks

COURSE NAME: EMBEDDED SYSTEMS AND RTOS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE66	Embedded systems and RTOS	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPE66	Embedded systems and RTOS	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPE66	Embedded systems and RTOS	20	20	60	2	-	-	100

Prerequisite: C programming, Digital Logic & Computer Organization and Architecture	
Course Objectives:	
1	Understand the basic structure, components, and characteristics of embedded systems.
2	Develop fundamental programming skills for microcontroller-based applications.
3	Familiarize with embedded software development tools, techniques, and processes.
4	Comprehend core concepts and features of real-time operating systems (RTOS).
5	Design, implement, and analyze embedded systems using RTOS concepts through real-world case studies.
Course Outcomes: After successful completion of the course, students will be able to:	
1	Explain the architecture, application domains, and design challenges of embedded systems.
2	Write basic programs for microcontroller-based embedded systems.

3	Apply embedded software design methodologies and utilize development tools effectively.
4	Describe real-time operating system principles such as multitasking, scheduling, and synchronization.
5	Develop basic applications using RTOS constructs like tasks, semaphores, and queues.
6	Analyze and propose solutions for real-world problems using embedded system design techniques.

Module	Content		CO	Hours
1	**Introduction to Embedded Systems**		CO 1	06
	1.1	What is an Embedded System, Characteristics, Embedded Systems Vs General-Purpose Computing Systems		
	1.2	Classifications of Embedded Systems		
	1.3	Quality attributes		
	1.4	Purpose of Embedded Systems		
	1.5	Major application areas of Embedded systems.		
2	Core Components and Communication Interfaces in Embedded Systems		CO2	07
	2.1	Elements of the Embedded System		
	2.2	Core of the embedded systems: General-purpose and domain-specific processors, Memory, Sensors, Actuators, I/O subsystems.		
	2.3	Communication Interfaces: Internal -I2C, SPI, UART, External - RS-232 and RS-485, USB		
	2.4	Embedded firmware		
3	Embedded Software Design and Tools		CO3	07
	3.1	**Introduction to Microcontrollers** Difference between Microprocessor and Microcontroller, Overview of the 8051 microcontroller family, Applications of microcontrollers		
	3.2	**8051 Architecture** Block diagram of 8051, Description of components: ALU, registers, RAM, ROM, stack, PSW, etc. I/O ports and memory organization, Pin configuration, and functions		

	3.3	**8051 Instruction Set**, **Development Tools, and Debugging** Data transfer instructions, Arithmetic instructions, Logical instructions, Bit manipulation instructions, Branching and looping, Use of simulators/emulators, Keil uVision IDE		
4	Real-Time Operating Systems (RTOS) Concepts		CO4	07
	4.1	What is a Real-Time System? Hard vs Soft Real-Time		
	4.2	GPOS and RTOS		
	4.3	Task, processes and threads, Multiprocessing and multitasking.		
	4.4	Task Scheduling, Scheduling Algorithms: Round Robin, Rate Monotonic, Earliest Deadline First		
	4.5	Task Synchronization: Mutex, Semaphore, Event Flags		
5	RTOS Programming Fundamentals		CO5	07
	5.1	Creating Tasks and Managing Priorities		
	5.2	Inter-task Communication: Queues, Pipes, Message Passing Interrupt Handling in RTOS Environment		
	5.3	Memory Management: Static vs Dynamic		
	5.4	Timers and Delays in RTOS		
6	Embedded Product development Life cycle (EDLC) and trends in the Embedded Industry		CO6	05
	6.1	Embedded Product Development Life Cycle (EDLC)		
	6.2	Trends in embedded industry: Processor trends, Os trends, development language trends.		
		Total		**39**

Textbooks:

1	K.V.K.K. Prasad, Embedded/Real-Time Systems: Concepts, Design and Programming, Dreamtech Press, 1st Edition, 2003.
2	Raj Kamal, Embedded Systems: Architecture, Programming and Design, McGraw-Hill Education, 3rd Edition, 2021.
3	Shibu K.V., Introduction to EMBEDDED SYSTEMS, McGraw-Hill Education (India) Private Limited, 2014.

4	Jonathan W. Valvano, Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers, CreateSpace Independent Publishing, Volume 1, 5th Edition, 2020.
5	Jane W. S. Liu, Real-Time Systems, Pearson Education, 1st Edition, 2000.
6	Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw-Hill, 2004.
References:	
1	David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
2	Michael Barr and Anthony Massa, Programming Embedded Systems: With C and GNU Development Tools, O'Reilly Media, 2nd Edition, 2006.
3	Edward Lamie, Real-Time Operating Systems: RTOS Explained, CRC Press, 1st Edition, 2016.
4	Andrew N. Sloss, Dominic Symes, and Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Morgan Kaufmann, 1st Edition, 2004.
5	Dr. P. R. Seshadri, The Design of the Real-Time Operating Systems, Wiley India Pvt. Ltd., 1st Edition, 2020.
Useful Links	
1	http://vlabs.iitkgp.ac.in/rtes/
2	http://vlabs.iitkgp.ernet.in/rtes/index.html
3	https://www.nielit.gov.in/calicut/content/lab-workshop-embedded-rtos
4	https://www.coursera.org/learn/real-time-embedded-systems-concepts-practices
AI Tools	
1	https://neuton.ai/
2	https://www.labcenter.com/
3	https://visualgdb.com/

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid

Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered upon approval by the subject teachers. It should be a minimum of 2 or a maximum of 4 from the following table

No.	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/workshop/talk/competition followed by a small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks
5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project-based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	GATE Based on Assignment tests/Tutorials etc	10 Marks
12	Peer Review and participation	5/10 Marks

*For sr.no.7, the date of the certification exam should be within the term, and in case a student is unable to complete the certification, the grading has to be done accordingly.

Indirect Assessment:

1	Skill Enhancement Lecture
2	Extra Assignments/lab/lecture
3	Quiz

End Semester Theory Examination:

1	Question paper will be of 60 marks

2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

EMBEDDED SYSTEMS AND RTOS (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMPEL66	Embedded systems and RTOS Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMPEL66	Embedded systems and RTOS Lab	-	-	-	-	25	-	25

Prerequisite: C programming, Digital Logic and Computer Architecture.	
Lab Objectives	
1	To introduce microcontroller programming and basic embedded system design.
2	To practice device interfacing and peripheral control.
3	To implement multitasking and task synchronization using RTOS.
4	To develop and test real-time embedded applications.
Lab Outcomes: After successful completion of the labs, students will be able to:	
1	To program microcontrollers for basic input/output operations.
2	To interface sensors, actuators, and communication modules.
3	To create and manage tasks using RTOS features.
4	To design and demonstrate real-time embedded projects.

Sr. No.	List of the Experiment	LOs
1	**Basic GPIO programming :** Write and simulate a C program to blink an LED connected to a microcontroller GPIO pin.	LO1
2	**Digital Input/Output:** Interface a push-button switch and LED. Write a C program to toggle LED on button press.	LO1
3	**Timer and PWM basics :** Generate a PWM signal using a microcontroller timer and control the brightness of an LED.	LO2
4	**Timer programming, avoiding delay loops :** Develop and simulate a simple delay function using hardware timers (without using software loops).	LO2
5	**UART serial communication :** Interface a UART device: Write a program to transmit and receive data over UART.	LO2
6	**Interrupt basics :** Develop an Interrupt Service Routine (ISR) for external interrupt (e.g., button press triggering an interrupt).	LO2
7	**Task creation and basic scheduling** : Create two simple tasks using an RTOS (like FreeRTOS) and switch between them.	LO3
8	**RTOS software timers :** Implement a software timer task to periodically toggle an LED under an RTOS.	LO3
9	Queue mechanism for task communication : Demonstrate Inter-Task Communication using Message Queues (RTOS-based project)	LO3
10	**Semaphore usage :** Synchronize two tasks using a Semaphore. (e.g., controlling access to a shared resource).	LO3
11	Advanced RTOS concept : Priority Inversion Problem: Write a small simulation showing how priority inversion happens and solve it using priority inheritance in an RTOS.	LO3
12	**Multiple tasks, queues, UART communication combined :** Design a mini project: Periodically read a sensor (simulated), process the data in a task, and send output via UART using RTOS.	LO4

Textbooks:	
1	K.V.K.K. Prasad, *Embedded/Real-Time Systems: Concepts, Design and Programming*, Dreamtech Press, 1st Edition, 2003.

2	Raj Kamal, *Embedded Systems: Architecture, Programming and Design*, McGraw Hill Education, 3rd Edition, 2021.
3	Jonathan W. Valvano, *Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers*, CreateSpace Independent Publishing, Volume 1, 5th Edition, 2020.
4	Jane W. S. Liu, *Real-Time Systems*, Pearson Education, 1st Edition, 2000.
5	Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata Mc Graw Hill, 2004.

References:	
1	David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
2	Michael Barr and Anthony Massa, *Programming Embedded Systems: With C and GNU Development Tools*, O'Reilly Media, 2nd Edition, 2006.
3	Edward Lamie, *Real-Time Operating Systems: RTOS Explained*, CRC Press, 1st Edition, 2016.
4	Andrew N. Sloss, Dominic Symes, and Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Morgan Kaufmann, 1st Edition, 2004.
5	Dr. P. R. Seshadri, *The Design of the Real-Time Operating Systems*, Wiley India Pvt. Ltd., 1st Edition, 2020.

Useful Links	
1	http://vlabs.iitkgp.ac.in/rtes/
2	http://vlabs.iitkgp.ernet.in/rtes/index.html
3	https://www.nielit.gov.in/calicut/content/lab-workshop-embedded-rtos
4	https://www.coursera.org/learn/real-time-embedded-systems-concepts-practices

AI Tools	
1	https://neuton.ai/

2	https://www.labcenter.com/
3	https://visualgdb.com/

COURSE NAME: DEEP LEARNING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning	1	2	-	-	2	-	2

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning	1	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM61	Deep Learning	-	-	-	-	50	25	75

Prerequisite: Basic mathematics and Statistical Concepts, Linear Algebra, and Machine Learning	
Course Objectives:	
1	To learn the fundamentals of Neural networks.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolutional Neural Networks, Autoencoders, and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning.
Course Outcomes: At the end of the course learner will be able to	
1	Understand the concepts of deep neural networks.
2	Train and optimize deep neural models.
3	Apply supervised learning models such as CNNs for image-related tasks.

4	Implement unsupervised models like autoencoders for representation learning.
5	Design and train sequential models like RNNs, LSTMs, and Transformers for sequence data.
6	Analyze and apply recent trends to real-world domains.

Module		Content	CO	Hours
1		**Introduction to Deep Learning**	CO1	01
	1.1	Fundamentals of Neural Networks,MLPs, Activation Functions, Loss Functions, Forward and Backward Propagation.		
2		**Training, Optimization, and Regularization of Deep Neural Networks**	CO2	02
	2.1	Optimizers (SGD, Adam, AdamW) Regularization (Dropout, BatchNorm, Early Stopping) Learning Rate Schedulers		
3		**Supervised Deep Learning with CNN**	CO3	03
		CNN Architecture, Filters,Pooling Modern Architectures: ResNet, EfficientNet Vision Transformers (ViTs) Introduction		
4		**Unsupervised Deep Learning and Autoencoders**	CO4	02
	4.1	Autoencoders, Denoising, Sparse, Variational Autoencoders (VAE) - Applications in Anomaly Detection and Representation Learning		
5		**Recurrent Neural Networks (RNNs)**	CO5	03
	5.1	LSTM, Backpropagation Through Time (BPTT)		
6	6.1	GANs, Diffusion Models, Transfer Learning (VGG16, ResNet50, YOLOv8), Ethical AI and Responsible Deployment	CO6	02
		Total		**13**

Text Books:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Lourville. —"Deep Learning", MIT Press Ltd, 2016
2	Li Deng and Dong Yu, —"Deep Learning Methods and Applications", Publishers Inc.

3	Satish Kumar, "Neural Networks: A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada —"Introduction to Artificial Neural Systems", Jai Co Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. —"Algorithms for Optimization", MIT Press.
Reference Books:	
1	Buduma, N. and Locascio, N., —"Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.
2	FranLOis Chollet. —"Deep learning with Python" —(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. —"Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, "Neural Network- A Comprehensive Foundation"- Prentice Hall International, Inc
5	Charu. Aggarwal, "Neural Networks and Deep Learning", Springer, 1st Edition
6	S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing"- Wiley India
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106184/
2	https://www.deeplearningbook.org/
3	https://www.coursera.org/specializations/deep-learning, https://course.fast.ai/

DEEP LEARNING (Lab)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning Lab	1	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM61	Deep Learning Lab	-	-	-	-	50	25	75

Prerequisite: Python, R Programming, Analysis of Algorithms, Basic Mathematics	
Lab Objectives:	
1	To implement basic neural network models.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised, and sequence learning.
Lab Outcomes: At the end of the course, the students will be able to	
1	Implement basic neural network models.
2	Design and train feedforward neural networks using various learning algorithms.
3	Develop and evaluate convolutional neural networks (CNNs) for tasks involving image and spatial data processing.
4	Construct and train autoencoders for unsupervised learning tasks, including dimensionality reduction and data reconstruction.
5	Design and implement sequential models such as RNNs and LSTMs for time-series and sequence prediction tasks.
6	Utilize and fine-tune pretrained deep learning models on real-world applications, demonstrating transfer learning and domain adaptation skills.

Suggested Experiments: Students are required to complete at least 8 experiments.		
Star (*) marked experiments are compulsory.		
Sr No	**List of Experiments**	LO
1*	Build and train a Multi-layer Perceptron (MLP) on the MNIST dataset to classify handwritten digits.	LO1
2*	Implement and compare activation functions (ReLU, LeakyReLU, Sigmoid, Tanh) and loss functions (MSE, CrossEntropy) for binary and multi-class tasks.	LO1LO2
3*	To visualize and compare optimizers (SGD, Adam, RMSprop) on a synthetic dataset to understand convergence and training dynamics.	LO1LO2
4*	To demonstrate overfitting on CIFAR-10 and apply regularization methods like dropout and weight decay (L2 penalty) to enhance generalization.	LO1LO2
5*	Build a custom CNN and evaluate its performance on CIFAR-10 or TinyImageNet. Use visualization techniques (e.g., feature maps, confusion matrix).	LO3
6*	Train a denoising autoencoder using noisy MNIST or Fashion-MNIST and evaluate.	LO4
7*	Use LSTM on stock prices or weather data. Apply normalization, sliding window, and sequential prediction.	LO5
8*	Use ResNet50 or MobileNetV2 with transfer learning on a custom image dataset (e.g., flower classification or cats vs. dogs). Analyze fine-tuning vs feature extraction.	LO6
9	Implement a basic GAN or run an inference pipeline using a diffusion model (Stable Diffusion)	LO6
10*	Mini Project	LO1 LO6

Useful Links:	
1	TensorFlow (www.tensorflow.org)
2	Keras (keras.io)
3	PyTorch (pytorch.org)
4	Scikit (https://scikit-learn.org/stable/)

5	OpenNN (www.opennn.net)
6	Theano https://github.com/Theano/Theano
7	Caffe https://caffe.berkeleyvision.org/
Math Links:	
1	ConvNet Playground(https://github.com/fastforwardlabs/convnetplayground)
2	CNN (https://poloclub.github.io/cnn-explainer/)
3	GAN (https://poloclub.github.io/ganlab/)
4	https://github.com/openai/gym
Virtual Lab	
1	https://github.com/materialsvirtuallab/megnet
Datasets	
1	Kaggle Datasets, ImageNet, CIFAR-10 and CIFAR-100, COCO Dataset, MNIST, UCI Machine Learning Repository, QM7 Dataset, QMOF Dataset, EDNet Dataset

Termwork	
1	**Term work should consist of a minimum of 8 experiments and a Mini Project.**
2	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work. **Lab work (Total 50 Marks)** • **Experiments: 15 marks** • **Mini project : 25 marks** • **Attendance Theory & Practical: 05-marks,** • **Assignment: 05-marks**
Practical & Oral Exam	
Based on the entire Syllabus of PCC Deep Learning and Deep Learning lab, Total 25 Marks	

COURSE NAME: MOBILE APP DEVELOPMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMVS61	Mobile App Development (Theory & Lab)	1	2	-	-	2	-	2

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMVS61	Mobile App Development (Theory & Lab)	1	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMVS61	Mobile App Development (Theory & Lab)	-	-	-	-	50	25	75

Course Objectives: Students should be able to	
1	To orient students to understand the fundamentals of mobile app development
2	To learn design and implement responsive and user-friendly mobile user interfaces
3	To develop skills to manage data and integrate applications with external services using APIs
4	To Learn techniques for debugging, optimizing performance, and ensuring application security.
Course Outcomes: Students should be able to	
1	Set up the development environment and create basic mobile apps.
2	Design and develop mobile applications with user-friendly interfaces.
3	Implement local and remote data storage solutions.
4	Integrate device-specific features like sensors, notifications, and media.

5	Optimize mobile applications for performance and security.
6	Collaborate effectively using version control systems like Git for mobile app development.

Module	Content	CO	Hours
1	**Introduction to Mobile App Development** Overview of Mobile Platforms (Android, iOS, etc.), Mobile App Architecture, Setting Up the Development Environment (Android Studio/Xcode), Alternatives for Building Mobile Apps: Native vs. Hybrid Applications, Introduction to Kotlin/Swift,	CO1	02
2	**User Interface Design** **Understanding Android Activities and Fragments:** Linking Activities Using Intents., Adding and Managing Fragments Dynamically , Displaying Notifications in Android. **Designing User Interfaces:** Layouts and Views: LinearLayout, RelativeLayout, ConstraintLayout, TableLayout (Android), Storyboards and View Controllers (iOS), **Specialized Views:** TextView, Button, ImageView, ProgressBar, AutoCompleteTextView, Spinner, and ListView **Event Handling:** Buttons, Touch Events, and Gesture Handling **Responsive Design** and Adapting to Different Screen Sizes	CO2	03
3	**Data Management and Integration** Local Storage (SQLite, Shared Preferences/Core Data),Introduction to Networking (HTTP Requests, JSON Parsing),Fetching Data from REST APIs, Content Providers: Accessing and Sharing Data	CO3	02
4	**Device Integration and Advanced Features** Working with Sensors: GPS, Accelerometer, Gyroscope Media Handling: Accessing Camera, Audio, and Video, Notifications and Background Tasks Android Services: Started and Bound Services, iOS Background Modes and Notifications	CO4	03
5	**Performance Optimization and Testing** Debugging and Performance Optimization, : T**ools for Performance Optimization** Android: **Android Profiler**: CPU, Memory, Network, and Energy Profiler., Memory Analysis Tool (MAT) for memory leaks., Systrace for advanced tracing.,	CO5	02

		iOS: **Instruments**: Time Profiler, Leaks, Allocations, Network, and Energy Instruments., XCTest for profiling performance., Testing Mobile Applications (Unit Testing, UI Testing) App Security Best Practices		
6	**Deployment and Maintenance**		CO6	01
		Publishing Apps on Google Play Store/App Store, Version Control and Collaboration (Git, GitHub/Bitbucket), App Maintenance and Updates		
			Total	**13**

MOBILE APP DEVELOPMENT (Lab)

Perform any eight experiments	
Sr.No	**List of experiments:**
1	Install and configure Android Studio or Xcode, and create your first "Hello, World!" application.
2	Design a responsive user interface using LinearLayout, ConstraintLayout (Android), or Storyboards (iOS).
3	Create an app with multiple screens using Intents and Fragments.
4	Build an app with buttons and gesture handling for event-driven interactions.
5	Save user data locally using SharedPreferences (Android) or Core Data (iOS).
6	Create an app to fetch and display data from a REST API.
7	Build an app that integrates a device sensor, such as GPS or accelerometer.Create an app with media handling to access and display images or videos.
8	Implement notifications and background tasks using Android Services or iOS Background Modes.
9	Implement push notifications: Use Firebase Cloud Messaging (Android) or APNs (iOS) for real-time updates.
10	Create a database-backed app: Use SQLite or Room Database (Android) or Core Data with CloudKit (iOS).
11	Integrate user authentication: Implement login and signup functionality using Firebase Authentication or OAuth.
12	Implement background tasks: Use Android Services or iOS Background Modes for periodic or continuous tasks.

Textbooks:	
1	Jerome DiMarzio, "Beginning Android Programming with Android Studio", 4 thEdition
2	Iversen, J., Eierman, M. (2013). Learning Mobile App Development: A Hands-on Guide to Building Apps with IOS and Android. (n.p.): Pearson Education.
3	Lewis, S., Dunn, M. (2019). Native Mobile Development: A Cross-Reference for IOS and Android. United States: O'Reilly Media.
References:	

1	Dawn Griffiths, David Griffiths, "Head First Android Development: A Brain-Friendly Guide", 2017.
2	Neil Smyth , "Android Studio 3.0 Development Essentials: Android", 8 th Edition.
3	Pradeep Kothari, "Android Application Development (With Kitkat Support)", Black Book 2014.

Useful Links	
1	https://developer.android.com/guide
2	Develop App for Free https://flutter.dev/
3	http://ai2.appinventor.mit.edu
4	https://aws.amazon.com/mobile/mobile-application-development/
AI Tools	
1	https://www.figma.com/
2	https://www.postman.com/
3	https://github.com/

Indirect Assessment	
1	Mock Viva/Practical
2	Skill Enhancement Lecture
3	Extra Assignments/lab/lecture
Term Work	
1	Term work should consist of 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 50 Marks Experiments: 15-marks, Case Study (UI Design): 10 marks , Assignments: 10 Marks, Mini Project Report : 10 Marks, Attendance: 5 Marks
Practical & Oral Exam	
1	Mini Project : 25 Marks (Demo and Presentation)

CAPSTONE PROJECT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMCP61	Capstone Project I	-	4	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMCP61	Capstone Project I	-	-	-	-	25	25	50

Prerequisite: Knowledge on number systems.	
Course Objectives	
1	Identify real-world problems and frame project requirements
2	Design solutions using engineering concepts, research, and innovation.
3	Develop and implement a prototype or detailed solution approach.
4	Analyze results, interpret data, and optimize the solution.
5	Communicate the project outcomes effectively through documentation and presentation.
6	Demonstrate teamwork, ethics, and project management skills.
Course Outcomes: Students will be able	
1	Identify and define a real-world problem through systematic requirement analysis and investigation.
2	Conduct a thorough literature review and benchmarking to propose innovative solutions.
3	Develop a structured project plan with well-defined milestones, timelines, and risk mitigation strategies.
4	Design and implement a working prototype using appropriate engineering tools and methods.
5	Analyze experimental results, validate the solution, and optimize performance based on data.
6	Effectively document and present the project outcomes, demonstrating professional ethics, teamwork, and project management skills.

Module	Content	Hours
1	Introduction to Capstone Projects (overview, importance, types)	2
2	Problem Identification & Requirement Analysis	4
3	Literature Review & Benchmarking	4
4	Project Planning (Gantt charts, milestones, risk analysis)	3
5	Design Methodologies and Solution Architecture	5
6	Prototype Development (initial phase)	6
7	Implementation and Testing	6
8	Data Collection, Results, and Analysis	3
9	Report Writing (format, content, technical documentation)	3
10	Project Presentation (seminar, viva, poster)	3
	Total	**39**

Evaluation Measures:	
Component	**Weightage**
Project Proposal Presentation	10%
Interim Evaluation 1 (Design/Plan Stage)	15%
Interim Evaluation 2 (Prototype Stage)	20%
Final Project Demo & Viva	30%
Project Report	15%
Teamwork and Project Management Assessment	10%

Deliverables:
1. Problem definition Document
2. Literature Review Report
3. Project Plan (Gantt Chart, Risk Analysis)
4. Prototype/Demo Videos
5. Test Cases and Results
6. Final Project Report (IEEE/University Format)
7. Presentation Slides
8. Poster (Optional)

MDM SYLLABUS

AIML

Department of Computer Engineering

MDM AIML Teaching Scheme TE CMPN

Course Type	Course Code	Course name	Teaching scheme (Contact Hours)			Credits assigned		Total
			Th	Pr	Tut	Th	Pr/Tut	
MDM	NCMMM51/ NCMMML51	Course 3	3	2	-	3	1	4
MDM	NCMMM61	Course 4	1	2	-	-	2	2

MDM AIML Examination Scheme TE CMPN

Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
MDM	NCMMM51/ NCMMML51	Course 3	20	20	60	2	25	25	**150**
MDM	NCMMM61	Course 4	-	-	-	-	50	25	**75**

COURSE NAME: MDM Course 3 MACHINE LEARNING SEM V

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM51	Machine Learning	3	2	-	3	1	-	4

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM51	Machine Learning	3	-	-	3	1	-	4

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM51	Machine Learning (Theory)	20	20	60	2	25	25	100

Prerequisite: Data Warehousing and Mining

Course Objectives:

1	Understand the fundamental concepts, types, and applications of Machine Learning.
2	Apply dimensionality reduction techniques and assess model performance using appropriate metrics
3	Implement supervised learning algorithms for regression and classification problems
4	Apply unsupervised learning methods for clustering and association rule mining.
5	Utilize ensemble learning strategies and model validation techniques.
6	Gain familiarity with MLOps practices for deploying, monitoring, and maintaining machine learning models.

Course Outcomes:

1	Understand the basics of Machine Learning, its types, and essential concepts.
2	Apply dimensionality reduction techniques and evaluate performance metrics for ML algorithms.
3	Implement supervised learning models for regression and classification problems.

4	Implement unsupervised learning techniques and evaluate clustering models.
5	Apply ensemble learning techniques and model validation strategies.
6	Understand and apply MLOps concepts for deploying, monitoring, and maintaining ML models.

Module	Content		CO	Hours
1	**Introduction to Machine Learning**		CO1	05
	1.1	Introduction to Machine Learning, Data Formats, ML Workflow: Data Preparation, Model Training, Model Evaluation, Train-Test-Validation Splits Data Formats in ML, Structured vs. Unstructured data, Applications of types of Machine Learning across various industries (e.g., Healthcare, Finance, Marketing, Robotics etc.)		
	1.2	Overfitting and Underfitting, Bias-Variance Tradeoff, Model Generalization and Model Overfitting		
2	**Dimensionality Reduction & Performance Measures**		CO2	06
	2.1	Importance of feature selection in improving model performance, PCA, LDA, Difference between PCA and LDA (Supervised vs Unsupervised), SVD		
	2.2	Performance Measures: Classification Metrics (Accuracy, Precision, Recall, F1-Score, ROC-AUC), Regression Metrics (MSE, RMSE, MAE)		
3	**Supervised Learning**		CO3	09
	3.1	Regression: Linear, Polynomial, Ridge, Lasso, Regularization: L1 Regularization (Lasso), L2 Regularization (Ridge), Elastic Net, Decision Tree Regression.		
	3.2	Classification: Numericals on Decision Tree (ID3, CART), Logistic Regression		
	3.3	Classification: Introduction to SVM, Support Vectors, Hyperplane, Margin, Linear SVM: Maximizing margin, Hard and Soft Margin SVM, Non-linear SVM and Kernel Trick		
4	**Unsupervised Learning**		CO4	06
	4.1	Clustering types: Graph-based,:Minimum Spanning Tree (MST) Clustering, Model-based: Expectation-Maximization (EM), Density-based: DBSCAN		
	4.2	Basics of Clustering Evaluation: Silhouette Score, Davies-Bouldin Index, Adjusted Rand Index (ARI)		

5	**Ensemble Learning**		CO5	07
	5.1	Concepts of Ensemble Learning, Advantages and challenges, Bias-Variance trade-off in ensembles, K-Fold Cross-validation		
	5.2	Basics of Bagging and Boosting, Random Forest algorithm, Use cases and benefits, AdaBoost, Gradient Boosting, XGBoost overview and comparison, Stacking: layered models and meta-learners, Voting Classifier: hard vs. soft voting		
6	**MLOps & Deployment**		CO6	06
	6.1	Introduction to MLOps: Concept and workflow, Model serving basics, Batch vs. Online (real-time) deployment		
	6.2	Model performance monitoring, Data drift and concept drift detection, Introduction to model retraining strategies, Updating deployed models.		
			Total	**39**

Textbooks:	
1	Peter Harrington, —Machine Learning n Action‖, DreamTech Press
2	Ethem Alpaydın, —Introduction to Machine Learning‖, MIT Press
3	Tom M. Mitchell, —Machine Learning‖ McGraw Hill
4	Stephen Marsland, —Machine Learning An Algorithmic Perspective‖, CRC Press
5	Noah Gift & Alfredo Deza, Practical MLOps: Operationalizing Machine Learning, OREILLY
References:	
1	Han Kamber, —Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2	Dr. Deepali Vora, Dr. Gresha Bhatia, Python for Machine Learning projects
3	Margaret. H. Dunham, —Data Mining Introductory and Advanced Topics, Pearson Education
4	Kevin P. Murphy , Machine Learning — A Probabilistic Perspective‖
5	Machine Learning For Absolute Beginners: A Plain English Introduction (Second Edition), Oliver Theobald
6	Richard Duda, Peter Hart, David G. Stork, —Pattern Classification‖, Second Edition, Wiley Publications.

7	Approaching (Almost) Any Machine Learning Problem, Abhishek Thakur

Useful Digital Links	
1	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
AI Tools	
1	https://onlinecourses.nptel.ac.in/noc25_cs46/preview
2	https://onlinecourses.nptel.ac.in/noc25_cs50/preview
3	https://nptel.ac.in/courses/106106198?utm_source
4	https://www.coursera.org/specializations/machine-learning
Case Studies	
1	https://mobidev.biz/blog/machine-learning-application-use-cases-manufacturing-industry?utm_source
2	https://www.businessinsider.com/ai-for-worker-site-safety-in-construction-2025-4?utm_source
3	https://www.coherentsolutions.com/insights/role-of-ml-and-ai-in-clinical-trials-design-use-cases-benefits.
4	https://dataforest.ai/blog/practical-data-warehousing-successful-cases
5	https://www.datamation.com/big-data/data-mining-use-cases/

Internal Assessment

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. The Mid Term test is to be conducted when approximately 50% syllabus is completed and its duration will be one hour.

Continuous Assessment

Continuous Assessment is of **20 marks.** The rubrics for assessment will be considered on approval by the subject teachers. It should be minimum 2 or maximum 4 from the following table.

Sr. No	Rubrics	Marks
1	Multiple Choice Questions (Quiz)	5 Marks
2	Literature review of papers/journals	5 Marks
3	Participation in event/ workshop/ talk / competition followed by small report and certificate of participation relevant to the subject	5 Marks
4	Wins in the event/competition/hackathon pertaining to the course	10 Marks

5	Case study, Presentation, group discussion, technical debate on recent trends in the said course	10 Marks
6	Project based Learning and evaluation / Extra assignment / Question paper solution	10 Marks
7	NPTEL/ Coursera/ Udemy/any MOOC Certificate course for 4 weeks or more	10 Marks
8	Content beyond syllabus presentation	10 Marks
9	Creating Proof of Concept	10 Marks
10	Mini Project / Extra Experiments/ Virtual Lab	10 Marks
11	Peer Review and participation	5/10 Marks
*For sr.no.7, the date of certification exam should be within the term and in case a student is unable to complet the certification, the grading has to be done accordingly.		
Indirect Assessment		
1	Mock Viva/Practical	
2	Skill Enhancement Lecture	
3	Extra Assignments/lab/lecture	
End Semester Theory Examination:		
1	Question paper will be of 60 marks	
2	Question paper will have a total of five questions	
3	All questions have equal weightage and carry 20 marks each	
4	Any three questions out of five need to be solved.	

MDM Course 3 MACHINE LEARNING (Lab) SEM V

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW&PR	Tut	Total
NCMMML51	Machine Learning Lab	-	2	-	-	1	-	1

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMML51	Machine Learning Lab	-	-	-	-	25	25	50

Lab Objectives	
1	Understand and apply core ML algorithms on real-world datasets.
2	Implement dimensionality reduction and supervised/unsupervised techniques.
3	Evaluate ML models for classification, regression and clustering using performance metrics and validation methods.
4	Apply ensemble learning strategies to improve model performance.
5	Engage in case study-based analysis and propose and deploy simple ML models as solutions for real life problems.

Lab Outcomes	
1	Implement and demonstrate fundamental ML algorithms.
2	Perform dimensionality reduction and assess its impact on model performance.
3	Apply regression and classification models and analyze results.
4	Execute clustering techniques and evaluate clustering outcomes.
5	Utilize ensemble methods and cross-validation techniques.
6	Deploy a simple ML model and monitor it post-deployment.

Exp No.	List of Experiments	LOS
1	Apply dimensionality reduction using PCA and LDA on a high-dimensional dataset and analyze feature importance and evaluate reduced feature set impact	LO2
2	Implementation of Linear, Polynomial or Ridge Regression and compare different regression techniques for prediction accuracy	LO3
3	Implement classification model using Logistic regression and evaluate performance measures	LO3
4	Build classification models using Decision Tree(CART) and compare performance metrics with logistic regression	LO3
5	Implement classification models using linear / nonlinear or kernelized SVM and compare their performance metrics	LO3
6	Implement ensemble models : Bagging, Random Forest and evaluate performance measures	LO5
7	Implement ensemble models : and Boosting: XG boost and compare the results	LO5
8	Apply cross-validation (K-Fold, Stratified) and compare ROC-AUC of models	LO5
9	Perform clustering using DBSCAN and evaluate using Silhouette Score	LO4
10	Deploy an ML model using Flask or Streamlit for basic web-based inference to build and deploy a simple interactive ML application	LO1

Term Work	
1	Term work should consist of at least 8 experiments.
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks) Pract/oral : 25 marks

COURSE NAME: MDM Course 4 DEEP LEARNING SEM VI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning	1	2	-	-	2	-	2

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning	1	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM61	Deep Learning	-	-	-	-	50	25	75

Prerequisite: Basic mathematics and Statistical Concepts, Linear Algebra, and Machine Learning	
Course Objectives:	
1	To learn the fundamentals of Neural networks.
2	To gain an in-depth understanding of training Deep Neural Networks.
3	To acquire knowledge of advanced concepts of Convolutional Neural Networks, Autoencoders, and Recurrent Neural Networks.
4	Students should be familiar with the recent trends in Deep Learning.
Course Outcomes: At the end of the course learner will be able to	
1	Understand the concepts of deep neural networks.
2	Train and optimize deep neural models.
3	Apply supervised learning models such as CNNs for image-related tasks.

4	Implement unsupervised models like autoencoders for representation learning.
5	Design and train sequential models like RNNs, LSTMs, and Transformers for sequence data.
6	Analyze and apply recent trends to real-world domains.

Module		Content	CO	Hours
1		**Introduction to Deep Learning**	CO1	01
	1.1	Fundamentals of Neural Networks,MLPs, Activation Functions, Loss Functions, Forward and Backward Propagation.		
2		**Training, Optimization, and Regularization of Deep Neural Networks**	CO2	02
	2.1	Optimizers (SGD, Adam, AdamW) Regularization (Dropout, BatchNorm, Early Stopping) Learning Rate Schedulers		
3		**Supervised Deep Learning with CNN**	CO3	03
		CNN Architecture, Filters,Pooling Modern Architectures: ResNet, EfficientNet Vision Transformers (ViTs) Introduction		
4		**Unsupervised Deep Learning and Autoencoders**	CO4	02
	4.1	Autoencoders, Denoising, Sparse, Variational Autoencoders (VAE) - Applications in Anomaly Detection and Representation Learning		
5		**Recurrent Neural Networks (RNNs)**	CO5	03
	5.1	LSTM, Backpropagation Through Time (BPTT)		
6	6.1	GANs, Diffusion Models, Transfer Learning (VGG16, ResNet50, YOLOv8), Ethical AI and Responsible Deployment	CO6	02
		Total		**13**

Text Books:	
1	Ian Goodfellow, Yoshua Bengio, Aaron Lourville. —"Deep Learning", MIT Press Ltd, 2016
2	Li Deng and Dong Yu, —"Deep Learning Methods and Applications", Publishers Inc.

3	Satish Kumar, "Neural Networks: A Classroom Approach" Tata McGraw-Hill.
4	JM Zurada —"Introduction to Artificial Neural Systems", Jai Co Publishing House
5	M. J. Kochenderfer, Tim A. Wheeler. —"Algorithms for Optimization", MIT Press.
Reference Books:	
1	Buduma, N. and Locascio, N., —"Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.
2	FranLOis Chollet. —"Deep learning with Python" —(Vol. 361). 2018 New York: Manning.
3	Douwe Osinga. —"Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi.
4	Simon Haykin, "Neural Network- A Comprehensive Foundation"- Prentice Hall International, Inc
5	Charu. Aggarwal, "Neural Networks and Deep Learning", Springer, 1st Edition
6	S.N. Sivanandam and S.N. Deepa, "Principles of Soft Computing"- Wiley India
Useful Links	
1	https://nptel.ac.in/courses/106/106/106106184/
2	https://www.deeplearningbook.org/
3	https://www.coursera.org/specializations/deep-learning, https://course.fast.ai/

MDM Course 4 DEEP LEARNING (Lab) SEM VI

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NCMMM61	Deep Learning Lab	1	2	-	-	2	-	2

Course Code	Course Name	Examination Scheme						
		Theory			Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam				
		Mid-Term Test	Continuous Assessment					
NCMMM61	Deep Learning Lab	-	-	-	-	50	25	75

Prerequisite: Python, R Programming, Analysis of Algorithms, Basic Mathematics	
Lab Objectives:	
1	To implement basic neural network models.
2	To implement various training algorithms for feedforward neural networks.
3	To design deep learning models for supervised, unsupervised, and sequence learning.
Lab Outcomes: At the end of the course, the students will be able to	
1	Implement basic neural network models.
2	Design and train feedforward neural networks using various learning algorithms.
3	Develop and evaluate convolutional neural networks (CNNs) for tasks involving image and spatial data processing.
4	Construct and train autoencoders for unsupervised learning tasks, including dimensionality reduction and data reconstruction.
5	Design and implement sequential models such as RNNs and LSTMs for time-series and sequence prediction tasks.
6	Utilize and fine-tune pretrained deep learning models on real-world applications, demonstrating transfer learning and domain adaptation skills.

Suggested Experiments: Students are required to complete at least 8 experiments.		
Star (*) marked experiments are compulsory.		
Sr No	**List of Experiments**	LO
1*	Build and train a Multi-layer Perceptron (MLP) on the MNIST dataset to classify handwritten digits.	LO1
2*	Implement and compare activation functions (ReLU, LeakyReLU, Sigmoid, Tanh) and loss functions (MSE, CrossEntropy) for binary and multi-class tasks.	LO1LO2
3*	To visualize and compare optimizers (SGD, Adam, RMSprop) on a synthetic dataset to understand convergence and training dynamics.	LO1LO2
4*	To demonstrate overfitting on CIFAR-10 and apply regularization methods like dropout and weight decay (L2 penalty) to enhance generalization.	LO1LO2
5*	Build a custom CNN and evaluate its performance on CIFAR-10 or TinyImageNet. Use visualization techniques (e.g., feature maps, confusion matrix).	LO3
6*	Train a denoising autoencoder using noisy MNIST or Fashion-MNIST and evaluate.	LO4
7*	Use LSTM on stock prices or weather data. Apply normalization, sliding window, and sequential prediction.	LO5
8*	Use ResNet50 or MobileNetV2 with transfer learning on a custom image dataset (e.g., flower classification or cats vs. dogs). Analyze fine-tuning vs feature extraction.	LO6
9	Implement a basic GAN or run an inference pipeline using a diffusion model (Stable Diffusion)	LO6
10*	Mini Project	LO1 LO6

Useful Links:	
1	TensorFlow (www.tensorflow.org)
2	Keras (keras.io)
3	PyTorch (pytorch.org)

4	Scikit (https://scikit-learn.org/stable/)
5	OpenNN (www.opennn.net)
6	Theano https://github.com/Theano/Theano
7	Caffe https://caffe.berkeleyvision.org/
Math Links:	
1	ConvNet Playground(https://github.com/fastforwardlabs/convnetplayground)
2	CNN (https://poloclub.github.io/cnn-explainer/)
3	GAN (https://poloclub.github.io/ganlab/)
4	https://github.com/openai/gym
Virtual Lab	
1	https://github.com/materialsvirtuallab/megnet
Datasets	
1	Kaggle Datasets, ImageNet, CIFAR-10 and CIFAR-100, COCO Dataset, MNIST, UCI Machine Learning Repository, QM7 Dataset, QMOF Dataset, EDNet Dataset

Termwork	
1	**Term work should consist of a minimum of 8 experiments and a Mini Project.**
2	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work.
3	The final certification and acceptance of term work ensure the satisfactory performance of laboratory work and minimum passing marks in term work. **Lab work (Total 50 Marks)** • **Experiments: 15 marks** • **Mini project : 25 marks** • **Attendance Theory & Practical: 05-marks,** • **Assignment: 05-marks**
Practical & Oral Exam	
Based on the entire Syllabus of PCC Deep Learning and Deep Learning lab, Total 25 Marks	

OPEN ELECTIVE-2
(Group A)
TE NEP 2025-26

Open Elective 2		
Sr. No.	**Course Code**	**Course names**
For Departments of AI & DS, CMPN, IT		
1	NOE506	Solid and Hazardous waste management
2	NOE507	Fundamentals of Sustainability Engineering
3	NOE508	Energy Audit and Management
4	NOE509	Electric Vehicles
5	NOE510	Industrial Automation
6	NOE511	Fundamentals of Robotics

Open Elective 2 Teaching Scheme

Course Type	Course Code	Course name	Teaching scheme (Contact Hours)			Credits assigned		Total
			Th	Pr	Tut	Th	Pr/Tut	
OE	NOE50X	Open Elective 2	3	-	1	4	-	4

Open Elective 2 Examination Scheme

Course Type	Course Code	Course Name	Theory				Term Work	Pract & oral	Total
			Internal Assessment		End Sem Exam	Exam Duration (in Hrs)			
			Mid Test	CA					
OE	NOE50X	Open Elective 2	20	20	60	2	-	-	**100**

COURSE NAME: SOLID AND HAZARDOUS WASTE MANAGEMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE506	Solid and Hazardous Waste Management	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid Term Test	CA				
NOE506	Solid and Hazardous Waste Management	20	20	60	---	---	100

Course Prerequisite:	
Course Objectives:	
1	To recognize the relevant regulations that apply for facilities used for disposal and destruction of waste.
2	To provide in depth knowledge of municipal solid waste management
3	To provide in-depth knowledge of hazardous waste management
4	To provide in-depth knowledge of Physico-chemical processes useful for the treatment of municipal and solid wastes
5	To provide in-depth knowledge of biological processes useful for the treatment of municipal and solid wastes.

6	Know the necessity of environmental risk assessment.

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

1	Understand rules and regulations for handling solid waste.
2	Understand principals of municipal solid waste management.
3	Understand hazardous waste management.
4	Learn physicochemical treatment of solid and hazardous waste.
5	Understand biological treatment of solid and hazardous waste.
6	Understand environmental risk assessment.

Module	Content	Hrs
1	**Rules and Regulations**	**5**
	Municipal solid waste (management and handling) rules, hazardous waste (management and handling) rules, biomedical waste handling rules, fly ash rules, recycled plastics usage rules, batteries (management and handling) rules	
2	**Municipal Solid Waste Management**	**6**
	Need for management, sources, composition, generation rates, collection of waste, separation, transfer and transport of waste, treatment and disposal options, source reduction of wastes, recycling and reuse.	
3	**Hazardous Waste Management**	**6**
	Need for management, hazardous characterization of waste, compatibility and flammability of chemicals, waste sampling, TCLP tests, fate and transport of chemicals, health effects	
4	**Physicochemical Treatment of Solid and Hazardous Waste**	**6**
	Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes), physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation), ground water contamination and remediation	

5	**Biological Treatment of Solid and Hazardous Waste**	**10**
	Composting, bioreactors, anaerobic decomposition of solid waste, principles of biodegradation of toxic waste, inhibition, co-metabolism, oxidative and reductive processes, slurry phase bioreactor, in-situ remediation. Landfill design for solid and hazardous wastes, leachate collection and removal, landfill covers, incineration	
6	**Environmental Risk Assessment**	**6**
	Defining risk and environmental risk, methods of risk assessment, case studies	
	Total	**39**

Textbooks:

1	Tchobanoglous G., Theisen H. and Vigil S.A., "Integrated Solid Waste Management", McGraw-Hill International editions.
2	Bhide A.D. and Sundaresan B.B., "Solid Waste Management, Collection, Processing and Disposal", Nagpur.
3	"Manual on Municipal Solid Waste Management", CPHEEO, Ministry of Urban Development, Government of India.
4	Management and Handling Rules for: municipal solid waste, biomedical waste, hazardous waste and radioactive wastes, Government of India Publications.
5	Solid Waste Management Hand Book – Pavoni

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed. 3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/anyMOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME: FUNDAMENTALS OF SUSTAINABILITY ENGINEERING

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE507	Fundamentals of Sustainability Engineering	03	---	01	03	---	01	04

Fundamentals of Sustainability Engineering

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE507	Fundamentals of Sustainability Engineering	03	---	01	03	---	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
NOE507	Fundamentals of Sustainability Engineering	20	20	60	---	---	100

Rationale: This course contains content that address sustainability issues and innovations of relevance to the discipline area. Sustainability content (principles and theory) is well integrated into the course. The course outline specifically addresses the sustainability content.	
Course Objectives:	
1	To acquire knowledge and awareness among students on issues in areas of sustainability.
2	To understand the role of engineering Environmental Pollution and Environmental legislations in India.
3	To understand the International Environmental Management Standards.
4	To apply a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.
5	To analyse the Sustainable Engineering.
6	To evaluate the Sustainable Assessment Systems.

Course Outcomes: After successful completion of the course students will be able to:	
1	To explain issues in areas of sustainability.
2	To summarize the role of engineering Environmental Pollution and Environmental legislations in India.
3	To interpret the International Environmental Management Standards.
4	To relate a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.
5	To connect the Sustainable Engineering
6	To develop the Sustainable Assessment Systems.

Fundamentals of Sustainability Engineering

Module		Content	Hrs
1		**Introduction to Sustainability**	**6**
	1.1	Sustainability-Introduction, Historical Evolution-Goals of Sustainable Development-Principles of Sustainability-Sustainability-need and concept, challenges.	
	1.2	Social, Environmental and Economic sustainability concepts	
	1.3	Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development.	
	1.4	Multilateral environmental agreements and Protocols-Clean Development Mechanism (CDM)	
2		**Environmental Pollution and Environmental legislations in India**	**7**
	2.1	Regional and Local Environmental Issues-Air Pollution, Sources-Effects Preventative Measures of Air Pollution; Water pollution-Land Pollution	
	2.2	Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concepts, 3 R concept	
	2.2	Environmental legislations in India-Water Act, Air (Pollution & Prevention) Act	
	2.4	Environmental Protection Act and Climate Change Act	
	2.5	Forest Act, Animal Protection Act, Factory Act, Labour Act	
	2.6	SEZ Notifications, CRZ Notifications etc	
3		**International Environmental Management Standards**	**7**
	3.1	International Environment Acts and Protocols, Global, Regional and Local environmental issues, Natural resources and their pollution, Carbon credits, Carbon Trading, Carbon FootPrint	

	3.2	ISO 14000, ISO 14001, Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat	
	3.3	Global environmental issues-Resource degradation, Climate change, Global warming, Ozone layer depletion	
	3.4	Sustainable materials-Conventional and renewable material sources, sustainable development, Sustainable urbanization, Industrial Ecology	
4		**Basic concepts of sustainable habitat and Energy sources**	**7**
	4.1	Basic concepts of sustainable habitat, Sustainable materials for building construction	
	4.2	Material selection for sustainable design	
	4.3	Conventional and non-conventional energy sources-Solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy-Methods for increasing energy efficiency of buildings	
	4.4	Embodied energy of various construction materials-Energy Management with respect to buildings	
	4.5	Clean Development Mechanism	
5		**Sustainable Engineering**	**6**
	5.1	Sustainable Urbanization- Sustainable cities	
	5.2	Sustainable transport-Industrialization and poverty reduction-Social and technological change	
	5.3	Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis	
	5.4	Bio-mimicking	

6		**Sustainable Assessment Systems**	**6**
	6.1	Studying few Green/Sustainable building assessments systems e.g. Living Building Challenge, Green Globes (Green Building Initiative)	

		(US)	
	6.2	LEED India and GRIHA Sustainability Assessment Techniques	
	6.3	Green Globes (ECD–Canada, International Initiative for a Sustainable Built Environment: iiSBTool	
	6.4	SBModel 15	
		Total	**39**

Textbooks:	
1	Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
2	Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
3	Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
4	Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Lang.
5	Prohit, S. S., Green Technology - An approach for sustainable environment, Agrobios publication uage Book Society (ELBS).
Reference books:	
1	Environment Impact Assessment Guidelines, Notification of Government of India, 2006
2	ECBC Code 2016, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
3	Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.

2) Mid Term test is to be conducted when approx. 50% syllabus is completed. 3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/anyMOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME: - ENERGY AUDIT AND MANAGEMENT

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE508	Energy Audit and Management (Theory)	03	---	---	03	---	---	03
NOE508	Energy Audit and Management (Tutorial)	---	---	01	---	---	01	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tut	Theory	TW	Tut	Total
NOE508	Energy Audit and Management (Theory)	03	---	---	03	---	---	03

Course Code	Course Name	Examination Scheme				
		Theory		Term Work	Practical & Oral	Total
		Internal Assessment	End Sem Exam			

		Mid Term Test	Continuous Assessment				
NOE508	**Energy Audit and Management (Theory)**	**20**	**20**	**60**	**---**	**---**	**100**

Course Objectives:	
1	To understand the present state of energy security and its importance.
2	To understand methodologies adopted in energy audit and Energy Economics
3	To understand basic principles and Objectives of Energy Management
4	To understand energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5	To understand energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
6	To understand the concept of Energy conservation measures in building complex.
Course Outcomes: After successful completion of the course students will be able to:	
1	To identify and describe the present state of energy security and its importance.
2	Identify and describe the methodologies adopted in energy audit and Energy Economics
3	Identify and describe the basic principles and Objectives of Energy Management
4	To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5	To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
6	To identify and describe the concept of Energy conservation measures in building complex.

ENERGY AUDIT AND MANAGEMENT
(THEORY)

Module	Contents	Hrs
1	**Energy Scenario & Energy Conservation measures**	**06**
1.1	Present Energy Scenario, Renewable and Non-Renewable form of Energy.	
1.2	Energy Pricing, Energy Sector Reforms.	
1.3	Energy Conservation and its Importance: Energy Conservation Act-2001 and its features. Role of Bureau of Energy Efficiency (BEE), Energy Security.	
2	**Energy Audit & Energy Economics**	**08**
2.1	Energy Audit: Definition, need, types of energy audit, Steps of detailed Energy Audit, Role of Energy Manager and Internal audit Team.	
2.2	Understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement.	
2.3	Energy Economics: Simple payback period (SPP), Net Present value (NPV), Return on investment (ROI), Internal rate of return (IRR).	
3	**Principles and Objectives of Energy Management**	**08**
3.1	Indian need of Energy Management, Duties of Energy Manager, Preparation and presentation of energy audit reports, Monitoring and targeting, some case study and potential energy savings	
3.2	Electricity billing, Basic concept of Electrical load management, Maximum demand Control, Energy efficient equipment and appliances, Star ratings of Electrical Equipment.	
4	**Thermal Energy Management**	**06**
4.1	Energy conservation in boilers - steam turbines and industrial heating systems	
4.2	Application of FBC, Cogeneration and waste heat recovery, Thermal insulation - Heat exchangers and heat pumps	

5	**Electrical Energy Management**	**06**
5.1	Renovation and modernization of power plants, Reactive power management, Energy efficient motors	
5.2	Lighting System control: Occupancy sensors, daylight integration, and use of intelligent controllers. Energy efficiency measures in lighting system	
6	**Energy conservation in Residential and Commercial Buildings**	**05**
6.1	Energy Conservation Building Codes (ECBC)	
6.2	Green Building norms, LEED ratings of buildings, Use of renewable energy sources in building complex	
Total		**39**

Textbooks:	
1	Murphy, W. R. (2007), Energy Management (1st edition), Elsevier India Private Limited.
2	De, B. K., (2010), Energy Management audit & Conservation, (2nd Edition), Vrinda Publication.
Reference books:	
1	Turner, W. C., Doty, S. and Truner, W. C., (2009), Energy Management Hand book, (7thedition), Fairmont Press.
2	L.C. Witte, P.S. Schmidt, D.R. Brown, (1988) Industrial Energy Management and Utilisation, (1stedition) Hemisphere Publication, Washington
3	Elias P. Gyftopoulos, (1982) Industrial Energy Conservation Manuals, (1st edition) MIT Press.
4	Patrick, Patrick, Fardo (1993), Energy Conservation guide book, (1st edition) Prentice Hall.

Access to Useful links:	
1	https://beeindia.gov.in/content/energy-auditors
2	https://nptel.ac.in/courses/112105221

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No.	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc.	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Peer Review and Participation	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.

2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME: - ELECTRIC VEHICLES

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
NOE509	Electric Vehicles (Theory)	03	---	---	03	---	---	03
NOE509	Electric Vehicles (Tutorial)	---	---	01	---	---	01	01
Total Credits								04

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tut	Theory	TW/ PR	Tut	Total
NOE509	Electric Vehicles (Theory)	03	---	-	03	---	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid Term Test	Continuous Assessment				
NOE509	Electric Vehicles (Theory)	20	20	60	---	---	100

Course Objectives:	
1	To understand the basics of Electric vehicles and its major parts.
2	To understand different types of electric vehicle and their challenges
3	To understand components of Battery Electrical vehicle
4	To understand components and classifications of Hybrid Electrical vehicle
5	To understand components and architecture of Fuel cell electric vehicle
6	To understand different types of Energy Storage systems

Course Outcomes: After successful completion of the course students will be able to:	
1	To explain the basics of Electric vehicles and its major parts.
2	To identify and describe different types of electric vehicle and their challenges
3	To identify and describe different components of Battery Electrical vehicle
4	To identify and describe different components and classifications of Hybrid Electrical vehicle
5	To identify and describe architecture and different components of Fuel cell electric vehicle
6	To identify and describe different types of Energy Storage systems

ELECTRIC VEHICLES (THEORY)

Module	Contents	Hrs
1	**Introduction to Electric vehicles**	**06**
1.1	Present scenario of electric vehicles, Need of Electric Vehicles, Economic and environmental impacts of using Electrical vehicles.	
1.2	Challenges faced by electric vehicles to replace ICE. Major requirements of electric vehicles.	
2	**Types of electric vehicle and their challenges**	**08**
2.1	Types of electric vehicle and their challenges: Types of electric vehicle, Pure Electric Vehicle (PEV): Battery Electric vehicle, Fuel Cell electric vehicle (FCEV), Hybrid Electric vehicle (HEV).	
2.2	Challenges of Battery Electric vehicle, Hybrid Electric Vehicle and Fuel cell Electric vehicle.	
3	**Battery Electrical vehicle**	**08**
3.1	Components of BEV drive train, the electric propulsion subsystem - Power converter, Driving wheels, Suspension system, Driveshaft, Mechanical transmission, Electric Motor, power electronics converters (DC-AC/DC DC), The electronic control unit (ECU).	
3.2	The energy source subsystem Battery pack with Battery Management System.	
3.3	On board charger, the auxiliary subsystem -Power steering unit, Common parts between ICE drive train and EV drive train, Differences (modifications/parts to be removed/added) between ICE and EV drive train.	
4	**Hybrid Electrical vehicle**	**08**
4.1	Hybrid Electric vehicle (HEV) -Basic architecture of hybrid drive trains, Components of HEV drive train system	
4.2	Classification of HEV: Conventional HEV (Micro, Mild and Full hybrid series hybrid, parallel hybrid, series parallel hybrid, complex hybrid).	
5	**Fuel cell electric vehicle**	**04**
5.1	Fuel cell electric vehicle (FCEV) -Basic architecture of FCEV.	

5.2	Components of FCEV drive train system.	
6	**Energy Storage**	**05**
6.1	Energy Storage: Battery based energy storage, Overview of batteries, Battery Parameters, Battery Charging, regenerative braking,	
6.2	Alternative novel energy sources-solar photovoltaic cells, fuel cells, super capacitors, and flywheels.	
	Total	**39**

Textbooks:	
1	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2 nd Edition, 2017. (Unit-I, II)
2	Ali Emadi, "Advanced Electric Drive Vehicles (Energy, Power Electronics, and Machines)", CRC Press, 2015. (Unit-III)
3	John G. Hayes and A. Goodarzi, "Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles", Wiley, 2018. (Unit IV & V)
Reference books:	
1	James Larminie, John Lowry, "Electric Vehicle Technology Explained", Wiley, 2 nd Edition 2012.
Access to NPTEL / Swayam Course:	
1	https://nptel.ac.in/courses/108106170
2	https://onlinecourses.nptel.ac.in/noc22_ee53
3	https://onlinecourses.nptel.ac.in/noc21_ee112

Internal Assessment:	
1	Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2	Mid Term test is to be conducted when approx. 50% syllabus is completed.
3	Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc.	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8	Multiple Choice Questions (Quiz)	05 marks
9	Peer Review and Participation	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five needs to be solved.

COURSE NAME:Industrial Automation (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE510	Industrial Automation (Theory)	03	---	01	03	---	01	04

Industrial Automation

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE510	Industrial Automation (Theory)	03	–	01	03	–	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	Continuous Assessment				
NOE510	Industrial Automation (Theory)	20	20	60	---	---	100

Course Prerequisite: Digital Electronics, Communication protocols	
Course Objectives:	
1	To impart knowledge of Industrial Automation
2	To make the students learn industrial sensors and actuators
3	To make the students learn about controller strategy and various automation tools like PLC, SCADA and DCS
4	To give an overview of MES and ERP
Course Outcomes: After successful completion of the course students will be able to:	
1	Discuss the need and types of automation
2	Select and configure industrial sensors and actuators
3	Identify components of PLC, and develop PLC ladder using instructions of PLC and design PLC based application
4	Describe SCADA architecture, communication in SCADA
5	Explain evolution and architecture of DCS, hierarchical control in DCS
6	Explain database and alarm management system

Module		Content	Hrs
1		**Introduction**	**04**
	1.1	Automation in production system, Principles and strategies of automation, Basic elements of an automated system, types of processes and controllers	

	1.2	Types of Automation, applications, Hierarchical level in automation,	
		Tutorials	**02**

2		**Sensors and Actuators**	**06**
	2.1	Introduction to Industrial Measurement, overview of sensors, classification, sensor characteristics, physical principles of sensing	
	2.2	Inductive sensors, capacitive sensors, vision sensors, ultrasonic sensors, Robotic sensors, Tactile sensing, Proximity sensors, Range sensor, Position sensors, Fibre optic sensors, specifications of sensors	
	2.3	Electrical actuation: A.C and DC motors, stepper motors, servo motors, mechanical switches and solid state switches. Pneumatic and hydraulic-directional and pressure control valves, cylinders, servo proportional control valves, rotary actuators.	
		Tutorials	**02**
3		**Programmable Logic Controller**	**10**
	3.1	**Hardware** Evolution of PLC, PLC Architecture, Types & Specifications. Safety PLC I/O modules, local and remote I/O expansion, special purpose modules, wiring diagrams of different I/O modules, communication modules, Memory & addressing memory organization, I/O addressing, hardware to software interface.	

	3.2	**Software** Introduction to PLC Programming, programming devices, IEC standard PLC programming languages, LD programming- basic LD instructions, PLC Timers and Counters: Types and examples, data transfer & program control instructions, advanced PLC instructions, PID Control using PLC.	
	3.3	**Case study:** PLC selection and configuration for any one process application**.**	

		Tutorials	**04**
4		**Supervisory Control and Data Acquisition (SCADA)**	**06**
	4.1	SCADA introduction, brief history of SCADA, elements of SCADA. Features of SCADA, Protocol structure, Specifications of SCADA, SCADA as a real time system	
	4.2	Communications in SCADA- types & methods used, components. SCADA Development for any one typical application Programming for GUI development using SCADA software	
		Tutorials	**02**
5		**Distributed Control System (DCS)**	**08**
	5.1	DCS: Overview and Features of DCS, DCS Architecture, Hardware elements, working of DCS, DCS displays, DCS interfacing with PLC, Applications and suppliers.	
	5.2	HMI: Overview, need, Types, Data Handling, configuration and interfacing with PLC & PC.	
		Tutorials	**02**
6		**Database and Alarm Management, MES, ERP**	**05**
	6.1	Introduction to Database management, alarm management system,	

	6.2	Manufacturing Execution System, Enterprise Resource Planning, and Integration with enterprise system.	
		Tutorials	**02**
		Total	**39**

Textbooks:	
1	Johnson Curtis D., Process Control Instrumentation Technology, 8th Ed., 2005
2	Bela G. Liptak, Instrument Engineers' Handbook, Fourth Edition, Volume One: Process Measurement and Analysis, June 27, 2003
3	Thomas Hughes, "Programmable Logic Controller", ISA Publication
Reference Books:	
1	Andrew Williams, "Applied instrumentation in the process industries", 2 nd Edition, Vol. 1 & 3, Gulf publishing company
2	Stuart A. Boyer, "SCADA supervisory control and data acquisition", ISA Publication
3	Krishna Kant, "Computer Based Process Control", Prentice Hall of India
4	Gary Dunning, "Introduction to Programmable Logic controller", Thomas Learning, edition, 2001
5	B.C Nakra, K.K. Chaudhary, Instrumentation, Measurement and Analysis, Tata McGraw-Hill Education, Oct 2003
6	Patranabis D, Sensors and Transducers, Prentice Hall India Learning Private Limited; 2 edition (2003)
7	A. K. Sawhney, Puneet Sawhney,A course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Co. Rai, 1996
8	Andrew Parr, Hydraulic & pneumatics; A Technicians & Engineers Guide, Second Edition

Internal Assessment:

1. Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2. Mid Term test is to be conducted when approx. 50% syllabus is completed.

3. Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc.	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

Continuous Assessment will be based on the tutorials undertaken.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME:Fundamentals of Robotics

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE511	Fundamentals of Robotics	03	-	01	03	-	01	04

Fundamentals of Robotics

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/PR	Tut	Total
NOE511	Fundamentals of Robotics	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid Term Test	Continuous Assessment				
NOE511	Fundamentals of Robotics	20	20	60	---	---	100

Course Prerequisite: Basics of control system	
Course Objectives:	
1	To provide students with the concepts and techniques for the design, modelling, analysis of robots
2	To provide students with the fundamental knowledge of machine vision for Robot guidance and automation.
Course Outcomes: After successful completion of the course students will be able to:	
1	Understand and discuss the fundamental elementary concepts of Robotics.
2	Understand the Anatomy and basic Kinematic of Robots
3	Classify the different types of grippers and actuators
4	Understand the basic fundamentals of Machine Vision
5	Apply the Image enhancement in spatial domain
6	Understand the colour Image processing in Machine Vision

Fundamentals of Robotics

	Content	Hrs
1	**Introduction To Robotics:**	

	Introduction to Robotics and Automation, laws of robotics, brief history of robotics, basic components of a robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market and the future prospects, advantages and disadvantages of robots. **Tutorial:** Selection of a robot for a user given specification	**06**
2	**Robot Anatomy And Motion Analysis:**	
	Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Work volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix. **Tutorial:** Calculation of the Direct Kinematic of simple 2R manipulator	**12**
3	**Robot Drives And End Effectors:**	
	Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control. **Tutorial:** Given a user specification project, select the actuators and end effectors to be used	**10**

4	**Introduction and Digital Image Fundamentals:**	
		08

	Digital Image Fundamentals, Human visual system, Image as a 2D data, Image representation – Grey= scale and Colour images, image sampling and quantization, Basic Relationship between Pixels.	
	Tutorial: Using Matlab/Scilab convert Image to grey scale and find histogram	
5	**Image enhancement in Spatial domain:**	
	Basic grey level Transformations, Histogram Processing Techniques, Histogram equalization, Histogram Matching, Spatial Filtering, Low pass filtering, High pass filtering. **Tutorial:** Using Matlab/Scilab apply Spatial Enhancement Techniques	**08**
	Colour Image Processing	
	Colour Fundamentals, Colour Models, Pseudo colour image processing, Colour Transformations, Smoothing and Sharpening, Image Segmentation based on Colour. **Tutorial:** Using Matlab/Scilab apply Colour Image Processing Techniques	**08**
	Total	**52**

Textbooks:

1	S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education, 2009.
2	Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, Special Edition, (2012).
3	Ganesh S Hegde, "A textbook on Industrial Robotics", University science press, 3rd edition, 2017.

4	Digital Image Processing, 3rd Edition, by Rafael C Gonzalez and Richard E Woods. Publisher: Pearson Education
5	Pratt W.K, ―Digital Image Processing‖, 3rd ed., John Wiley & Sons, 2007
Reference Books:	
1	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2	Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence",McGraw Hill, 1987. https://www.robots.com/applications.
3	Fundamentals of Digital Image Processing by Anil K Jain, PHI
Web Links	
1	https://motion.cs.illinois.edu/RoboticSystems/Kinematics.html
2	https://opencv.org/university/free-opencv-course/
3	https://onlinecourses.nptel.ac.in/noc21_me76/preview

Internal Assessment:

1. Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2. Mid Term test is to be conducted when approx. 50% syllabus is completed.
3. Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

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2	Wins in the event/competition/hackathon	10 marks

3	Content beyond syllabus presentation	10 marks

4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc.	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
9.	Peer Review and participation the marks can be left blank (with discretion of faculty)	05 Marks

Continuous Assessment will be based on the tutorials undertaken

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

Dual Minor(MEA)
Minor in Emerging Area

MEA SEM V and VI

Sr. No.	Course Name
1	RTL VLSI Design
2	Robotics
3	Quantum Technologies

RTL VLSI Design

TE Sem V and VI
RTL VLSI Design

Semester	Course Name	Teaching scheme (Contact Hours)			Credits Assigned		
		Theory	Prac	Tut	Th	Pr/Tut	Total
V	Advance Digital System Design	3	2	---	3	1	4
VI	Project Based Learning : Design with VERILOG	3	2 +2*	--	3	2	5

*** Self study : Mini Project slot**

Examination Scheme								
Sem	Course Name	Theory				Term Work	Mini Project Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (hrs.)			
		MT	CA					
V	Advance Digital System Design	20	20	60	2	25	25	125
VI	Project Based Learning with VERILOG	20	20	60	2	25		150

RTL VLSI Design

TE Sem V

COURSE NAME: Advance Digital System Design

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Advance Digital system Design	03	---	---	03	---	---	03

Advance Digital System Design (Theory)

Cours e Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Advance Digital system Design (Theory)	03	---	---	03	--	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Advance Digital system Design (Theory)	20	20	60	--	--	100

Course Prerequisite: Digital System Design, Computer Architecture.	
Course Objectives:	
1	Design and optimize sequential machines (Mealy vs. Moore FSMs).
2	Analyse and synthesize synchronous and asynchronous sequential circuits.
3	Understand the differences between hardwired and micro programmed control units.
4	Design and optimize finite state machines (FSMs) for control logic.
5	Implement micro programmed control units using microcode.
Course Outcomes: After successful completion of the course students will be able :	
1	To analyse, design and implement sequential logic circuits.

2	To develop a digital logic and apply it to solve real life problems.
3	To analyse and design clocked synchronous State Machines.
4	To develop a hardwired programmed processor.
5	To Design a Micro programmed controlled processor.
6	To address real world challenges through digital design.

Advance digital System design (Theory)

Module		Content	Hrs
1		**Fundamentals of Sequential Machines**	**8**
	1.1	Design of 4-bit adder, CLA Adder, ones complement adder, BCD adder , Latches, FF, Shift Register and counters	
	1.2	Finite State Machines (FSMs): Mealy vs. Moore models, State transition tables & diagrams, Synchronous vs. asynchronous sequential circuits, Timing considerations (setup/hold time, clock skew), Metastability and synchronization techniques.	
2		**Clocked Synchronous State Machine Analysis**	**8**
	2.1	**Clocked Synchronous State Machine Analysis:** State Machine Structure, Output logic, Characteristics equation, State Minimization techniques, state diagram, state diagram design and examples. State minimization techniques (Partitioning, Implication Tables). State encoding strategies (Binary, One-Hot, Gray Code), Flip-flop selection (D, T, JK) and excitation tables.	
	2.2	Analysis State Machine with DFF, Analysis State Machine with JK-FF.	
3		**Clocked Synchronous State Machine Design**	**8**
	3.1	State Table design Example, State assignment.	
	3.2	Synthesis using D-FF and JK-FF Design state machine using state diagrams.	
4		**ASM charts and Hazards**	**4**
	4.1	ASM charts, Hazards in sequential circuits (static/dynamic), Testability and fault detection in sequential logic	
5		**Hardwired Control Unit Design**	**4**
	5.1	Control unit basics and design approaches, Hardwired control: Finite State Machine (FSM) approach, Multi-level control logic implementation, Timing and performance considerations, Case study: Hardwired control in RISC processor	

6		**Micro programmed Control Unit Design**	**7**
	6.1	Microprogramming concepts and terminology, Horizontal vs. vertical microcode, Microinstruction formats and encoding, Microprogram sequencers and control stores, Advantages and disadvantages of microprogramming, Case study: Microprogrammed control in CISC processor	
		Total	**39**

Textbooks:	
1	John F. Warkerly, "Digital Design Principles and Practices", Pearson Education, Fifth Edition (2018).
2	Morris Mano, Michael D. Ciletti, "Digital Design", Pearson Education, Fifth Edition (2013).
3	Carl Hancher, Zvonko Vranesic, Safawat Zaky, "Computer Organization", McGraw Hill, Fifth Edition-2002
Reference Books:	
1	Donald P. Leach / Albert Paul Malvino/Gautam Saha, "Digital Principles and Applications", The McGraw Hill, Eight Edition (2015).
2	Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic Design with VHDL", Second Edition, TMH (2009).
3	Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.
NPTEL/Swayam Courses:	
1	https://cse15-iiith.vlabs.ac.in/List%20of%20experiments.html
2	https://da-iitb.vlabs.ac.in/List%20of%20experiments.html

B

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks

2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Mini Project / Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks

*For sr.no.1, the date of the certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME: Advance Digital System Design LAB

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Advance Digital System Design Lab	---	02	---	--	01	---	1

Advance Digital System Design LAB

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Advance Digital System Design Lab	---	02	---	---	01	---	01

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Advance Digital System Design (LAB)	--	---	--	25		25

Course Prerequisite: Digital Design, Computer Organization	
Course Objectives:	
1	Develop practical skills in designing, simulating, and implementing digital circuits.
2	Understand the complete workflow from logic design to implementation and testing.
3	Apply theoretical concepts (Boolean algebra, FSM design, sequential logic) to real-world problems.
4	Learn debugging techniques for identifying and resolving issues in digital designs.
Course Outcomes:	

After successful completion of the course students will be able :	
1	Design Digital Circuits & Implement combinational logic.
2	Design Digital Circuits & Implement sequential logic.
3	Understand cascaded logic implementation with ICs
4	Debug and verify circuits with breadboards and GPPs.

Suggested Experiments: Students are required to complete at least 10 experiments.	
Sr. No.	**Name of the Experiment**
1.	Debugging technique with breadboard and multi meter.
2.	Implementation 4-bit adder and cascaded adder using 7483.
3.	Implementation of CLA adder using gates and ICs
4.	Implementation of Counter using 7490.
5.	Implementation of Mod counter using 7492.
6.	Testing of FF and Latches with ICs
7.	Testing of Static Hazards
8.	Testing of Dynamic Hazard
9.	Implementation of FSM circuit with FF, Latches and Gates
10.	4-5 Experiments with Virtual lab

Term Work:	
1	Term work should consist of 8 to 10 experiments.
2	Journal may include assignments.
3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments/Quiz/mock viva/activity: 05-marks)

RTL VLSI Design
TE Sem VI
COURSE NAME: Project Based Learning with Verilog

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Project Based Learning with Verilog	03	---	---	03	---	---	03

Project Based Learning with Verilog (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Project Based Learning with Verilog (Theory)	03	---	---	03	--	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Project Based Learning with Verilog (Theory)	20	20	60	--	--	100

Course Prerequisite: Digital System Design, Advance Digital System design	
Course Objectives:	
1	Write synthesizable Verilog code for combinational and sequential circuits.
2	Simulate and verify designs using testbenches.

3	Implement designs on FPGAs
4	Debug and optimize Verilog-based digital systems.
5	Design and implement VERILOG based project
Course Outcomes: After successful completion of the course students will be able :	
1	Understand Verilog HDL syntax, data types, and modeling styles.
2	Differentiate between simulation and synthesis in digital design workflows.
3	Design combinational and sequential circuits (e.g., ALUs, FSMs, counters) using Verilog.
4	Debug Verilog code using waveform analysis tools
5	Assess timing constraints and critical paths in FPGA-based implementations.
6	Develop a complete FPGA project using veroilog and Demonstrate hardware-software co-verification techniques.

Project Based Learning with Verilog (Theory)

Module		Content	Hrs
1		**Introduction to VERILOG HDL**	**8**
	1.1	Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools, Test Benches.	
	1.2	introduction, Keywords, Identifiers, White Space Characters, Comments, Numbers, Strings, Logic Values, Strengths, Data Types, Scalars and Vectors, Parameters, Memory, Operators, System Tasks: $display, $monitor, $time	
2		**Structural and Dataflow Modeling**	**8**
	2.1	**Dataflow**: Introduction, Continuous Assignment Structures, Delays and Continuous Assignments, Assignment to Vectors, Operators. Example: gates, full adder	
	2.2	**Structural:** Instantiating Modules, Port Mapping (Positional and Named), Hierarchical Naming and Scope, Gate-level Modeling (Basic Logic Gates), Parameter, generate block, Examples: Multiplexer, decoder, CLA adder, 4 bit adder	
3		**Behavioral Modeling**	**6**

	3.1	**Behavioral:** initial and always Blocks, Procedural Assignments, Control Flow Statements: if, case, for, while, Blocking vs. Non-blocking Assignments, Delay Modeling. Sequential circuits (Flip-flops, counters, shift registers)	
	3.2	Tasks and Functions	
4		**Testbenches & Verification**	**5**
	4.1	Testbench structure ($display, $monitor), Clock generation & reset strategies, Stimulus generation (random, file-based inputs), Waveform analysis. Self-checking Testbenches	
5		**RTL Modeling**	**5**
	5.1	Finite State Machine (FSM) design (Mealy & Moore machines), Memory modeling (RAM, ROM).	
6		**FPGA Implementation & Advanced Topics**	**7**
	6.1	Synthesis vs. simulation differences, FPGA architecture overview (LUTs, CLBs, IOBs), Timing constraints & critical path analysis, Optimization techniques (pipelining, resource sharing), Mini-project (UART, PWM, or simple CPU design).	
		Total	**39**

Textbooks:	
1	Samir Palnitkar, "Verilog HDL A guide to Digital Design and Synthesis", 2nd Edition, Pearson Education, (2009)
2	Stephen Brown & Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Third Edition, MGH (2014).
3	Frank Vahid, "Digital Design with RTL design, VHDL and VERILOG", John Wiley and Sons Publisher 2011.
NPTEL/Swayam Courses:	
1	https://onlinecourses.nptel.ac.in/noc24_cs61/preview
2	https://archive.nptel.ac.in/courses/106/105/106105165/

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Wins in the event/competition/hackathon	10 marks
3	Content beyond syllabus presentation	10 marks
4	Creating Proof of concept	10 marks
5	Extra Experiments/ Virtual Lab	10 marks
6	GATE Based Assignment test/Tutorials etc	10 marks
7	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
8.	Multiple Choice Questions (Quiz)	05 marks
*For sr.no.1, the date of the certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.		

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five need to be solved.

COURSE NAME: Project Based Learning with Verilog (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Project Based Learning with Verilog (LAB)	---	02	---	--	02	---	02

Project Based Learning with Verilog (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Project Based Learning with Verilog (LAB)	---	02	---	---	02	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		MT	CA				
	Project Based Learning with Verilog(LAB)	--	---	--	25	25	50

Course Prerequisite: Digital Design, Computer Organization.	
Course Objectives:	
1	Develop Proficiency in Verilog Coding
2	Master Simulation and Verification
3	Optimize Digital Circuits
4	Debug and Troubleshoot Effectively
5	Adopt Industry Best Practices
Course Outcomes: After successful completion of the course students will be able :	
1	Understand Verilog HDL Fundamentals
2	Design and Simulate Digital Circuits

3	Synthesize and Optimize RTL Designs
4	Debug and Verify Hardware Functionality
5	Implement FPGA-Based Projects
6	Work with Industry-Standard Tools

Suggested Experiments: Students are required to complete at least 10 experiments.
Suggested Tool : AMD Xilinx Vivado, Intel Quartus, EDA Playground
Suggested FPGA Boards : Boolean FPGA Board, Zynq Boards

Sr. No.	**Name of the Experiment**
1.	Implement and verify using test bench Data Flow code for different logic gates and Full adders using VERILOG
2.	Implement and verify using test bench Behavioural code for 4-bit adder
3.	Implement and verify Generic adder using VERILOG
4.	Implement and verify using test bench Behavioural code for mux and encoder using VERILOG
5.	Implement and verify using test bench Behavioural code for demux and decoder using VERILOG
6.	Implement FF's, Counter using VERILOG
7.	Implement traffic signal FSM and simulate using VERILOG
8.	State machine for one's counter using VERILOG
9.	Implement Multiplier using VERILOG
10.	Implement RAM using VERILOG
	MINI Project: Suggested List
1.	PWM Generator ● Concepts: Duty cycle control, counters. ● Application: LED dimming, motor speed control.
2.	ALU (4 Operations: Add, Sub, AND, OR) ● Concepts: Multiplexers, RTL design. ● Extension: Add shift operations.

3.	FIFO Buffer ● Concepts: Memory modeling, read/write pointers. ● Challenge: Add overflow/underflow flags.
4.	UART (Serial Communication) ● Concepts: Baud rate generation, start/stop bits. ● Test: Send/receive data between FPGA and PC.
5.	VGA Signal Generator (Display Patterns) ● Concepts: Clock domain crossing, metastability. ● Application: Reliable input for FSMs.
6.	Debounce Circuit for Pushbuttons ● Concepts: Clock domain crossing, metastability. ● Application: Reliable input for FSMs.
7.	SPI Interface (Master/Slave) ● Concepts: Serial communication, clock synchronization. ● Extension: Connect to an ADC (e.g., MCP3008).
8.	**RISC-V Single-Cycle CPU Core** ● Concepts: ISA implementation, control unit design. ● Minimal: Support 5-10 instructions (ADD, LW, SW, BEQ).
9.	**CNN Accelerator (Fixed-Point Multiplier)** ● Concepts: Pipelining, parallel processing. ● Simplified: 3x3 convolution for image edge detection.
10.	**Cache Memory Simulator** ● Concepts: Direct-mapped/set-associative caching, LRU policy. ● Input: Trace files of memory accesses.

Term Work:	
1	Term work should consist of 8 to 10 experiments.
2	Compulsory Mini project [10 Marks]: 1. RTL project must be design and implemented using VERILOG. 2. Simulated with testbench and verified on tool. 3. Synthesized with EDA tool and implemented on FPGA. 4. Small 5-10 pages report to be produced.

3	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4	Suggested TW Mark scheme: Total 25 Marks (Experiments: 10-marks, Attendance Theory & Practical: 05-marks, Mini Project: 10-marks)

Robotics

TE Sem V and VI

Robotics
TE Semester V

Sem	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned		
		Theory	Pract	Tut	Theory	Pract/ tut	Total
V	Fundamentals of Robotics	3	2	-	3	1	**4**
VI	Industrial Automation and Robotics	3	4	-	3	2	**5**

Examination Scheme								
Sem	Course Name	Theory				Term Work	Mini Project Oral	Total
		Internal Assessment		End Sem Exam	Exam Duration (hrs.)			
		MT	CA					
V	Fundamentals of Robotics	20	20	60	2	25	-	125
VI	Industrial Automation and Robotics	20	20	60	2	25	25	150

TE Sem V
Fundamentals of Robotics

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Fundamentals of Robotics	03	---	---	03	---	---	03

Fundamentals of Robotics (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Fundamentals of Robotics	03	---	---	03	--	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Fundamentals of Robotics	20	20	60	--	--	100

Prerequisite:	
Course Objectives:	
1	To make students aware about fundamentals of the Robot
2	Overall study of various components of the robot and robotic manipulators
3	To study various technical parameters of the robotic systems
4	Analysis of Robot Movement and control mechanism.
5	To provide knowledge about Robot trajectory
6	To explore various areas where Robotics can be adopted
Course Outcomes: After successful completion of the course student will be able to	
1	To get detailed Knowledge on Robotic Manipulators and Robot components.
2	To study different Technical Specification of Robot and Mathematical Representation of Robot Movements

3	Robot Control Mechanism
4	To study Direct Kinematics and Inverse Kinematics for Robot
5	To define Robot Trajectory and planning the same
6	To well verse with various application of Robots

Module		Content	Hrs
1	INTRODUCTION TO ROBOTICS		
	1.1 **1.2**	Introduction to Robotics and Automation, Define robot, Laws of robotics, brief history of robotics, basic components of robot, robot specifications, classification of robots, human system and robotics, safety measures in robotics, social impact, Robotics market, and the future prospects, advantages and disadvantages of robots.	6
2	ROBOT ANATOMY AND MOTION ANALYSIS		
	2.1	Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations, Robot links and joints, Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw, Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.	6
3	ROBOT DRIVES AND END EFFECTORS		
	3.1	Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors, Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control.	6
4	Kinematics of Robots		
	4.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation. Denavit-Hatenberg representation of forward kinematics,Forward kinematic solutions of two DOF, Three DOF and Four DOF (SCARA) robots	**9**

	4.2	Inverse kinematic solutions of two DOF, Three DOF and FourDOF (SCARA) robots.	
5		Trajectory and Motion Planning	
	5.1	Trajectory planning, Path Planning and Task Planning Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	6
	5.2	Gross motion Planning; Grasp planning, Fine-motion Planning	
6		Application of Robotics	
	6.1	Medical, agricultural and space applications, unmanned vehicles:Areial Robots, Humanoid and Under water,	6
		Total	**39**

Textbooks:	
1	Robert Schilling, Fundamentals of Robotics, Analysis and Control, Prentice Hall Publications
2	Dilip Kumar Pratihar, Fundamentals of Robotics, Narosa Publishing House, (2019)
3	Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill,Special Edition, (2012).
References:	
1	J. J. Craig, "Introduction to Robotics: Mechanics and Control", 3rd edition, Addison Wesley (2003)
2	S. K. Saha, Introduction to Robotics 2e, TATA McGraw Hills Education (2014)
3	Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)

Internal Assessment:
Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:
Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No.	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Creating Proof of concept	10 marks
4	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5	Multiple Choice Questions (Quiz)	5 marks
6	GATE Based Assignment/Tutorials etc	10 marks

*For sr. no.1, the date of the certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Useful Links	
1	https://www.youtube.com/watch?v=svyhLDAoyKc
2	https://www.youtube.com/watch?v=1-FJhmey7vk
3	https://motion.cs.illinois.edu/RoboticSystems/Kinematics.html
4	https://opentextbooks.clemson.edu/wangrobotics/chapter/forward-kinematics/

Fundamentals of Robotics lab

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Fundamentals of Robotics(**LAB**)	---	02	---	--	02	---	02

Project Based Learning with Verilog (LAB)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Fundamentals of Robotics(**LAB**)	---	02	---	---	02	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		MT	CA				
	Fundamentals of Robotics(**LAB**)	--	---	--	25	25	50

Lab Objectives:

1	1. **Understand and apply the principles of Direct Kinematics** ○ Derive the position and orientation of the robot's end-effector based on given joint parameters. ○ Implement and simulate forward kinematics models for different types of robotic manipulators. 2. **Develop and implement trajectory planning algorithms** ○ Formulate point-to-point and continuous trajectory planning for robotic arms. ○ Generate smooth and feasible trajectories considering position, velocity, and acceleration constraints. 3. **Integrate kinematic models with trajectory planning** ○ Combine direct and inverse kinematics with trajectory planning to control robotic motion accurately. ○ Simulate end-to-end robotic movement from kinematic model generation to trajectory execution. 4. **Enhance skills in simulation tools and programming environments** ○ Utilize software such as MATLAB, ROS, or Python for kinematics analysis and trajectory planning. ○ Interpret simulation results and validate theoretical models through practical experiments. 5. **Foster problem-solving and critical thinking** Troubleshoot issues related to kinematic singularities, redundancy, and path planning in robots. ○ Optimize trajectory plans for efficiency, safety, and task-specific requirements.
2	**Analyze and solve Inverse Kinematics problems** ○ Determine joint variables that achieve a desired position and orientation of the end-effector.
3	○ Apply analytical and numerical methods for solving inverse kinematics in manipulators with different configurations (e.g., planar, articulated, SCARA robots).
4	**Develop and implement trajectory planning algorithms** ○ Formulate point-to-point and continuous trajectory planning for robotic arms. ○ Generate smooth and feasible trajectories considering position, velocity, and acceleration constraints.
Lab Outcomes:	
1	Apply the concepts of direct kinematics to determine the position and orientation of a robotic manipulator's end-effector.
2	Formulate and solve inverse kinematics problems for different types of robotic configurations using analytical and numerical approaches

3	Utilize simulation and programming tools (e.g., MATLAB, Python, ROS) to model, analyze, and validate kinematic and trajectory planning algorithms
4	Demonstrate the ability to plan and implement practical robotic tasks, such as pick-and-place, through the integration of kinematics and trajectory planning.

Suggested Experiments	
Sr. No.	Name of the Experiment
1	Implementation of CHCTM for 2 DOF Robotics arm(PARA).
2	Implementation of CHCTM for 2 DOF Robotics arm (Cylindrical workspace).
3	Implementation of CHCTM for 3 DOF Robotics arm (PARA).
4	Implementation of CHCTM for 4 DOF Robotics arm (PARA).
5	To perform and visualise various types of translations and rotations (and combinations of both) in X-Y Plane.
6	To perform workspace analysis of 2 DOF and 4 DOF robotic arm.
7	Implementation of Inverse Kinematics for 2-DOF Robotic arm. (PARA)
8	Implementation of Inverse Kinematics for 3-DOF Robotic arm. (PARA)
9	Straight line motion control using ROS.
10	Various trajectory implementations using ROS.

Useful Links:	
1	https://www.youtube.com/watch?v=svyhLDAoyKc
2	https://www.youtube.com/watch?v=1-FJhmey7vk

TE Sem VI

Industrial Automation and Robotics

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Industrial Automation and Robotics	03	---	---	03	---	---	03

Fundamentals of Robotics (Theory)

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Industrial Automation and Robotics	03	---	---	03	--	---	03

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Industrial Automation and Robotics	20	20	60	--	--	100

Prerequisite:	
Course Objectives:	
1	To get detailed Knowledge on Automation
2	To have detailed analysis of How Robots can be major players in automation
3	To study various Sensors and Actuators
4	Detailed Study of integrating Sensors and Actuators in Robotic Manipulator
5	Overview of Industrial Automation
6	To study various advance applications
Course Outcomes: After successful completion of the course student will be able to enhance their skills in	
1	Automation Heuristics and Study of Various Robotic Manipulators.

2	Different Equipments such as Transducers and Actuators and Sensors
3	Image Processing for Robots and factors for Image Processing.
4	Industrial Automation and Process Control
	Data Management in Automation Systems
5	To Study Various Robotics Applications in Various Domain

Module	Content		Hrs
1	**Introduction**		
	1.1	Definition of Automation, Hard Automation and Soft automation. Sense act and control paradigm. Reactive Paradigm. Need of Biological Science in automation. Animal Behavior.	6
	1.2	Sensors and actuators.Working Principles of various sensors and actuators.. Analog and Digital components for automation.Various Transmission mechanisms. Sensor Characteristics,Types of Sensors, Vision Systems, Voice Synthesizer Characteristics of Actuating Systems, Comparison of Actuating Systems, Hydraulic Devices, Pneumatic Devices, Electric Motors, Magnetostrictive Actuators.	
	1.3	Self-learning Topics: Microprocessor Control of Electric Motors, Microswitches, Range Finders, Voice Recognition DevicesTransducers	
2	**Equipments and Transducers**		
	2.1	Instrumentation Systems: - Introduction, Block diagram, Functional elements of measurement system, Static and Dynamic characteristics of transducers. Sensor and Transducer: Definition, classification, selection criteria, transducer specifications.	8
	2.2	Transducers for Displacement: Resistance type transducers: Potentiometer, piezo resistive effect. Inductive type transducers: LVDT, RVDT (transfer function, linearity, sensitivity, source frequency dependence, phase null, and signal conditioning). Selection and properties of materials for LVDT and general electromagnetic sensors.	
	2.3	Digital transducers: translation and rotary encoders (absolute position and incremental position encoders). Proximity Sensors: inductive, capacitive, optical, ultrasonic, hall effect and magnetic. Pneumatic transducer: Flapper – nozzle transducer.	
3	**Robot Vision and Task Planning**		

	3.1	Image Acquisition, Image representation, Template matching, Polyhedral objects: Edge Detection, Corner Points,RLE. Shape analysis: Boundary of an Object, Area Description Segmentation, Shrink and swell Operators, Iterative processing, Perspective transform, Camera Calibration	6
	3.2	Task Planning in Robot Task planner block diagram, task level programming, uncertainty, rotation and gross motion, Motion Heuristics and Grasp Planning	
4	**Automation**		
	4.1	Introduction and Fundamentals: Introduction to Industrial Automation, Architecture of Industrial Automation Systems: different components and their interactions within an automation system. Signal Conditioning and Processing: How sensor signals are prepared for use in control systems. Data Acquisition Systems	8
	.2	Introduction to Process Control: The principles of feedback control and process control. P-I-D Control: Proportional-Integral-Derivative control, its implementation, and tuning. Special Control Structures: Feedforward, ratio, cascade, and other advanced control methods. Controller Tuning: Methods for optimizing control system performance. Sequence Control and PLCs: Programmable Logic Controllers (PLCs) and their use in sequence control. Relay Ladder Logic (RLL): The language used to program PLCs. PLC Hardware and Software: Understanding the components and programming environment of PLCs.	
5	**Automation Systems**		
	5.1 **5.2**	TYPES OF AUTOMATION SYSTEMS Localized Process, Distributed Process, Supervisory Control and Data Acquisition. Major Functionalities like Data Acquisition, Data Supervision or Monitoring, Process Survey, Process Control, Process Studies, Human Interaction, Data Logging and History Generation, Data Exchange, Data Availability, Current Trends in Automation Systems, Modern Control Center, Application Areas of Automation System.	8
6	**Various Robotic Applications**		
	6.1	Surgical Robots, Robots in diagnostics	3
	6.2	Industrial Applications of Robots	
	6.3	Automobile Industry and robots, CNC Machines, Case study of Robots in Media Industry	
		Total	39

Textbooks:	
1	Fundamentals of Robotics Analysis and Control , Robert Schilling PHI Publications
2	Lawrence D. Goettsche, "Maintenance of Instruments and Systems", International Society of Automation, 2nd Edition, 2005.
3	Saeed Niku Introduction to Robotics: Analysis, Control, Applications, 3ed (An Indian Adaptation) Saeed B. Niku, Wiley Editorial Team
4	Norman A. Anderson, "Instrumentation for Process Measurement and Control", CRC Group, Taylor and Francis Group, 3rd Edition, 2010.
	John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 5th Edition, Prentice Hall Inc., New Jersey, 2003. 3. Krishna Kant, "Computer - Based Industrial Control", 2nd Edition, Prentice Hall, New Delhi, 2011. 4. Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.
	Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010. 2. Richaerd D Klafter, Thomas Achmielewski and MickaelNegin, "Robotic Engineering – An integrated Approach" Prentice Hall India, New Delhi, 2001. 3. Deb S R and Deb S, ―Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010. 4. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.

References:	
1	INTRODUCTION TO AI ROBOTICS, SECOND EDITION (Intelligent Robotics and Autonomous Agents series) by Robin Murphy
2	Springer Hand Book On Robotics
3	Stephen J. Derby, "Design of Automatic Machinery", Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 2004.
4	J J Craig, ―Introduction to Robotics: Mechanics and Control, Prentice Hall, 2004.
5	R M Murray, Z. Li and S S Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.

Internal Assessment:

Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks. Mid Term test is to be conducted when approximately 50% syllabus is completed. Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of 20 marks. The rubrics for assessment will be considered based on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No.	Rubrics	Marks
1	*Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Creating Proof of concept	10 marks
4	Mini Project / Extra Experiments/ Virtual Lab / Competitive programming-based event / Group Discussion	10 marks
5	Multiple Choice Questions (Quiz)	5 marks
6	GATE Based Assignment/Tutorials etc	10 marks

*For sr. no.1, the date of the certification exam should be within the term and in case a student is unable to complete the certification, the grading has to be done accordingly.

End Semester Theory Examination:	
1	Question paper will be of 60 marks
2	Question paper will have a total of five questions
3	All questions have equal weightage and carry 20 marks each
4	Any three questions out of five needs to be solved.

Industrial Automation and Robotics Lab

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Industrial Automation and Robotics Lab	---	02	---	--	02	---	02

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Industrial Automation and Robotics Lab	---	02	---	---	02	---	02

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Practical & Oral	Total
		Internal Assessment		End Sem Exam			
		MT	CA				
	Industrial Automation and Robotics Lab	--	---	--	25	25	50

Prerequisite:	
Lab Objectives:	
1	To Explore Various Robotic Manipulators and its Components
2	To study various Technical Parameters of Robots and analyse them
3	To study various Sensors and actuators and their assembly in Robots
4	Programming Robots for desired Task
Lab Outcomes: After Successful Completion of Lab Work Students will be able to	

1	Study and Analyse Robotic Manipulators and their Technical Characteristics
2	Apply Technical Knowledge of Various Mechanical Joints in Robot Construction
3	Use of Sensors and Actuators to make robots more Smart and Intelligent.
4	Use of Robot Vision Techniques to make Robot capable to grasp the environment

Suggested Experiments	
Sr. No.	Name of the Experiment
1	To Analyse PEAS Factors for Robotic Manipulators (Performance, Environment, Actuators, Sensors) Using Actual Robot Model or Image of Robots
2	To study Technical Characteristics of Sensors such as IR , Ultrasonic, Optoisolators and Other Analog Sensors.
3	Motor Interface for Robotic Manipulator
4	To Perform Pick Up and Place Operation for Robotic Manipulator
5	To use Sensor for Object Detection and Carry Out Predefined Task for Robots
6	Study of PLC and Designing PLC for the Particular Tasks
7	Use of Camera and its Integration with Robots, Use of Camera for Performing Environmental analysis and Apply Image Processing for Acomplition of Task
8	White Line Follower robot and its Navigation and Control.
9	PLC Based Experiment
10	Using Limit Switch , Analog Control Mechanism for Particular Tasks for Robots
11	Case Study on Assembly Line in Various Industries
12	Study of 3D printer for Smart Manufacturing
13	Automated Testing

Useful Links:

1	Robotlab https://www.robotlab.com/?srsltid=AfmBOopRDJynj1OA73e3P5CWhN-RcyGevJIOaooNDF9kHokJqtFS_gut
2	Mind Project https://mind.ilstu.edu/curriculum/virtual_robotics_lab/
3	E-Yantra Lab IITB https://www.e-yantra.org/

Applied Robotics Mini Project

Semester long Mini Project on application of Robotics
Following are recommended list of project

1. **Automated Object Sorting System:** Use MATLAB to program a robotic hand that sorts objects based on color, size, or shape using sensor inputs.
2. **Grasp Optimization for Robotic Hands:** Develop an algorithm in MATLAB to enhance the grasp stability of robotic hands for different object geometries.
3. **Sensor-Based Pick-and-Place Automation:** Build a robotic system that uses distance and motion sensors to perform pick-and-place tasks autonomously.
4. **Task Planning for Multi-Finger Robotic Hands:** Create a MATLAB-based task planner for coordinated motion control of multi-finger robotic hands.
5. **Force Sensing and Feedback System:** Design a robotic hand with force sensors to perform delicate operations, like handling fragile objects.
6. **Prosthetic Hand Control Using EMG Signals:** Use MATLAB to process electromyography (EMG) signals and control robotic hand movements for prosthetics.
7. **Gesture Recognition for Robotic Hand Control:** Implement vision sensors and MATLAB to recognize human hand gestures and replicate them using a robotic hand.
8. **Robotic Hand Calibration System:** Develop an automated MATLAB script to calibrate sensors and actuators of a robotic hand for optimal performance.
9. **Tactile Feedback for Enhanced Grasping:** Build a system that integrates tactile sensors on robotic fingers to provide real-time feedback for adaptive grasping.
10. **Autonomous Assembly Line Robot:** Combine task planning, sensor data, and a robotic hand to automate repetitive tasks in a simulated assembly line.

Quantum Technologies

TE Sem V and VI

TE Sem V and VI
Quantum Technologies

		Teaching Scheme (Teaching Hours)			Credits Assigned			
MDM2	**Course Name**	**Theory**	**Practical**	**Tutorial**	**Theory**	**TW/ PR**	**Tut**	**Total**
SEM V	Foundations of Quantum Technologies	**03**	**-**	**02**	**03**	**01**	**---**	**4**
SEM VI	Semester VI: Quantum Circuits and Algorithms	**03**	**02+02 (Lab+MP)**	**---**	**03**	**02**	**---**	**5**

MDM2	**Course Name**	**Examination Scheme**					
		Theory			**Term Work**	**Oral**	**Total**
		Internal Assessment		**End Sem Exam**			
		Mid-Term Test	**CA**				
SEM V	Foundations of Quantum Technologies	**20**	**20**	**60**	**25**	**-**	**125**
SEM VI	Semester VI: Quantum Circuits and Algorithms	**20**	**20**	**60**	**25**	**25**	**150**

TE Sem V

Foundations of Quantum Technologies

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Foundations of Quantum Technologies	3	-	2	3	1	---	4

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Foundations of Quantum Technologies	20	20	60	-	-	100

Course Prerequisite: Linear algebra, Matrices, logic gates, Vectors, Probability and Statistics (Basic Review), Complex Numbers, NumPy, Matplotlib	
Course Objectives:	
1.	**Understand** the fundamental differences between classical and quantum computation, including the concept of qubits and superposition.
2.	**Develop** the necessary mathematical background, including linear algebra, Pauli matrices, and tensor products, for quantum computing.
3.	**Analyze** quantum systems through measurement theory, Bloch sphere visualization, and the phenomenon of entanglement.
4.	**Apply** the principles of quantum mechanics to build and interpret quantum circuits, understand hardware implementations, and explore real-world applications.
5.	**Develop** the necessary mathematical background, including linear algebra, Pauli matrices, and tensor products, for quantum computing.
Course Outcomes: After successful completion of the course students will be able to:	
1	Design and analyze quantum circuits using various quantum gates.
2	Understand the principles of quantum algorithms and their advantages over classical algorithms.

3	Learn key quantum algorithms such as QFT, Grover's, and Shor's algorithm, including their mathematical formulation and circuit implementation.
4	Apply quantum algorithms in factoring, search, cryptography and optimization problems.

Module	Content	Hours
1	**Introduction to Quantum Computing**	5
	Classical vs. Quantum Computing, Bits vs. Qubits, Bra-Ket Notation, Evolution and Key Milestones, Industrial Impact	
2	**Mathematical Foundations**	7
	Pauli Matrices, Hermitian and Unitary Operators, Spectral Decomposition, Heisenberg Uncertainty Principle, Composite Systems and Tensor Products	
3	**Quantum Measurement and Entanglement**	7
	Superposition and Measurement, Bloch Sphere Representation,Probability and Density Operators, Mixed States, Bell's Theorem and Quantum Entanglement	
4	**Introduction to Quantum Gates and Circuits**	8
	Unitary Gates and Reversibility, Single-Qubit Gates: X, Y, Z, H, S, T, Phase Gates, Multi-Qubit Gates: CNOT, SWAP Building Quantum Circuits, Measurement in Circuits	
5	**Physics of Quantum Devices**	5
	Schrödinger Equation and Heisenberg Picture, Density Matrices and Decoherence, Thermal Equilibrium and Gibbs Principle	
6	**Quantum Hardware and Applications**	7
6.1	Physical Realization of Quantum Gates, Superconducting qubits, Trapped ions, Optical implementations, Quantum Circuit Model:	
6.2	Industrial Applications, Cryptography, Optimization, Drug Discovery	
	Total	39

Textbooks	
1	Elements of Quantum Computation and Quantum Communication, Dr. Anirban Pathak, CRC Press (Taylor & Francis)
2	P.K. Ghosh, Book: "Quantum Mechanics", NCBA (National Council of Educational Research and Training)
3	Quantum Mechanics: Theory and Applications, Dr. Ajoy Ghatak, Dr. S. Lokanathan, Springer India
4	Quantum Computation: A Beginner's Guide, Dr. M. Nakahara, T. Ohmi, CRC Press
Reference Books	
1	ebook : Phillip Kaye, Raymond Laflamme et. al., An introduction to Quantum Computing, Oxford University press, 2007. https://files.batistalab.com/teaching/attachments/chem584/Mosca.pdf
2	book url:QUANTUM COMPUTING Jozef Gruska (book detail not available) https://www.fi.muni.cz/usr/gruska/qbook1.pdf
e resources	
1	Quantum Computing: Lecture Notes Ronald de Wolf QuSoft, CWI and University of Amsterdam, https://homepages.cwi.nl/~rdewolf/qcnotes.pdf.
2	Quantum computer science by N David Merwin: http://www-f1.ijs.si/~ramsak/Nanofizika/QCS/books_3092_0.pdf

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers.

The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks
2	Content beyond syllabus presentation	10 marks
3	Mini Project / Extra Experiments/ Virtual Lab	10 marks
4	Assignment test/Tutorials etc	10 marks

5	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
6	Multiple Choice Questions (Quiz)	05 marks

End Semester Theory Examination	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five need to be solved.

Foundations of Quantum Technologies
Tutorial

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Foundations of Quantum Technologies	-	-	-	25	-	25

Sr.No.	Suggested topics for Tutorial
1	**Introduction to Quantum Computing: From Bits to Qubits, Elements of Quantum Computation**
2	**Mathematical Tools for Quantum Computing, Linear Algebra for Quantum Computing (Qiskit Series)** (Ref: Anirban Pathak (Chapters 1–2), NPTEL Video: Quantum Computing by Prof. Arvind (IISER Mohali), IBM Quantum Experience (free sign-up) – basic concepts}
3	**Quantum States and Measurements** Ref: Tool: Bloch Sphere simulator online (IBM Q Experience)
4	**Quantum gates** (Qiskit textbook: Single-Qubit Gates, IBM Quantum Lab (to run simple gates))
5	**Building Quantum Circuits** IBM Qiskit Playground (build 2–3 qubit circuits),YouTube: Quantum Circuits Visualized – Veritasium
6	**Quantum physics:decoherence** Ref: Video: Quantum Decoherence Explained (Veritasium), Simple notes on Density Matrices and Decoherence (TIFR Lecture Series PDF)
Resources	
1	**Qiskit Tutorials**: https://qiskit.org/documentation/tutorials.html **IBM Quantum Lab for Practice**: https://quantum-computing.ibm.com/lab **Quantum Experience Lab Guide (Beginner Friendly)**: https://quantum-computing.ibm.com/composer/docs/intro

Term Work	
1	**Lab work: Minimum 4 experiments/ tutorials/assignments are to be submitted as a part of TW submission.**
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

TE Sem VI

COURSE NAME: QUANTUM CIRCUITS AND ALGORITHMS

Course Code	Course Name	Teaching Scheme (Teaching Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ PR	Tut	Total
	Quantum Circuits and Algorithms	03	02+02 (Lab+MP)	---	03	02	---	5

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Quantum Circuits and Algorithms	20	20	60	-	-	100

Course Prerequisite: Foundations of Quantum Technologies	
Course Objectives:	
1.	To Understand the fundamental principles of quantum computing and how they differ from classical computing.
2.	To Learn about quantum bits (qubits) and their representation using quantum states.
3.	To analyze and implement various quantum gates and quantum circuits.
4.	To develop an understanding of quantum algorithms and their applications.
5.	To gain hands-on experience in designing simple quantum circuits using quantum computing frameworks.
Course Outcomes: After successful completion of the course students will be able to:	
1	**Differentiate** between classical bits and quantum qubits using Bra-Ket notation.
2	**Demonstrate** operations using Pauli matrices, Hermitian and Unitary operators, and tensor products in quantum systems.
3	**Interpret** quantum states on the Bloch Sphere and explain the principles of superposition, measurement, and entanglement.
4	**Design** simple quantum circuits using basic single and multi-qubit gates (X, H, CNOT, etc.).

5	**Explain** the physical realization of qubits in superconducting, trapped ion, and optical systems.
6	**Evaluate** potential industrial applications of quantum computing in fields like cryptography, optimization, and drug discovery.

Module	Content	Hours
1	**Fundamentals of Quantum Gates and Bloch Sphere**	6
	Quantum Gates,Bloch sphere representation for quantum gates,Pauli gates (X,Y, Z), Hadamard gate (H), Phase gates (S, T), π/8 gate,Rotation gates	
2	**Multi-Qubit Systems, Reversible Computing and Entanglement**	6
	Multi-Qubit Systems,Toffoli and Fredkin gates, Controlled-U operations, Reversible computing, SWAP gate and its role, Entanglement basics	
3	**Universal Quantum Gates and Quantum Circuit Design**	7
	Universal Quantum Gates: Definition and components, Decomposition into elementary gates, Quantum Circuit Model, Quantum circuit diagrams, Gate synthesis and circuit depth optimization, Quantum adders	
4	**Core Concepts in Quantum Computation**	6
	Core Concepts in Quantum Computation, No-cloning theorem, Quantum parallelism, Basics of Quantum Algorithms, Comparison of Classical vs Quantum Algorithms, Circuit vs Query Complexity, Quantum Oracle and Phase Oracle	
5	**Basic Quantum Algorithms for Parity and Balanced Functions**	6
	Algorithm for Parity:Problem, Classical solution, Quantum solution Deutsch Algorithm), Algorithm for Constant and Balanced Functions: Problem, Classical solution, Quantum solution **(Deutsch-Jozs Algorithm)**	
6	**Advanced Quantum Algorithms: Search and Factoring**	8
	Algorithm for Secret XOR Mask **(Simon's Algorithm),** Algorithm for Search:Classical database search, Grover's Concept of amplitude amplification, Algorithms for Factoring:Classical integer factorization problem, **Shor's Algorithm,** Period finding and order finding	
	Total	39

Textbooks	
1	Introduction to Classical and Quantum Computing, Thomas G. Wong,
2	Quantum Computing Explained By DAVID McMAHON, Wiley-Interscience , IEEE Computer Society (2008)
3	Quantum Computation and Quantum Information – Nielsen and Chuang, Cambridge University Press. Cambridge, 2010
4	An Introduction to Quantum Computing, P Kaye, R Laflamme and M Mosca, Oxford University Press
5	Learn Quantum Computing with Python and IBM Quantum Experience, A hands-on introduction to quantum computing and writing your own quantum programs with Python, Robert Loredo, Packt Publishing
6	Quantum Communications and Cryptography,Edited By Alexander V. Sergienko, Routledge, Taylor & Francis
7	Elements of Quantum Computation and Quantum Communication, By Anirban Pathak,Routledge, Taylor & Francis
Reference Books:	
1	Quantum Computing and Techniques, Rajiv Chopra, Khanna Publishing House, 2024
2	Principles of Quantum Computation and Information, Vol. I: Basic Concepts, Vol II: Basic T ools and Special Topics, World Scientific.
3	An Introduction to Quantum Computing, Pittenger, Birkhauser Verlag AG
4	Quantum error Correction - Frank Gaitan"Quantum Computing" by N. S. Kumar (Tata McGraw-Hill Education)
E Resources	
	Learn Quantum Computation Using Qiskit" https://qiskit.org/learn/ 20235.
	https://onlinecourses.nptel.ac.in/noc21_cs103/preview
	https://archive.nptel.ac.in/courses/115/101/115101092/

Internal Assessment:

1) Assessment consists of one Mid Term Test of 20 marks and Continuous Assessment of 20 marks.
2) Mid Term test is to be conducted when approx. 50% syllabus is completed.
3) Duration of the midterm test shall be one hour.

Continuous Assessment:

Continuous Assessment is of **20 marks**. The rubrics for assessment will be considered on approval by the subject teachers. The rubrics can be any 2 or max 4 of the following:

Sr. No	Rubrics	Marks
1	Certificate course for 4 weeks or more: NPTEL/ Coursera/ Udemy/any MOOC	10 marks

2	Content beyond syllabus presentation	10 marks
3	Mini Project / Extra Experiments/ Virtual Lab	10 marks
4	Assignment test/Tutorials etc	10 marks
5	Participation in event/workshop/talk / competition followed by small report and certificate of participation relevant to the subject (in other institutes)	05 marks
6	Multiple Choice Questions (Quiz)	05 marks

End Semester Theory Examination:	
1	Question paper will be of 60 marks.
2	Question paper will have a total of five questions.
3	All questions have equal weightage and carry 20 marks each.
4	Any three questions out of five need to be solved.

QUANTUM CIRCUITS AND ALGORITHMS LAB

Course Code	Course Name	Examination Scheme					
		Theory			Term Work	Oral	Total
		Internal Assessment		End Sem Exam			
		Mid-Term Test	CA				
	Quantum Circuits And Algorithms	-	-	-	25	25	50

Sr. No.	Learning Objectives
1	Implement key quantum algorithms: Deutsch–Jozsa, Shor, Simon's, and Grover's algorithm.
2	Understand their computational advantage over classical counterparts.
3	Analyze quantum speed-up and algorithmic efficiency.
4	Apply quantum computing concepts to real-world problems through a mini-project.
Sr. No	**Learning Outcomes**
1	Students will write and execute quantum programs to solve problems using Deutsch-Jozsa, Shor's, Simon's, and Grover's algorithms.
2	Students will compare classical and quantum runtimes for specific problems.
3	Students will analyze quantum algorithm outputs to validate efficiency.
4	Students will develop a mini-project demonstrating application of quantum computing to a real-world problem (e.g., cybersecurity, finance, weather forecasting).

Suggested list of experiments

1	Qiskit/Cirq for quantum programming
	Single-Qubit Gates: Implementation of **Pauli Gates** (X, Y, Z) and their effects on qubits.

	Hadamard Gate (H): Creating superposition. **Phase Gates (S, T)**: Understanding phase shifts. **Identity Gate (I)**: Checking qubit stability.
2	**Multi-Qubit Gates:** **CNOT (Controlled-NOT) Gate**: Testing quantum entanglement. **Toffoli Gate**: Implementation of classical AND in quantum systems. **Swap Gate**: Exchanging two qubit states. **Fredkin Gate**: Quantum-controlled swap.
3	**Entanglement and Measurement Experiments:** Bell State Generation (Using Hadamard + CNOT). GHZ State (Three-qubit entanglement). Measurement in different bases (Computational and Hadamard basis).
4	Write a program to implement **Deutsch's-Jozsa algorithm :** Identifying constant vs. balanced functions.
6	Write a program to implement **Shor factorization technique** to factor large numbers exponentially faster.
7	Write a program to implement **Simon's Algorithm** to detect periodic patterns faster than classical methods.
8	Write a program to implement **Grover search technique** for quadratic speed-up in searching an unsorted database.
9	Prepare case study for any suitable application on quantum encryption methods for Cyber security/ financial modeling/ traffic optimization/weather forecasting and climate change etc. **(Mini project)**

Term Work	
1	**Lab work: Total 6 experiments out of 8 are to be submitted as a part of TW submission and Mini project.**
2	The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
3	Total 25 Marks (Experiments: 15-marks, Term work Assessment: 10-marks)

Practical & Oral Exam	
1	Based on the subject and related lab of Data Structures Theory and Lab, Total 25 Marks

Honors by Research

Rules and Regulations

Rules and Regulations

Students_Honours by Research

The **"Honours with Research"** is a **4-year undergraduate degree** that includes a **major research project or dissertation** in the third and fourth year. It allows academically strong students to dive deeper into their subject of interest, preparing them for research careers or direct entry into doctoral programs.

Objectives of the "Honours with Research" Track

- Promote **early research orientation** in undergraduate education.
- Foster **independent thinking** and **analytical skills**.
- Build a **pipeline of researchers and innovators**.
- Make graduates **internationally competitive**.

Key Features

To obtain a **B.E./B.Tech. (Honours with Research)** degree:

Feature	**Details**
Duration	2 year full time (four semesters.)
Fees structure	Rs. 20,000/- for the entire course.
Academic Requirement **CGPA Requirement**	1. Must have passed all courses from semesters 1 to 4. 2. Minimum **7.0 CGPA** by end of second year(IVth sem) 3. Minimum **7.0 CGPA has to be maintained for 5th and 6th semester also.**
Research Requirement	A full research project/thesis in the 3rd and 4th year earning an additional **18 credits** supervised by an academic Final written thesis (~10,000–20,000 words depending on the field).
Eligibility	1.Only those meeting academic criteria (CGPA, subject credits) can opt-in
Methodology	1.On the said date , SOP for the problem identified must reach the HOD of the respective department . 2.Screening of the said problem statement would be done for the problem statements received at the institute level. 3. Final list would then be shared with the students
Important note	**1.Honours by research project has to be different from the regular project** **2.This project would span a total for 4 semesters.**

Key Guidelines

- Research should be conducted in collaboration with an institute of eminence or with a research organization or internal research work with very high intrinsic value.
- Must be conducted under supervision of VESIT internal faculty
- Encouraged to align with ongoing institutional research or societal/industrial needs.
- Research should reflect originality, problem-solving, and application of domain knowledge. The research should adhere to plagiarism and ethics standards

b. Timeline (Initiated in 5th semester - 8th Semester)

- **Semester 5: 4 credits**
  - Finalize topic & research guide
  - Submit proposal & begin initial work
  - Literature review
  - **Termwork : 50 marks - Presentation and oral : 50 marks**
- **Semester 6: 5 credits**
  - **Methodology Design**
  - **Initiation of implementation**
  - Midterm review
  - Submit progress report
  - **Termwork : 50 marks , Presentation and oral : 100 marks**
- **Semester 7: 4 credits**
  - **Complete experimental/simulation work**
  - Submit progress report
  - **Termwork : 50 marks , Presentation and oral : 50 marks**
- **Semester 8: 5 credits**
  - **Research Publications/Patent/Product**
  - Final report submission
  - Oral defense (viva)
  - **Termwork : 50 marks, Presentation and oral : 100 marks**

a. Term work Component :-

It focuses on regular work, engagement and quality of research development.

Components of Term Work (Total: 50 Marks or Equivalent Credits)

Component	Description
Research Proposal	Problem identification, literature review, objectives
Literature Review	Depth, currency, relevance, proper citations
Methodology Design	Clarity in experimental setup or analytical framework
Implementation Work	Coding, simulation, modeling, or lab work
Innovation/Originality	Novelty of approach or findings, critical thinking
Progress Reports	Monthly or bi-monthly updates, mentor feedback
Documentation Quality	Interim reports, thesis structure, formatting
Presentation & Viva	Mid-term and final evaluation by a panel
Logbook/Research Diary	Record of weekly progress, meetings, and reflections
Ethics & Plagiarism	Ethical standards, plagiarism check compliance (e.g.,<10%)

Suggested Assessment Tools:

Criteria	Excellent (4)	Good (3)	Satisfactory (2)	Needs Improvement (1)
Research Proposal	Clear, original, well-structured	Relevant and clear	Adequate, lacks depth	Vague, lacks direction
Literature Review	Comprehensive, current	Good coverage	Limited sources	Incomplete or irrelevant
Methodology	Well-designed and justified	Good design	Basic approach	Inadequate or unclear
Implementation	Thorough and accurate	Complete	Partially Complete	Incomplete or flawed
Progress & Commitment	Regular updates, highly engaged	Good progress	Irregular effort	Lacks consistency
Report Quality	Clear, well-structured, properly cited	Well-written	Some structure issues	Poorly organized
Presentation & Viva	Confident, clear, responsive	Clear and adequate	Lacks clarity	Unclear or unprepared
Research Diary / Logbook	Detailed and consistent	Complete	Some missing entries	Not maintained

Scoring Guide:

- Total Score (out of 50/100)
- Grades:
  O (95-100), **A** (85-94), **B** (75–84), **C** (60–74), **D** (<60)

Other Rules :-

- Strict deadlines for thesis submission.
- Academic integrity and ethical research compliance.
- You may be required to attend seminars or research training workshops.