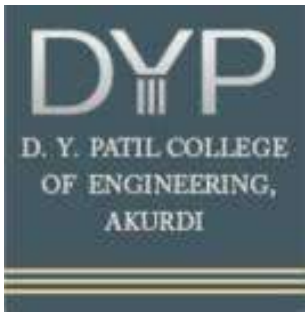
D Y Patil College of Engineering, Akurdi, Pune

An Autonomous Institute from AY2024-25, Affiliated to Savitribai Phule Pune University, Pune

Department of Computer Engineering

T. Y B Tech Curriculum

Semester V/VI (2024 Pattern)



(With effect from Academic Year 2026-2027)

Preface

D Y Patil College of Engineering, Akurdi, Pune (DYPCOE) has been recognized for providing quality education in Maharashtra for the past 40 years. With a commitment to academic excellence and a vision for the future, DYPCOE has now boarded a new journey towards Autonomy, in line with the latest educational reforms. The Institute is dedicated to the effective implementation of the New Education Policy (NEP) 2020, as per the guidelines by the Government of Maharashtra. This initiative is aimed at fostering the holistic development of our students, ensuring they are well-equipped to meet the challenges of the 21st century.

The present Curriculum of the Third Year Engineering (TY), is meticulously designed to align with the NEP 2020 and is effective from the academic year 2026-27. The curriculum is structured to provide a vast knowledge base by including various elective tracks through which the students can focus on their area of interest and excel in the same.

The Core Courses are included in a manner that the students don't miss the vital concepts of Computing. The preparedness of the students towards employability is also catered to.

The development of this curriculum has been a collaborative effort, and we owe a debt of gratitude to all those who have contributed to its creation. Our sincere thanks to the Management, Steering Committee Members, Heads of Departments, and the Board of Studies members for their invaluable input and dedication. Their collective expertise and commitment have been instrumental in shaping this curriculum.

We are confident that this new curriculum will pave the way for our students to achieve academic excellence and holistic development, preparing them to thrive in an ever-evolving global landscape.

Dr. Mrs. P. Malathi

Principal

List of Program Outcomes :

PO1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	**Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WKS)
PO4	**Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.
PO10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) indepe ndent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

List of Abbreviations and Definitions :

NEP: National Education Policy

PEO: Program Educational Objectives

PO: Program Outcomes

PSO: Program Specific Outcomes

CO: Course Outcomes

BSC: Basic Science Courses

ESC: Engineering Science Courses

VSEC: Vocational and Skill Enhancement Courses

AEC: Ability Enhancement Courses

CC: Co-Curricular Courses

IKS: Indian Knowledge System

HSSM: Humanities Social Science and Management

PCC: Program Core Course

CCE: Continuous Comprehensive Evaluation

ESE: End Semester Examination Cr: Credits

L: Lecture T: Tutorial P: Practical

FY: First Year SY: Second Year TY: Third Year BY: Final Year

SL: Self Learning

D Y Patil College of Engineering, Akurdi, Pune

An Autonomous Institute affiliated to Savitribai Phule Pune University

Third Year Computer Engineering TY B Tech Semester V(2024 Course)

Proposed Curriculum Structure

Course Code	Course	Teaching Scheme				Evaluation Scheme						
							Theory Marks			Practical Marks		
		L	T	P	Cr	Exam	Max	Min for Pass		Max	Min for Pass	
CE124PC501	**Data Engineering**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
CE124PC502	**Data Engineering Lab**	0	0	2	1	CCE				50	20	40
						ESE				50	20	
CE124PC503	**Computer Networks & Security**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
CE124PC504	**Computer Networks & Security Lab**	0	0	2	1	CCE				50	20	40
						ESE				50	20	
CE124PC505	**Principles of Programming Languages with JAVA**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
CE124PC506	**JAVA Programming Languages Lab**	0	0	2	1	CCE				50	20	40
						ESE				50	20	
CE124PE507A	**Program Elective Course 1 Advanced Graphics Programming**	3	0	0	3	CCE	50	20	40			
CE124PE507B	**Blockchain Technologies**											
CE124PE507C	**Machine Learning**					ESE	50	20				
CE124PE508A CE124PE508B CE124PE508C	**Advanced Graphics Programming Lab Blockchain Technologies Lab Machine Learning Lab**	0	0	2	1				CCE	50	20	40
									ESE	50	20	
CE124MD509	Multidisciplinary Minor 3 **Machine Learning for Data Science**	4	0	0	4	CCE	50	20	40			
						ESE	50	20				
CE124OE510	Open Elective 3 **Prompt Engineering**	2	0	0	2	CCE	50	20	40			
						ESE	50	20				
CE124NC511	Non Credit Course-5 **Sustainable Technologies and Green Computing**	0	0	2	0	CCE				50	20	
CE124NC512	Non Credit Course -6 **Aptitude and Technical Mastery for Placements-3**	0	0	2	0	CCE				50	20	
	Total	**18**	**0**	**12**	**22**							
				Hrs								
L	Lecture	**Theory**		**18**								
T	Tutorial	**Pract/Lab**		**12**								
P	Practical	**Total**		**30**								
Cr	Credits											
NC	Non Credit Course (Pass/Fail)											
CCE	Continuous and Comprehensive Evaluation											
ESE	End Semester Examination											

D Y Patil College of Engineering, Akurdi, Pune

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Third Year Computer Engineering TY B Tech Semester VI(2024 Course)

Proposed Curriculum Structure

Course Code	Course	Teaching Scheme				Evaluation Scheme						
							Theory Marks			Practical Marks		
		L	T	P	Cr	Exam	Max	Min for Pass		Max	Min for Pass	
CE124PC601	**Artificial Intelligence**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
CE124PC602	**Artificial Intelligence Lab**	0	0	2	1	CCE				50	20	
						ESE				50	20	40
CE124PC603	**Finite Automata and Algorithmic Analysis**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
CE124PC604	**Systems Programming and Operating System**	3	0	0	3	CCE	50	20	40			
						ESE	50	20				
	Program Elective Course 2											
CE124PE605A	**Real Time Operating System**	3	0	0	3	CCE	50	20	40			
CE124PE605B	**Soft Computing**					ESE	50	20				
CE124PE605C	**Game Theory**											
CE124PE606A CE124PE606B CE124PE606C	**Real Time Operating System Lab** **Soft Computing Lab** **Game Theory Lab**	0	0	2	1	CCE				50	20	40
						ESE				50	20	
	Program Elective Course 3											
CE124PE607A	**Computer Vision**	3	0	0	3	CCE	50	20	40			
CE124PE607B	**Advanced Network Systems**					ESE	50	20				
CE124PE607C	**Data Mining and Warehousing**											
CE124PE608A CE124PE608B CE124PE608C	**Computer Vision Lab** **Advanced Network Systems Lab** **Data Mining and Warehousing Lab**	0	0	2	1	CCE				50	20	40
						ESE				50	20	
CE124MD609	Multidisciplinary Minor 4 **Data Science with Python**	2	0	0	2	CCE	50	20	40			
						ESE	50	20				
CE124VS610	Vocational and Skill Enhancement Course 4 **Cyber Security and Data Protection - 2**	1	0	2	2	CCE				100	40	
CE124NC611	Non Credit Course-7 **Human Rights**	0	0	2	0	CCE				50	20	
CE124NC612	Non Credit Course - 8 **Aptitude and Technical Mastery for Placements-4**	0	0	2	0	CCE				50	20	
	Total	**18**	**0**	**12**	**22**							
				Hrs								
L	Lecture	**Theory**		**18**								
T	Tutorial	**Pract/Lab**		**12**								
P	Practical	**Total**		**30**								
Cr	Credits											
NC	Non Credit Course (Pass/Fail)											
CCE	Continuous and Comprehensive Evaluation											
ESE	End Semester Examination											

Semester-V

Course Category	Program Core Course 1	Course Code	CE124PC501
Course Title: Data Engineering			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	**T**	**P**	***SL**	**Cr**	**Exam**	**Max**	**Min Marks for Pass**		**Max**	**Min for Pass**
3	**0**	**0**		**3**	**CCE**	**50**	**20**	**40**	**-**	**-**
Total Hours					**ESE**	**50**	**20**			
39 HOURS	**-**	**-**	**51 HOURS**	**90 HOURS**		**100**				

Prerequisites: Mathematical Foundations of Computer Engg (CE124PC303)and Fundamentals of Data Structures (CE124PC301)	
Course Objectives: 1. To provide a strong foundation in database management systems, relational data models, and ER modelling techniques. 2. To develop the ability to use SQL and PL/SQL for efficient data definition, manipulation, and retrieval. 3. To enable learners to apply normalization and design principles for building optimized and scalable relational databases. 4. To introduce core concepts of Data Science and Big Data relevant to data engineering, including data pre-processing and data wrangling. **5.** To equip students with statistical inference techniques and essential Python libraries for data analysis in data engineering pipelines.	
Course Outcomes: After successful completion of the course, student will be able to	
CO1	**Describe** the architecture and components of database management systems and design
CO2	**Develop** efficient SQL and PL/SQL queries for data definition, manipulation, and retrieval.
CO3	**Apply** normalization techniques to design optimized relational databases
CO4	**Analyse** data using data science concepts, data pre-processing, and data wrangling techniques
CO5	**Apply** statistical inference techniques and Python libraries for data analysis in data engineering pipelines

Unit I	Introduction to DBMS, ER Model & Relational Algebra	8 Hrs

Introduction to Database Systems, Need & Purpose of DBMS, Types of Users, Applications, Data Models & DBMS Architecture , ER Model: Entities, Attributes, Relationships, Keys, ER Diagrams – Basic to Moderate Examples, Converting ER → Tables, Relational Algebra – Basic Concepts: Selection, Projection, Union, Set Difference, Cartesian Product, Simple Join

Case Study: Design an ER diagram for a real-world problem and convert it into relational tables with constraints

Unit II	SQL Fundamentals and PL/SQL Basics	8 hrs

SQL Overview & Advantages, SQL Data Types, DDL, DML, DCL, TCL, Basic & Intermediate SQL Queries, Joins, Aggregate Functions, Simple Subqueries, Views & Indexes (Basics), PL/SQL Basics: Simple Procedures & Functions, Basic Cursors, Simple Triggers

Case Study : Design and manage relational databases using SQL for a real world problem considered in unit I. Create and manipulate database schema using SQL DDL and DML commands and PL/SQL concepts.

Unit III	Relational Database Design & Normalization	8 Hrs

Relational Model: Attributes, Domains, Concept of Good Database Design, Functional Dependencies (basic form), Normal Forms: 1NF, 2NF, 3NF (Simple Examples Only), BCNF (very brief), Simple Decomposition Examples, Introduction to Database Transaction, Transaction states, ACID properties, ACID Vs BASE, Comparative study of RDBMS and NoSQL, MongoDB (with syntax and usage): CRUD Operations, Indexing, Aggregation, MapReduce

Case Study: Normalize the database created in UNIT I case study in the appropriate form

Unit IV	Introduction to Data Science and Big Data	7Hrs

Basics and need of Data Science and Big Data, Application of Data Science, Data explosion, 5 V's of Big Data, Relationship between Data Science and Information Science , Business Intelligence versus data science, Data Science Life Cycle, Data: Data Types, Data Collection. Need of Data Wrangling, Methods: Data Cleaning, Data Integration, Data Reduction, Data Transformation, Data Discretization.

Case Study: Create Corporate performance dataset of Employee of company and perform data pre-processing using techniques of data cleaning and data transformation.

Unit V	Statistical Interference	8 Hrs

Need of statistics in Data science and Big Data Analytics, Measures of Central Tendency: Mean, Median, Mode, Mid range. Measures of Dispersion: Range, Variance, Mean Deviation, Standard Deviation. Bayes Theorem, Basics and Need of hypothesis and hypothesis testing, Pearson Correlation, Sample Hypothesis testing, Chi-Square Test, t-test. Essential Python Libraries

Case Study: For an employee dataset, create measure of central tendency and its measure of dispersion for statistical analysis of given data

Text Books:

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 7th edition
2. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled", Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626
3. David Dietrich, Barry Hiller,"Data Science and Big Data Analytics",EMC Education Services, Wiley Publication, 2012,ISBN: 0-07-120413-X

References Books:

1. C J Date, "An Introduction to Database Systems", Addison-Wesley, ISBN: 0201144719
2. S.K.Singh, "Database Systems: Concepts, Design and Application", Pearson Education,ISBN 978-81-317-6092-5
3. Kristina Chodorow, Michael Dierolf, "MongoDB: The Definitive Guide", O'Reilly Publications, ISBN: 978-1-449-34468-9
4. Adam Fowler, "NoSQL For Dummies", John EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data"
5. DT Editorial Services,"Big Data, Black Book",DT Editorial Services, 2016 Edition,ISBN: 9789351197577
6. Jiawei Han, Micheline Kamber, and Jian Pei,"Data Mining: Concepts and Techniques",Elsevier Publishers, Third Edition, ISBN: 9780123814791, 9780123814807

E-Resources

1. **NPTEL Course on** Data Base Management System by **Prof. Partha Pratim Das** at https://onlinecourses.nptel.ac.in/noc26_cs39/preview
2. **NPTEL Course on** Python for Data Science by **Prof. Ragunathan Rengasamy https://onlinecourses.nptel.ac.in/noc22_cs32/preview**
3. **NPTEL Course on** Data Science for Engineers by **Prof. Ragunathan Rengasamy and Prof. Shankar Narasimha** https://onlinecourses.nptel.ac.in/noc19_cs60/preview

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 2	Course Code	CE124PC502
Course Title: Data Engineering Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Companion Course : Data Engineering **(**CE124PC501)

Course Objectives:

1. To provide hands-on experience in database design using relational schema.
2. To enable students to implement database operations using SQL and PL/SQL.
3. To develop skills in database normalization and transaction management.
4. To introduce NoSQL databases and big data concepts using MongoDB.
5. To apply data science and statistical techniques using Python for real-world data analysis.

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

CO1	Implement SQL queries for given requirements using different SQL concepts.
CO2	Implement PL/SQL code block for given requirement
CO3	Implement NoSQL queries using MongoDB
CO4	Design and develop considering actual requirements and using database concepts
CO5	Apply the principles of Data Science for the analysis of real time problems and data representation using statistical methods

CO	Topic	Assignment 1	2hrs
CO1	**SQL DDL and DML Commands**	**Aim:** To create and manipulate database schema using SQL DDL and DML commands. **Commands Covered:** CREATE, ALTER, DROP, TRUNCATE, INSERT, UPDATE, DELETE, SELECT, INDEX **Outcome:** Ability to design and manage relational databases using SQL.	
		Assignment 2	
CO1	**Joins, Aggregate Functions and Subqueries**	**Aim:** To retrieve and analyse data using joins, aggregate functions, and subqueries. Write schema SQL queries for suitable database applications using SQL DML statements. Note: Instructor will design the queries which demonstrate the use of concepts like all types of Join, Sub-Query and View **Outcome:** Ability to write complex SQL queries for data analysis.	
		Assignment3	
CO2	**Unnamed PL/SQL code block:**	Use of Control structure and Exception handling is mandatory. Suggested Problem statement: Consider Tables: 1. Borrower(Roll_no, Name, DateofIssue, NameofBook, Status) 2. Fine(Roll_no,Date,Amt) • Accept Roll_no and NameofBook from user. • Check the number of days (from date of issue). • If days are between 15 to 30 then the fine amount will be Rs 5per day. • If no. of days>30, per day fine will be Rs 50 per day and for days less than 30, Rs. 5 per day. • After submitting the book, status will change from I to R. • If the condition of fine is true, then details will be stored into fine table. • Also handles the exception by named exception handler or user define exception handler. **Outcome:** Ability to use Control structure and Exception handling in PL/SQL	
		Assignment 4	
CO2	**Cursors**	Write a PL/SQL block of code using internal and external Cursor. Write a PL\SQL block that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped. Use Implicit and Explicit Cursor to retrieve the data from database. **OR** Write a PL/SQL block of code using FOR loop and parameterized Cursor. Write a PL\SQL block that will merge the data available in the newly created table N_RollCall with the data available in the table O_RollCall. If the data in the first table already exist in the second table then that data should be skipped. Using Cursor FOR Loop, Parameterized Cursor retrieve the data from database. **Outcome:** Ability to use types of cursors in PL/SQL	
		Assignment 5	
CO3	**Database Trigger**	**All Types: Row level and Statement level triggers, Before and After Triggers.** Write a database trigger on Library table. The System should keep track of the records that are being updated or deleted. The old value of updated or deleted records should be added in Library Audit table. **Outcome:** Ability to use all types of triggers in PL/SQL	
		Assignment 6	
CO3	**MongoDB CRUD Operations and**	Aim: Perform CRUD operations Using MongoDB **OR** Perform CRUD operation and aggregation using MongoDB	

	Aggregation	**Outcome:** Practical exposure to NoSQL databases and schema-less data models**.**
		Assignment 7
CO4	Database Connectivity	**Aim:** To perform connecting frontend with the database. Write a program to implement MySQL/Oracle/MongoDB database connectivity with Python/Java language as front end to implement Database navigation operations like Create database, create table, insert data, retrieve data, search ,delete and update. **Outcome:** Ability to perform database connectivity with front-end
		Assignment 8
CO5	Data Cleaning, Integration and Transformation	**Aim:** To perform data wrangling operations on raw datasets. **Methods Covered:** Handling missing values, data integration, data transformation Perform the following operations using Python on any open source dataset (e.g., data.csv) 1. Import all the required Python Libraries. 2. Locate an open source data from the web (e.g., https://www.kaggle.com). Provide a clear description of the data and its source (i.e., URL of the web site). 3. Load the Dataset into Pandas data frame. 4. Data Pre-processing: check for missing values in the data using pandas isnull(), describe() function to get some initial statistics. Provide variable descriptions. Types of variables etc. Check the dimensions of the data frame. 5. Data Formatting and Data Normalization: Summarize the types of variables by checking the data types (i.e., character, numeric, integer, factor, and logical) of the variables in the data set. If variables are not in the correct data type, apply proper type conversions. 6. Turn categorical variables into quantitative variables in Python. In addition to the codes and outputs, explain every operation that you do in the above steps and explain everything that you do to import/read/scrape the data set. **Outcome:** Ability to prepare clean datasets for analysis.
		Assignment 9
CO5	Data Reduction and Discretization Techniques Data Wrangling II	**Aim:** To apply data reduction and discretization methods. Create an "Academic performance" dataset of students and perform the following operations using Python. 1. Scan all variables for missing values and inconsistencies. If there are missing values and/or inconsistencies, use any of the suitable techniques to deal with them. 2. Scan all numeric variables for outliers. If there are outliers, use any of the suitable techniques to deal with them. 3. Apply data transformations on at least one of the variables. The purpose of

		this transformation should be one of the following reasons: to change the scale for better understanding of the variable, to convert a non-linear relation into a linear one, or to decrease the skewness and convert the distribution into a normal distribution. Reason and document your approach properly. **Outcome:** Efficient data representation and reduced data complexity.	
		Assignment 10	
CO5	Descriptive Statistics using Python	**Aim:** To compute measures of central tendency and dispersion using Python. **Measures Covered:** Mean, Median, Mode, Variance, Standard Deviation - Measures of Central Tendency and variability Perform the following operations on any open source dataset (e.g., data.csv) 1. Provide summary statistics (mean, median, minimum, maximum, standard deviation) for a dataset (age, income etc.) with numeric variables grouped by one of the qualitative (categorical) variable. For example, if your categorical variable is age groups and quantitative variable is income, then provide summary statistics of income grouped by the age groups. Create a list that contains a numeric value for each response to the categorical variable. 2. Write a Python program to display some basic statistical details like percentile, mean, standard deviation etc. of the species of 'Iris-setosa', 'Iris-versicolor' and 'Iris-versicolor' of iris.csv dataset. Provide the codes with outputs and explain everything that you do in this step. **Outcome:** Perform descriptive statistical analysis on datasets.	
		Mini Project	
CO1, CO2, CO3, CO4, CO5	**Mini Project**	Design and Implement a database management system selecting a real-world problem (e.g. educational institute, hospital, library etc.) **Problem Statement:** Design and implement a database system to manage the domain you have selected as a mini project. **Scope & Modules:** ● ER design ● Conversion to relational schema with constraints ● Normalization at least till 3NF ● Perform DML operation. ● PL/SQL concepts like CURSOR/function/ procedures / triggers for result calculation a possible **Tools: MySQL / PLSQL/Oracle/MongoDB** **Learning Outcome:** Students apply end-to-end DBMS concepts to a real world problem **OR** **Real-World Context:** Select real world organizations analyze transactional and customer data to improve decision-making. **Problem Statement:** Develop a data-driven sales and customer analytics system integrating relational, NoSQL, and analytical components. Data to be driven based	

		on the domain selected by the students along with the required fields. **Scope & Modules:** • Relational database for: Products, Customers, Orders, Payments • MongoDB collections for: Customer interaction logs / browsing history • Data wrangling using Python: Cleaning, transformation, aggregation • Statistical analysis: o Mean sales, variance o Correlation between discounts and sales o Hypothesis testing (t-test / Chi-square) **Tools:** MySQL, MongoDB, Python (Pandas, NumPy, Matplotlib) **Learning Outcome:** Students integrate DBMS + NoSQL + Data Science + Statistics to solve a real business analytics problem.	

Reference Books :

1. Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", McGraw Hill Publishers, ISBN 0-07-120413-X, 7th edition
2. Pramod J. Sadalage and Martin Fowler, "NoSQL Distilled", Addison Wesley, ISBN-10: 0321826620, ISBN-13: 978-0321826626
3. David Dietrich, Barry Hiller,"Data Science and Big Data Analytics",EMC Education Services, Wiley Publication, 2012,ISBN: 0-07-120413-X
1. Wes McKinney, "Python for Data Analysis", O' Reilly media, ISBN : 978-1-449-31979-3.

Web Links:

https://www.simplilearn.com/data-science-vs-big-data-vs-data-analytics-article

MOOC's Link:

4. **NPTEL Course on** Data Base Management System by **Prof. Partha Pratim Das** at https://onlinecourses.nptel.ac.in/noc26_cs39/preview
5. **NPTEL Course on** Python for Data Science by **Prof. Ragunathan Rengasamy https://onlinecourses.nptel.ac.in/noc22_cs32/preview**
6. **NPTEL Course on** Data Science for Engineers by **Prof. Ragunathan Rengasamy and Prof. Shankar Narasimha** https://onlinecourses.nptel.ac.in/noc19_cs60/preview

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 3	Course Code	CE124PC503
Course Title: Computer Networks & Security			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Computer Organization & Architecture (CE124PC304)

Course Objectives:

1. To provide a strong foundation in fundamental concepts, architectures, models, and technologies used in computer networks.
2. To develop an understanding of data link layer functions, error control mechanisms, multiple access protocols, and network devices.
3. To explain the design and working of network layer protocols, addressing mechanisms, routing algorithms, and switching techniques.
4. To introduce transport layer operations including process-to-process delivery, flow control, congestion control, and socket programming.
5. To develop a basic understanding of internet applications and the essential security steps needed for safe communication.

Course Outcomes: After successful completion of the course units the student will

CO1	Describe the fundamental concepts, models, and architectures of computer networks using appropriate terminology
CO2	Explain and analyze data link and MAC layer protocols, error control techniques, and multiple access methods.
CO3	Apply and demonstrate network layer functionalities including addressing, routing algorithms, and switching techniques.
CO4	Examine and compare transport layer protocols, congestion control mechanisms, and socket programming concepts.
CO5	Evaluate and implement network, transport, and application layer security mechanisms to mitigate threats and vulnerabilities.

Syllabus

Unit I	Introduction to Computer Networks	8 Hrs

Definition, **Types of Networks**: Local area networks (LAN), Metropolitan area networks (MAN), Wide area networks (WAN), Wireless networks, Design issues for the layers. **Network Models**: The OSI Reference Model, TCP/IP Model, Network Topologies, Types of Transmission Medium. **Network Architectures**: Client-Server, Peer To Peer, Hybrid. Network Devices, Line Coding Schemes, Frequency Hopping (FHSS) and Direct Sequence Spread Spectrum (DSSS).

Case Study: Smart Campus Network Design

Unit II	Data Link Layer	8 hrs

Introduction, functions, Design Issues of data link layer, ARQ strategies: Error detection and correction, Hamming Codes and CRC. Flow Control Protocols: Unrestricted Simplex, Stop and Wait, Sliding Window Protocol. WAN Connectivity: PPP and HDLC. MAC Sub layer: Multiple Access Protocols: Pure and Slotted ALOHA, CSMA, WDMA, CSMA/CD, CSMA/CA, Binary Exponential Back-off algorithm, Introduction to Ethernet, IEEE 802.3, IEEE 802.11 a/b/g/n, IEEE 802.15 and IEEE 802.16 standards.

Case Study : Reliable Data Transmission in Industrial Networks

Unit III	Network Layer	8 Hrs

Introduction: Functions of Network layer. Switching Techniques: Circuit switching, Message Switching, Packet Switching. IP Protocol: Classes of IP, IPv4, IPv6, Network Address Translation, Sub-netting, CIDR. Network layer Protocols: ARP, RARP, ICMP, IGMP. Network Routing and Algorithms: Static Routing, Dynamic Routing, Distance Vector Routing, Link State Routing, Path Vector. Routing Protocols: RIP, OSPF, BGP, MPLS.

Case Study: NAT Implementation in Corporate Networks

Unit IV	Transport layer	7Hrs

Process to Process Delivery, Sockets services, Socket Programming. Elements of Transport Layer Protocols: Addressing, Connection establishment, Connection release, Flow control and buffering, Multiplexing, Congestion Control. Transport Layer Protocols: TCP and UDP, SCTP, RTP, Congestion control and Quality of Service (QoS), Differentiated services, TCP and UDP for Wireless networks.

Case Study : Online Gaming Network Performance

Unit V	Application layer and Security	8 Hrs

Introduction, Web and HTTP, Web Caching, DNS, Email: SMTP, MIME, POP3, Webmail, FTP, TELNET, DHCP, SNMP.

Introduction, Security services, Need of Security, Key Principles of Security, Threats and Vulnerabilities, Types of Attacks, Security Policy and mechanisms, Operational Model of Network Security, Symmetric and Asymmetric Key Cryptography. Security in Network, Transport and Application: Introduction of IPSec, SSL, HTTPS, S/MIME, Overview of IDS

and Firewalls

Case Study: Man-in-the-Middle Attack on Public Wi-Fi

Text Books

[1]Data Communications and Networking – Behrouz A. Forouzan, 6th Edition, McGraw Hill, 2022.

[2] Computer Networks – Andrew S. Tanenbaum and David J. Wetherall, 6th Edition, Pearson, 2021.

[3] Cryptography and Network Security: Principles and Practice – William Stallings, 8th Edition, Pearson, 2023

Reference Books

[1] Computer Networking: A Top-Down Approach – James F. Kurose and Keith W. Ross, 8th Edition, Pearson, 2021.

[2] Computer Networks: A Systems Approach – Larry Peterson and Bruce Davie, 6th Edition, Morgan Kaufmann, 2021.

[3] Computer Networks and Internets – Douglas E. Comer, 6th Edition, Pearson.

[4] Cryptography and Information Security – V. K. Pachghare, 4th Edition, PHI Learning.

1. **NPTEL Course on Computer Networks and Internet Protocol by Prof. Soumya Kanti Ghosh and Prof. Sandip Chakraborty available at https://nptel.ac.in/courses/106105183.**
2. **NPTEL Course on Computer Networks by Prof. Sujoy Ghosh available at https://nptel.ac.in/courses/106105081.**
3. **NPTEL Course on Network Security by Prof. Gaurav S. Kasbekar available at https://nptel.ac.in/courses/106106091.**
4. **NPTEL Course on Cryptography and Network Security by Prof. D. Mukhopadhyay available at https://nptel.ac.in/courses/106105031.**

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 4	Course Code	CE124PC504
Course Title: Computer Networks & Security Lab			

Teaching Scheme					Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Data Structures Lab(CE124PC302)

Course Objectives:

1. Understand the architecture, protocols, and mechanisms of computer networks.
2. Apply theoretical concepts to practical scenarios in LAN/WAN setup, routing, and error control.
3. Develop programming skills for implementing network protocols and security mechanisms.
4. Analyze vulnerabilities and simulate attacks in controlled environments to understand defense strategies.
5. Gain hands-on experience with tools like Wireshark, Packet Tracer, and socket programming for real-world applications.

Course Outcomes: After successful completion of the course units the student will

CO1	To Configure LANs and test connectivity using modern tools to demonstrate fundamental networking concepts.
CO2	To Implement error detection, correction, and flow control protocols to ensure reliable data communication.
CO3	Demonstrate network layer operations by implementing IP addressing, subnetting and routing algorithms and protocols in LAN/WAN environments.
CO4	To develop socket programming applications using TCP and UDP for secure and efficient communication services.
CO5	Evaluate application layer protocols and implement network security mechanisms and cryptographic protocols to ensure secure communication in computer networks.

CO	Topic	Assignment 1	2hrs
CO1	LAN Configuration & Connectivity Testing	Configure a wired LAN using a Layer-2 switch and test connectivity using the **PING utility**. Capture and analyze ICMP packets using **Wireshark**.	
		Assignment 2	**2hrs**
CO1	Packet Capture & Protocol Stack Identification	Capture network packets and identify OSI layer protocols using **Wireshark**. Demonstrate different **network topologies and transmission media** using Packet Tracer.	
		Assignment 3	**2hrs**
CO2	Error Detection and Correction	Implement a program for error detection and correction using Hamming Code or CRC for 7/8-bit ASCII codes.	
		Assignment 4	**2hrs**
CO2	Sliding Window Protocols	Write a program to demonstrate Sub-netting and find subnet masks.	
		Assignment 5	**2hrs**
CO3	Routing and Subnetting	Write a program to demonstrate **subnetting and subnet mask calculation** and analyze routing paths using the **Traceroute utility**.	
		Assignment 6	**2hrs**
CO3	Address Resolution Protocol	Simulate the **ARP protocol** in a LAN network to map IP addresses to MAC addresses using **ARP Request and ARP Reply messages**	
		Assignment 7	**2hrs**
CO4	TCP Socket Programming	Develop TCP socket-based programs for the following applications: (1) Hello message exchange, (2) File transfer, and (3) Client-Server calculator.	
		Assignment 8	**2hrs**

CO4	UDP Socket Programming	Implement **UDP socket programming** to transfer different file types (script, text, audio, video) between two machines.	
		Assignment 9	**2hrs**
CO5	Network Attacks and Vulnerability Analysis	To simulate common network attacks and identify vulnerabilities using monitoring and analysis tools in a controlled LAN environment.	
		Assignment 10	**2hrs**
CO5	Simulation and Analysis of Domain Name System (DNS) Protocol	To simulate the working of the **Domain Name System (DNS)** protocol and analyze the process of **domain name resolution from domain name to IP address** using network simulation and packet analysis tools.	
		Assignment 11	**2hrs**
CO5	IPsec Security Protocol	Study **IPsec protocols (ESP and AH)** by capturing and analyzing packets using the Wireshark tool	

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 5	Course Code	CE124PC505
Course Title: Principles of Programming Languages with JAVA			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Programming and Problem Solving (ESC2401L08)

Course Objectives:

1. Analyze core Java constructs to design efficient modular programs.
2. Evaluate OOP principles to architect scalable Java applications.
3. Develop robust solutions using exceptions, packages, and file handling.
4. Optimize data-intensive applications using collections and generics
5. Create optimized, concurrent applications using collections and modern Java features.

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

CO1	Apply core concepts like control flow, array operations, and foundational I/O mechanisms in modular Java programing.
CO2	Design object-oriented systems using inheritance, polymorphism, interfaces, and abstraction.
CO3	Develop resilient Java applications by integrating exception hierarchies, custom exceptions, packages, and file-handling systems.
CO4	Optimize data-intensive applications using collections, generics, and functional constructs
CO5	Create scalable and robust Java applications using concurrency, coding standards, testing, and JDBC.

Syllabus

Unit I	Core Java Foundations	8 Hrs
Java Overview: Evolution of Java, JVM, JDK, JRE Platform independence, bytecode, WORA philosophy Basic Java Syntax: Variables, data types (primitive & reference), type conversion Operators and expressions Control Flow ,Decision making: if/else, switch (including modern switch expressions), Loops: for, while, do-while , Arrays & Strings: 1D & 2D arrays, String vs StringBuilder vs StringBuffer ,Introduction to Java Modules (JDK 9+) Basic idea of modularity, simple module declarations, Input/Output Basics Console input using Scanner Printing, formatting output **Case Study:** Implement a console-based Student Management System to demonstrate fundamental programming concepts.		
Unit II	**Object-Oriented Programming in Java**	**8 hrs**
Classes & Objects: Fields, methods, constructors, Method overloading Encapsulation: Access modifiers, getter/setter standards Static Members & the 'this' Keyword, Inheritance: Single & multilevel, super keyword Constructor chaining, Polymorphism: Overriding, dynamic method dispatch, Abstract Classes & Interfaces: Interface evolution (default & static methods) **Case Study:** Develop a Java application for managing employee records to illustrate object-oriented concepts.		
Unit III	**Advanced OOP, Exception Handling, and File I/O**	**8 Hrs**
Packages & Access Control: Creating and using packages CLASSPATH basics Inner & Nested Classes: Static inner class, local classes, anonymous classes, Exception Handling: Types of exceptions, try-catch-finally, checked vs unchecked exceptions, Custom exceptions, best practices, File Handling: Byte streams, character streams Buffered Streams Reading/writing text & binary files **Case Study:** Create a Java program that illustrates custom exceptions		
Unit IV	**Collections, Generics & Functional Java**	**7Hrs**
Java Collections Framework: Collection hierarchy List, Set, Map, Queue Common Implementations: ArrayList, LinkedList, HashSet, TreeSet HashMap, TreeMap, LinkedHashMap, Generics: Generic classes & methods, Utility Libraries: Arrays, Collections helper methods Sorting and searching with Comparators **Case Study:** Smart Scheduling with Priority Queue in various applications		
Unit V	**Concurrency, Best Practices & Introduction to JDBC**	**7 Hrs**
Thread Fundamentals: Thread class, Runnable interface Thread states & lifecycle Synchronization & Inter-Thread Communication: Locks, synchronized keyword wait/notify (classic concurrency), Concurrency Java coding standards and documentation (Javadoc) Introduction to Real-world Java Development: Intro to JUnit testing, Introduction to JDBC Using Java in: cloud, microservices, big data, enterprise apps Introduction to Real-world Java Development: Intro to JUnit testing, Introduction to JDBC Using Java in: cloud, micro services, big data, enterprise apps **Case Study:** Implement a solution in Java showcasing the use of JDBC, unit testing		

Text Books:

1. Java: The complete reference, by Herbert Schildt, Dr. Danny Coward ,13th Edition , Jan 2024, ISBN: 9781265062705 , McGraw Hill Professional

2. Programming with Java by E Balagurusamy, McGraw Hill Education, 2019,6th Edition, ISBN: 9353162335, 9789353162337

References Books:

1. Core Java Volume I – Fundamentals – Cay S. Horstmann (detailed core Java concepts), 12th Edition 21 Dec 2021, ISBN-13 : 978-0137673629 by Oracle Pr

2. Java Concurrency in Practice – Brian Goetz, Tim Peierls, Doug Lea, David Holmes, Joshua Bloch, Joseph Bowbeer (in-depth concurrency) ,13th Edition ,ISBN 0-321-34960-1 by Addison-Wesley Professional.

E Resources:

Programming in Java, by Prof. Debasis Samanta available at https://onlinecourses.nptel.ac.in/noc26_cs36/preview

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

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Course Category	Program Core Course 6	Course Code	CE124PC506
Course Title: JAVA Programming Languages Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Object Oriented Programming using C++ (CPE2402L01)	
Course Objectives: 1. Apply arrays, loops, and conditional statements to solve programming problems. 2. Develop basic Java applications using classes and object-oriented principles. 3. Construct applications utilizing file handling and collection frameworks. 4. Implement functional-style programs using streams 5. Design and develop multithreaded Java applications for concurrent execution.	
Course Outcomes: After successful completion of the course the student will be able to	
CO1	Implement array, loops and conditional statements
CO2	Build basic applications using java class
CO3	Design applications using files and collection classes
CO4	Create applications streams .
CO5	Design multithreading application

CO	Topic	Assignment 1
CO1	Personal Finance Tracker Application	Implement an expense tracker that allows users to enter expenses under categories such as food, travel, shopping, etc. Use **arrays/loops/conditionals** to: • Store daily expenses • Display category-wise totals • Identify the highest and lowest expense days • Provide a menu-driven interface
		Assignment 2
CO1	Student Marks Analyzer System	Create a program that helps manage and analyze students' marks across different subjects. Use **arrays/loops/conditionals wherever applicable**
		Assignment 3
CO2	Student Grade Management System	Build a program with a Student **class** to store marks in multiple subjects. The system must: • Calculate total, average, and grade • Accept details for multiple students • Display a ranked list based on performance
		Assignment 4
CO2	Vehicle Rental System using Interface	Create a base class Vehicle with subclasses Car, Bike, and Truck. Implement Rentable **interface** with a calculate Rent (hours) method. The system should: • Compute rent for each vehicle type • Generate a customer invoice
		Assignment 5
CO3	Hospital Patient Record Manager with File Handling	Design a system to manage patient records using **Exception Handling.** The program should: • Add and validate patient data • Raise custom exceptions (e.g., invalid age) • Store records in a file • Read and display records from the file • Use try-with-resources for file safety
		Assignment 6
CO3	Employee Data Insights Engine using Streams	Develop a data analytics module for employee records. **Use Streams** to: • Compute average salary per department • Identify departments with highest / lowest headcount • Filter employees by salary threshold
		Assignment 7
CO4	Smart Inventory Manager using Collections & Generics	Develop an Inventory Management System to handle products with id, name, quantity, and price. The application must: • Add, update, delete items • Sort items by price or quantity • Search items by name • Use Collections and Generics
		Assignment 8

CO4	Online Movie Rating Analyzer using Collections	Create a Movie Analyzer application using **Collections** to store movie title, genre, rating & year. The system should: • Sort movies by rating or year • Filter movies by genre • Find the highest-rated movie in each genre • Display results using formatted output
		Assignment 9
CO5	Smart Banking Simulator using Multithreading	Implement a banking simulation with multiple customer **threads** operating on a shared Bank Account. • Perform deposit/withdraw operations • Protect balance using synchronization • Compare results with and without synchronization
		Assignment 10
CO5	Real-Time Auction Processing System using Modern Concurrency	Design a **concurrent** auction system where multiple bidders place bids in parallel. The program must: • Process each bid using executor pool or virtual threads • Maintain a thread-safe collection of bids • Identify winning bid dynamically • Log timestamped bids
		Assignment 11
CO1, CO2, CO3, CO4, CO5	Integrated Mini Project	Students will build a complete real-world mini application. The project should include: • Packages & modular structure • File storage or serialization • Streams-based data analytics • Multi-threaded background operations (auto-save, notifications) • Exception handling & clean code practices Students will build a complete real-world mini application such as: 1.Library Management System 2.Hostel Room Booking System 3.Food Delivery Simulation 4.Inventory + Billing Console System 5.Simple Banking & Loan Approval System Any one of this miniproject is compulsory but not limited to this.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course	Course Code	
Course Title: Advanced Graphics Programming			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	**T**	**P**	***SL**	**Cr**	**Exam**	**Max**	**Min Marks for Pass**		**Max**	**Min for Pass**
3	**0**	**0**		**3**	**CCE**	**50**	**20**	**40**	**-**	**-**
Total Hours					**ESE**	**50**	**20**			
39 HOURS	**-**	**-**	**51 HOURS**	**90 HOURS**		**100**				

Prerequisites: Basic knowledge of C/C++ or Python

Course Objectives:

1. Understand the fundamental concepts of computer graphics, including the graphics pipeline, geometric transformations, and basic drawing algorithms.
2. Apply 2D and 3D graphics techniques such as projections, lighting models, shading, and rendering methods.
3. Explore advanced topics like rendering techniques, animation principles, and 3D modeling concepts.
4. Develop a strong foundation in UI/UX design, including visual design, interaction design, and usability principles.
5. Use industry-standard UI/UX tools to design, prototype, and evaluate user interfaces effectively.

Course Outcomes: After successful completion of the course units the student will

CO1	Explain the fundamentals of computer graphics, graphics pipeline stages, coordinate systems, and 2D transformations.
CO2	Implement line, circle, and ellipse drawing algorithms and apply viewing and clipping techniques.
CO3	Apply 3D transformations, projections, lighting, and shading models for realistic rendering.

CO4	Develop basic graphics applications using OpenGL and write vertex and fragment shaders.
CO5	Analyze and apply advanced rendering techniques, texture mapping, curves, surfaces, and basic animation methods.

Syllabus

Unit I	**Computer Graphics Fundamentals**	**8 Hrs**

Overview of computer graphics, Graphics pipeline & rendering stages, Coordinate systems and transformations, 2D transformations: translation, rotation, scaling, Viewing & clipping, Line, circle, ellipse drawing algorithms (DDA, Bresenham)

Case study: 2D Transformations in Graphic Design Software (Analysis of how **translation, rotation, and scaling** are implemented in software like **Adobe Photoshop** and **CorelDRAW)**

Unit II	**3D Graphics & OpenGL Programming**	**8 hrs**

3D transformations (rotation, scaling, translation), Projection: orthographic & perspective, Hidden surface removal, lighting models (Phong, Gouraud), Shading techniques, Introduction to OpenGL (legacy + modern pipeline), Shader programming (vertex & fragment shaders)

Case Study: Projection Techniques in 3D Graphics (Analysis of **orthographic and perspective projection** used in CAD software such as **AutoCAD** to represent 3D objects on a 2D screen.)

Unit III	**Advanced Rendering & Animation**	**8 hrs**

Texture mapping, Anti-aliasing, Curves & surfaces (Bezier, B-splines), Ray tracing basics, 3D models & mesh representation, Keyframe animation fundamentals, Motion & physics-based animation basics

Case Study: Bezier and B-Spline Curves in Graphic Design (Case study of how **Bezier curves and B-splines** are used in vector graphics software like **Adobe Illustrator** for smooth curve creation.)

Unit IV	**UI/UX Foundations**	**7Hrs**

Principles of good design, Visual hierarchy & layout systems, Color theory & typography, Design heuristics (Nielsen's 10 principles), Interaction design (IxD), User flows, site maps, information architecture, Wireframes (low-fidelity & high-fidelity)

Case Study: Color Theory and Typography in Brand Identity (Analysis of how companies such as **Google** and **Spotify** use color schemes and typography to create recognizable user interfaces.)

Unit V	**UI/UX Design**	**8 Hrs**

Component libraries and responsive design, Prototyping: static + interactive, User testing & usability evaluation, Accessibility (WCAG basics), UI design workflow: Research → Wireframe → Prototype → Testing, Mini-project: end-to-end UI design for an app or website

Case Study: Study and Application of UI/UX Design Tools (Figma, Adobe XD, Sketch)

Text Books:

1. Hearn, D., & Baker, M. P. (2011). *Computer Graphics with OpenGL* (4th ed.). Pearson Education.
2. Angel, E., & Shreiner, D. (2014). *Interactive Computer Graphics: A Top-Down Approach with OpenGL* (6th ed.). Pearson.
3. Watt, A. (2000). *3D Computer Graphics* (3rd ed.). Addison-Wesley.

Reference Books:

1. The Design of Everyday Things – Don Norman (2013). Revised and Expanded Edition. Basic Books.
2. Fundamentals of Computer Graphics – Steve Marschner & Peter Shirley (2016). 4th Edition. A K Peters / CRC Press.

E-Resources:

NPTEL Course – Computer Graphics by Prof. Samit Bhattacharya available at **https://onlinecourses.nptel.ac.in/noc24_cs82/preview**

Course Category	Program Elective Course 1	Course Code:	CE124PE507B
Course Title: Blockchain Technologies			

Teaching Scheme					Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: **Computer Networks & Security [CE124PC503]**

Course Objectives:

1. To provide a clear understanding of how blockchain technology evolved and how its architecture and types support applications across various domains.
2. To build foundational knowledge of cryptographic methods, digital signatures, and consensus mechanisms that enable secure and reliable blockchain networks.
3. To develop the ability to understand major cryptocurrency systems and the Ethereum ecosystem, including smart contracts and token standards used in real blockchain applications.
4. To introduce learners to different blockchain platforms and development tools to help them explore decentralized application development and Web3 environments.
5. To strengthen the learner's ability to examine privacy features, security issues, scalability methods, and regulatory aspects that shape modern blockchain systems.

Course Outcomes: After successful completion of the course units the student will:

CO1	Explain the evolution, architecture, and types of blockchain systems and identify their applications in different domains.
CO2	Apply cryptographic hash functions, digital signatures, and consensus protocols to understand secure blockchain operations.
CO3	Apply the concepts of cryptocurrencies, Ethereum architecture, smart contracts, and token standards to analyze how blockchain-based transactions and applications function.
CO4	Compare blockchain platforms and use suitable tools to understand DApp development and Web3 components.
CO5	Analyze privacy mechanisms, security threats, scalability solutions, and regulatory factors to determine their influence on blockchain systems.

Syllabus

Unit I	Fundamentals of Block chain	8 Hrs
Introduction to Blockchain, Evolution of Blockchain, Characteristics: decentralization, transparency, immutability; Blockchain architecture: blocks, transactions, nodes; Types of blockchain: Public, Private, Consortium, Hybrid; Distributed Ledger Technology (DLT), Applications in various domains (Finance, Healthcare, Supply Chain, Government). **Case Study:Blockchain in Financial Services – Cross-Border Payments**		
Unit II	**Cryptography & Blockchain Mechanics**	**8 Hrs**
Introduction to Cryptography: Cryptographic Hash Functions, SHA256, Hash Pointers and Data Structures, Merkle tree, Patricia Tree; Digital Signatures: Elliptic Curve Digital Signature Algorithm (ECDSA), Public-key infrastructure & key management; Centralization vs. Decentralization; Distributed Consensus, Consensus without identity using a block chain; Network protocols, mining & block validation process. **Case Study: Bitcoin Transaction Verification Process**		
Unit III	**Cryptocurrencies & Ethereum Ecosystem**	**8 Hrs**
Introduction to cryptocurrencies, Bitcoin: architecture, UTXO model, mining process; Ethereum: Architecture, Ethereum Virtual Machine, Wallets for Ethereum; Smart contracts: concept & lifecycle, Attacks on smart contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, Comparing Bitcoin scripting vs. Ethereum Smart Contracts; Overview of Solidity programming , Token standards: ERC-20, ERC-721, ERC-1155. **Case Study: Smart Contract-Based Crowdfunding on Ethereum**		
Unit IV	**Blockchain Platforms, Hyperledger, Web3 & Applications**	**7 Hrs**
Blockchain platforms: Ethereum and Hyperledger Fabric, Corda; DApps: architecture & development overview; Web3 tools: Web3.js, Ethers.js; DeFi overview: DEX, AMM, yield farming; NFTs and real-world use-cases; Enterprise applications of blockchain (Supply chain, Finance, Insurance) **Case Study:Supply Chain Management using Hyperledger Fabric**		
Unit V	**Privacy, Security issues, Scalability & Future Trends**	**8 Hrs**
Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation; Attacks on Blockchains: Sybil attacks, Selfish mining, 51% attacks, Double-spending, Smart contract vulnerabilities; Layer-2 scaling: Sidechains, State Channels, ZK-Rollups, Optimistic Rollups; Interoperability: Polkadot, Cosmos; Current research trends; Ethical, legal & regulatory considerations in Blockchain technology. **Case Study:Privacy Enhancement using Zcash & zk-SNARKs**		

Text Books:

1. Kevin Werbach, The Blockchain and the new architecture of trust, MIT Press, 2018.
2. Joseph J. Bambara and Paul R. Allen, Blockchain – A practical guide to developing business, law, and technology solutions, Tata McGraw-Hill Education, 2018.

References Books:

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, and S. Goldfeder, *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction*. Princeton, NJ, USA: Princeton University Press, 2016.
2. J. Thompson, *Blockchain: The Blockchain for Beginners, Guide to Blockchain Technology and Blockchain Programming*. CreateSpace Independent Publishing Platform, 2017.
3. I. Bashir, *Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained*. Birmingham, U.K.: Packt Publishing, 2017.
4. M. Grincalaitis, *Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-Supported Tools, Services, and Protocols*. Birmingham, U.K.: Packt Publishing, 2019.
5. S. Chakraborty and P. Jayachandran, *Blockchain Architecture Design and Use Cases*. Springer, 2018.

E-resources: 1. NPTEL Course - Introduction to Block Chain technology and Application by Prof. Sandeep Shukla available at https://nptel.ac.in/courses/106104220

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Elective Course 1	Course Code:	CE124PE507C
Course Title: Machine Learning			

Teaching Scheme					Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites:

1. Linear Algebra and Differential Calculus(BSC2401L09),
2. Mathematical Foundations of Computer Engineering(CE124PC303)

Course Objectives:

1. To build strong foundations in Machine Learning concepts and mathematical models.
2. To apply data preprocessing and visualization techniques for intelligent analysis.
3. To design and implement supervised and unsupervised learning algorithms.
4. To learn Generative AI, Transformer-based Large Language Models (LLMs), TinyML and Edge AI.

Course Outcomes: After successful completion of the course units, the student will:

CO1	Understand and apply Machine Learning concepts for real time applications.
CO2	Apply various data pre-processing techniques to simplify and speed up machine learning algorithms.
CO3	Apply and analyse supervised learning algorithms for various applications.
CO4	Apply unsupervised and probabilistic learning models for data analysis.
CO5	Analyze and Compare Generative AI, LLMs, TinyML and Edge AI solutions.

Syllabus

Unit I	Introduction to Machine Learning	7 Hrs
Introduction to Machine Learning, Evolution of Machine Learning, Types of Learning: Supervised, Unsupervised, Semi-supervised, Reinforcement Learning; Machine Learning workflow; Training vs Testing; Overfitting and Underfitting, Applications of Machine Learning, Challenges and limitations. Case Study- Machine Learning in Healthcare-disease prediction, Medical Image Diagnosis.		
Unit II	**Data Understanding and Visualization**	**8 Hrs**

Data types and attributes, Data preprocessing: cleaning, normalization, handling missing values; Exploratory Data Analysis (EDA); Univariate, Bivariate, and Multivariate analysis; Data visualization techniques; Dimensionality reduction: PCA, LDA.

Case study: Traffic data Analysis: Study and analysis of traffic patterns using collected data to reduce congestion, improve road safety, and optimize traffic management systems.

Unit III	Supervised Learning Techniques	8 Hrs

Similarity-based learning: k-Nearest Neighbors; Linear Regression, Multiple Regression, Logistic Regression; Decision Trees, Random Forests; Model evaluation metrics: Accuracy, Precision, Recall, F1-score, ROC Curve and cross-validation.

Case Study- Social media Sentiment Analysis: Analysis of social media data to identify public opinions, emotions, and trends using data analytics.

Unit IV	Unsupervised and Probabilistic Learning	8 Hrs

Clustering techniques: k-Means, Hierarchical Clustering, DBSCAN; Association Rule Mining; Probability-based models: Naïve Bayes, Bayesian Learning

Case Study- Customer segmentation: Process of dividing customers into groups based on behavior, demographics, or preferences to improve marketing strategies and business decisions.

Unit V	Generative AI and Large Language Models (LLMs)	8 Hrs

Introduction to Generative AI and Foundation Models- Autoencoder; Large Language Models (LLMs): Transformer Architecture, Pre-training, Fine-tuning, TinyML: Concept, Model development, Applications; Edge AI: On-device Intelligence, Federated Learning Basics, Privacy and Security Considerations.

Case Study- Media Content Creation: Process of generating digital content such as text, images, audio, and video using creative tools and AI technologies for communication and engagement.

Text Books:

1. Tom M. Mitchell, Machine Learning, McGraw-Hill, 2017. ISBN: 9781259096952.
2. Ethem Alpaydin, Introduction to Machine Learning, MIT Press 2020. ISBN: 9780262043793

References Books:

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer. 2006, ISBN: 9780387310732
2. Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press. 2012, ISBN: 9780262018029
3. Sebastian Raschka, Machine Learning with PyTorch and Scikit-Learn, Packt Publishing Ltd., 2022, ISBN: 9781801819312
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press 2016. ISBN: 9780262035613

e-Resources

NPTELCourse

1. Introduction to Machine Learning, by Prof. Balaraman Ravindran, available at https://nptel.ac.in/courses/106106139
2. Machine Learning,ML by Prof. Carl Gustaf Jansson, available at https://nptel.ac.in/courses/106106202
3. Introduction to Machine Learning, by Prof. Sudeshna Sarkar, available at https://nptel.ac.in/courses/106105152

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Elective Course 1 Lab	Course Code	CE124PE508A
Course Title: Advanced Graphics Programming Lab			

		Teaching Scheme			Evaluation Scheme						
						Theory Marks			Practical Marks		
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Fundamentals of Programming, Data Structures and Algorithms

Course Objectives: This course aims to build the

1. To understand the basic concepts of computer graphics, coordinate systems, 2D transformations, and fundamental drawing algorithms for creating graphical objects.
2. To learn 3D transformations, projection techniques, hidden surface removal, shading, and lighting models, and implement them using OpenGL and shader programming.
3. To explore advanced graphics concepts including curves and surfaces (Bezier, B-Splines), texture mapping, ray tracing, and animation techniques such as keyframe and physics-based animation.
4. To understand the principles of good design, visual hierarchy, color theory, typography, interaction design, and wireframing for creating effective user interfaces.
5. To develop end-to-end interactive prototypes, conduct usability testing, and apply accessibility standards for creating responsive and user-centered applications

Course Outcomes: After successful completion of the course units the student will

CO1	Apply 2D transformations, viewing, clipping, and basic drawing algorithms (line, circle, ellipse) to create and manipulate graphical objects.
CO2	Implement 3D transformations, projections, and shading techniques using OpenGL, and understand the rendering pipeline for visualizing 3D objects.
CO3	Design and render advanced graphics using curves (Bezier, B-Splines), texture mapping, ray tracing, and keyframe animation for realistic visualization.
CO4	Analyze and design intuitive user interfaces by applying principles of visual hierarchy, color theory, typography, interaction design, and wireframing.
CO5	Develop end-to-end interactive prototypes, conduct usability testing, and apply accessibility standards to create responsive, user-centered applications.

CO	Topic	Assignment 1
CO 1	Computer Graphics Fundamentals	Implement 2D transformations (translation, rotation, scaling) on a 2D object using Python (Pygame) or Java (AWT/Graphics).
		Assignment 2
CO 1	Computer Graphics Fundamentals	Implement line, circle, and ellipse drawing algorithms (DDA and Bresenham) to draw shapes on a 2D grid.
		Assignment 3
CO2	3D Graphics & OpenGL Programming	Apply 3D transformations (translation, rotation, scaling) on a 3D object in OpenGL.
		Assignment 4
CO2	3D Graphics & OpenGL Programming	Implement lighting and shading techniques (Phong and Gouraud) on a 3D object in OpenGL.
		Assignment 5
CO3	Advanced Rendering & Animation	Create Bezier curves and B-Spline curves for smooth shapes in Python (Matplotlib) or OpenGL.
		Assignment 6
CO3	Advanced Rendering & Animation	Apply texture mapping to a 3D object and implement a simple ray tracing program to render a sphere with basic lighting.
		Assignment 7
CO4	UI/UX Foundations	Create a low-fidelity wireframe and user flow for a simple mobile app (e.g., To-Do app).
		Assignment 8
CO4	UI/UX Foundations	Analyze 2 popular apps/websites (e.g., Google, Spotify) for color schemes, typography, and design heuristics. Prepare a report with visual examples.
		Assignment 9
CO5	UI/UX Design	Design an interactive prototype for a small app or website using Figma, Adobe XD, or Sketch. Include navigation, clickable interactions, and responsive layouts.
		Assignment 10
CO5	UI/UX Design	Conduct usability testing on your prototype with at least 3 users. Document issues and improvements. Check for basic accessibility (WCAG) compliance.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Elective Course 1 Lab	Course Code	CE124PE508B
Course Title: Blockchain Technologies Lab			

Teaching Scheme					Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Fundamentals of Data Structures [CE124PC301] , Computer Network Security[CE124PC503]

Course Objectives:

1. To understand the basic concepts and architecture of blockchain technology.
2. To learn cryptographic techniques used in blockchain systems.
3. To explore cryptocurrency transactions and blockchain wallets.
4. To develop and deploy smart contracts using Solidity and Ethereum platforms.
5. To understand decentralized applications (DApps) and real-world blockchain applications.

Course Outcomes: After successful completion of the course units the student will

CO1	Explain the fundamental concepts of blockchain including architecture, types of blockchain networks, and their real-world applications.
CO2	Apply cryptographic techniques such as hash functions and Merkle trees to understand data integrity and security in blockchain systems.
CO3	Demonstrate the use of cryptocurrency wallets and perform blockchain transactions using tools such as MetaMask.
CO4	Develop and deploy smart contracts using Solidity on Ethereum test networks to implement basic decentralized applications.
CO5	Analyze blockchain platforms and design simple decentralized applications to understand practical blockchain implementation.

Programming Tool Recommended		**Javascript, Python, Solidity,Metamask.**
CO	**Topic**	**Assignment 1**
CO1	Installation and Configuration of MetaMask Wallet	Install the MetaMask wallet extension and configure it with an Ethereum test network. Perform a sample Ether transaction and observe the transaction hash, gas fee, and transaction confirmation.
		Assignment 2
CO1	Creating a Cryptocurrency Wallet Using MetaMask	Create a personal wallet using MetaMask and explore wallet functionalities such as account creation, key management, sending and receiving cryptocurrency.
		Assignment 3
CO2	Smart Contract for Bank Account Operations	Write and deploy a smart contract on an Ethereum test network to simulate bank account operations such as deposit money, withdraw money, and display account balance.
		Assignment 4
CO2	Implementation of Student Data Storage Using Solidity	Develop a Solidity program to store student information using structures, arrays, and fallback functions. Deploy the smart contract and observe the transaction fee and gas consumption.
		Assignment 5
CO3	Study of Cryptographic Hash Functions in Blockchain	Study cryptographic hash functions such as SHA-256 and demonstrate how hash values change when input data is modified.
		Assignment 6
CO3	Implementation of Merkle Tree for Transaction Verification	Create a simple Merkle Tree structure using sample transactions and demonstrate how Merkle roots are used to verify transaction integrity in blockchain.
		Assignment 7
CO4	Study of Bitcoin Blockchain Architecture	Study the architecture of Bitcoin including the UTXO model, mining process, block creation, and block validation mechanism.
		Assignment 8
CO4	Study of Ethereum Architecture and Smart Contract Execution	Study Ethereum architecture including Ethereum Virtual Machine (EVM), smart contract lifecycle, and transaction execution process.
		Assignment 9
CO5	Comparative Study of Types of Blockchain Networks	Study different blockchain types such as Public, Private, Consortium, and Hybrid blockchain and analyze their real-world applications.

		Assignment 10
CO 5	Development of a Decentralized Application (dApp) for E-Voting	Design and implement a decentralized voting system using blockchain and smart contracts to ensure secure, transparent, and tamper-proof voting.
	Mini Project	Create a dApp (de-centralized app) for e-voting system or crowdfunding platform or supply chain tracking system (any one).
Virtual Laboratory: https://bc-amrt.vlabs.ac.in/List%20of%20experiments.html		

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Elective Course 1 Lab	Course Code	CE124PE508C
Course Title: Machine Learning Lab			

	Teaching Scheme				Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Advanced Data Structures and Algorithms (CE124PC401)

Course Objectives:

6. **To understand the fundamental concepts of Machine Learning**, its evolution, applications, and different learning paradigms such as supervised, unsupervised, and reinforcement learning.
7. To Understand data preprocessing and exploratory data analysis techniques.
8. **To understand supervised learning algorithms** such as k-Nearest Neighbours, Linear Regression, Decision Tree, and Random Forest for classification and prediction tasks.
9. **To understand unsupervised learning techniques** such as k-Means Clustering and Hierarchical Clustering for discovering patterns in data.
10. **To understand modern AI concepts** including Generative AI, and Large Language Models along with their applications.

Course Outcomes: After successful completion of the course units the student will

CO1	Understand the basic concepts, evolution, and types of Machine Learning including supervised, unsupervised, semi-supervised, and reinforcement learning.
CO2	Implement data preprocessing, exploratory data analysis, and visualization techniques
CO3	Implement supervised learning algorithms such as k-Nearest Neighbours, Linear Regression, Decision Tree, and Random Forest for prediction and classification tasks.
CO4	Apply unsupervised learning techniques such as k-Means Clustering and Hierarchical Clustering to identify patterns and clusters in datasets.
CO5	Develop modern AI technologies including Generative AI, Transformer architecture, and Large Language Models and their applications.

CO	Topic	Assignment 1
CO1	**Introduction to Machine Learning**	**Tasks:** • Create your own dataset (e.g., student marks, house prices) • Store in CSV file • Load dataset using Pandas
		Assignment 2
CO 1	**Introduction to Machine Learning**	**Machine Learning Workflow Implementation Tasks** 1. Select a dataset (e.g., healthcare or student performance dataset). 2. Perform data loading using Python and Pandas. 3. Split the dataset into **training and testing sets**. 4. Evaluate model performance.
		Assignment 3
CO2	**Data Understanding and Visualization**	Implement data preprocessing techniques such as handling missing values, normalization, and encoding categorical variables using Pandas and NumPy.
		Assignment 4
CO2	**Data Understanding and Visualization**	Implement Exploratory Data Analysis (EDA) to perform univariate, bivariate, and multivariate analysis and visualize the dataset using Matplotlib and Seaborn.
		Assignment 5
CO3	**Supervised Learning Techniques**	Implement similarity-based learning. **Tasks** 1. Implement classification using k-Nearest Neighbors. 2. Experiment with different **K values**. 3. Plot accuracy vs K.
		Assignment 6
CO3	**Supervised Learning Techniques**	Implement tree-based supervised learning algorithms such as Decision Tree and Random Forest and compare their performance.
		Assignment 7
CO4	**Unsupervised and Probabilistic Learning**	Implement K-means clustering/hierarchical clustering on sales_data_sample.csv sample.
		Assignment 8
CO4	**Unsupervised and Probabilistic Learning**	Implement probabilistic classification using Naïve Bayes and evaluate the model using precision, recall, and F1-score..
		Assignment 9
CO5	**Generative AI and Large Language Models (LLMs)**	Implement a Fake News Detection System using text classification techniques with Naïve Bayes.

		Assignment 10
CO5	**Generative AI and Large Language Models (LLMs)**	Implement an AI-based Content Generation System using concepts of Transformer architecture and modern Large Language Models.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Multidisciplinary Minor 3	Course Code	CE124MD509
Course Title: Machine Learning for Data Science			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
4	0	0		4	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
52 HOURS	-	-	68 HOURS	120 HOURS		100				

Prerequisites:.

1. Programming and Problem Solving (ESC24014L08).
2. Python for Data Science (AID2402L01).

Course Objectives:

1. To understand the foundations, evolution, types, and life cycle of machine learning, along with its applications, challenges, and essential concepts such as testing, validation, and learning system design.
2. To learn various learning paradigms including supervised, unsupervised, semi-supervised, reinforcement learning, and instance-based approaches such as k-NN, SVM, and locally weighted regression.
3. To explore Bayesian learning principles and ensemble method**s**, including concepts of probability-based reasoning, Naïve Bayes, Bayesian networks, EM algorithms, bagging, boosting, random forests, and stacking.
4. .To study clustering algorithms such as partition-based, hierarchical, density-based, and spectral clustering, along with their distance measures and applications.
5. To understand and apply dimensionality reduction techniques, including subset selection, PCA, Kernel PCA, LLE, and LDA to handle high-dimensional data effectively.

Course Outcomes: After successful completion of the course units the student will

CO1	Demonstrate the history, types, and life cycle of machine learning, along with its applications, challenges, and evaluation concepts such as validation and testing.
CO2	Apply supervised, unsupervised, semi-supervised, and reinforcement learning methods, and mplement instance-based models including k-NN, SVM, and regression techniques.
CO3	Utilize Bayesian learning principles and ensemble techniques to build reliable and probabilistic machine learning models.
CO4	Analyze and implement clustering algorithms—including k-means, k-medoids, hierarchical, DBSCAN, and spectral clustering—for grouping and pattern discovery in data.
CO5	Apply dimensionality reduction and feature extraction methods to simplify high-dimensional datasets while preserving structure.

Syllabus

Unit I	Introduction to Machine Learning	10 hrs

Introduction to Machine Learning: History of ML, Types of Learning, ML Life cycle, Applications and Challenges of Machine Learning, , Testing and Validating, Positive and Negative Class, Learning problems, Designing a Learning system, Perspectives and Issues.
Case Study : Email Spam Detection System using Machine Learning

Unit II	Learning	10 hrs

Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning, Reinforcement Learning
Instance- Based Learning: Support Vector Machines: Linear and Non-Linear, SVM regression, k- Nearest Neighbor Learning, Locally Weighted Regression.
Case Study: Customer Segmentation and Recommendation System using Multiple Learning Techniques

Unit III	Bayesian & Ensemble Learning	12 Hrs

Bayesian Learning: Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Network, EM Algorithm. **Ensemble and Probabilistic Learning Model**: Voting classifiers, Bagging, Boosting ,Random forests, Stacking.
Case Study: Disease Prediction System using Bayesian and Ensemble Learning Techniques

Unit IV	Clustering	10 Hrs

Partitional Clustering - k-means, k-medoids; Hierarchical Clustering - Agglomerative, Divisive, Distance measures; Density based clustering - DBScan; Spectral clustering
Case Study: Market Segmentation using Clustering Techniques

Unit V	Dimensionality Reduction	10 hrs

Dimensionality Reduction: Subset selection, Main Approaches for Dimensionality Reduction, PCA, Kernel PCA, LLE, Linear Discriminant Analysis (LDA).
Case Study: Face Recognition System using Dimensionality Reduction Techniques

Text Books:

1. Introduction to Machine Learning, Ethem Alpaydın, 3rd Edition, MIT press, 2014,ISBN: 9780262028189
2. Mark Treveil and the Dataiku Team- Introducing MLOps How to Scale Machine Learning in the Enterprise, O'Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472 1st Edition ,2020,ISBN : 9781492083290

References Books:

1. MACHINE LEARNING - An Algorithmic Perspective, Stephen Marsland, 2nd Edition, 2015.
2.Introduction to Machine Learning with Python, A Guide for Data Scientists, Andreas C.Miller and Sarah Guido, O'Reilly Media, 2017.

3.Hands-on Machine Learning with Scikit-Learn and Tensor Flow: concepts, tools, and techniques to build intelligent systems, Aurelien Geron, O'Reilly Media, 2019.

E-resources:

1. **NPTEL Course - Introduction to Machine Learning by Prof. Balaraman Ravindran available at https://nptel.ac.in/courses/106106139**

2. **NPTEL Course - Introduction to Machine Learning by Prof. Sudeshna Sarkar available at https://nptel.ac.in/courses/106105152**

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Open Elective 1	Course Code	CE124OE510
Course Title: Prompt Engineering			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
2	0	0		2	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
26 HOURS	-	-	24 HOURS	60 HOURS		100				

Prerequisites:	
Course Objectives: 1. Understand the principles and techniques of prompt engineering, including the designs of effective prompts 2. Explore the capabilities of large language models for text and image generations and to leverage the creation of engaging content 3. Gain crafting prompts and generating text and images using AI tools and platforms	
Course Outcomes: After successful completion of the course the student will be able to	
CO1	Understand fundamentals of LLMs.
CO2	Understand the basics of Prompt Engineering .
CO3	Analyse an appropriate GenAI model for text generation
CO4	Implement and Analyze the Generating Text with AI for Content Creation.
CO5	Understand Latent Diffusion and Text-to-Image Architectures

Syllabus

Unit I	Introduction of LLM	5 Hrs
Introduction to Large Language Models Text Generation Models, Large Language Models, Brief History of LLMs, LLMs in the Market. Zero Shot Prompting **Case study : Gemini**		
Unit II	**Introduction of Prompt Engineering**	**6 hrs**
Five Principles of Prompting, Introducing LLM Prompts, How LLM Prompts Work, Types of Prompts, Components of a Prompt, Chain of thoughts prompting, Defining Personality in Prompts, Mix and Match Strategic Combination for Enhanced Prompts, Challenges and Limitations of Using Prompts **Case study : Green AI Initiatives**		
Unit III	**Text Data Generation with GenAI**	**5 Hrs**

Generating Lists, Explain It Like I'm Five, Universal Translation Through, LLMs, Ask For Context, Text Style Unbundling, Identifying the Desired Textual Features, Generating New Content with the Extracted Features, Role Prompting, Analyzing Existing Prompts for Strengths and Weaknesses.

Case Study : Secure prompting

Unit IV	**Generating Text with AI for Content Creation**	**5 Hrs**

Using AI for Copywriting, Creating Social Media Posts. Writing Video Scripts, Using AI for Personalized Messaging, Creating Engaging and Tailored Content with AI, Techniques for Crafting Effective Prompts for Surveys, Assessments, and Data Collection.

Case Study : Using Prompts for Research

Unit V	**Introduction to Diffusion Models for Image Generation**	**5 Hrs**

Introduction to Image Generation with AI, Principles of Designing Prompts for Image Generation, Available Models - OpenAI DALL-E, Midjourney, Stable Diffusion, Google Gemini, Text to Video, Model Comparison, Reverse Engineering Prompts, Negative Prompts, Prompt Re-Writing, Prompt Analysis

Case Study : Image and Video generation tools

Reference Books:

1. Introduction to Large Language Models –Book by Tanmoy Chakraborty,Wiley
2. Foundations of Large Language Models by Tong Xiao and Jingbo Zhu available at https://arxiv.org/pdf/2501.09223?
3. Generative Artificial Intelligence: Exploring the Power and Potential of Generative AI Kindle Edition by Shivam R Solanki and Drupad K Khublani
4. Introduction to Generative AI, Second Edition, Reliable, responsible, and real-world applications by Numa Dhamani and Maggie Engler available at https://www.manning.com/books/introduction-to-generative-ai-second-edition

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Non Credit Course 5	Course Code	CE124NC511
Course Title: Sustainable Technologies and Green Computing			

Teaching Scheme				Evaluation Scheme				
					Theory Marks		Practical Marks	
L	T	P	Cr	Exam	Max	Min Marks for Pass	Max	Min for Pass
0	0	2	0	CCE	-	-	50	20
Total Hours: 26								

Prerequisites: Nil

Course Objectives:

1. Introduce the concept of sustainability and its importance in technology.
2. Understand the principles and practices of green computing.
3. Learn energy-efficient hardware, software, and data center practices.
4. Explore emerging sustainable technologies and their real-world applications.
5. Promote environmentally responsible use of computing resources.

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

CO1	Describe the fundamentals of sustainability and sustainable technologies.
CO2	Explain the need, principles, and practices of green computing.
CO3	Apply energy-efficient strategies in computing environments.
CO4	Evaluate green IT solutions such as virtualization, cloud, and smart systems.
CO5	Demonstrate good practices for reducing carbon footprint in daily computing tasks.

Syllabus

Assignments

Assignment 1
Case study on E-Waste Recycling in Pune – Local practices and their effectiveness.

Assignment 2
Case study on Carbon Neutral Tech Firms – Google's carbon neutrality journey since 2007.

Assignment 3
Case study on Energy Consumption in Laptops – Comparing traditional vs. energy-efficient laptops.

Assignment 4
Case study on Corporate Green IT Practices – IBM's sustainability policies in IT.

Assignment 5
Case study on Energy-Efficient Storage Systems – SSDs vs. HDDs in terms of power usage.

Assignment 6
Case study on Green Software Engineering – Microsoft's Windows power management features.

Assignment 7
Case study on Google's Renewable Energy Data Centers – Achieving 100% renewable energy.

Assignment 8
Case study on Facebook's Prineville Data Center – Evaporative cooling for energy efficiency.

Assignment 9
Case study on Smart Grids in India – Efficient energy distribution via Smart Grid Mission.

Assignment 10
Case study on Smart Cities in India – Pune Smart City IoT-based waste management.

Text Books

5. Green IT: Principles and Practices – B. R. Raghavendra
6. Green Computing and Sustainability – John Lamb

Reference Books

1. Green IT: Reduce Your Information System's Environmental Impact – Mark O'Neill
2. Handbook of Sustainability in ICT – Various Authors

E-Books:.

1. IEEE / ACM digital library resources on Green Computing
2. NPTEL materials on Sustainability and ICT

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Non Credit Course 6	Course Code	CE124NC512
Course Title: Aptitude & Technical Mastery placements 6			

Teaching Scheme				Evaluation Scheme				
					Theory Marks		Practical Marks	
L	**T**	**P**	**Cr**	**Exam**	**Max**	**Min Marks for Pass**	**Max**	**Min for Pass**
0	0	40	0	CCE ESE	-	-	50	20
Total Hours: 40								

Course Objectives: Purposes of Course are:

1. To STUDY fundamental quantitative aptitude concepts and mathematical techniques.
2. To LEARN numerical problem-solving methods for statistics, probability, and permutations.
3. To ANALYZE logical reasoning problems using systematic and analytical approaches.
4. To DEVELOP effective communication and group discussion skills for professional environments.
5. To PREPARE students for personal, HR, and technical interviews required for campus placements.

Course Outcomes: By the end of this course, students will be able to:		BT
CO1	**APPLY** quantitative aptitude techniques such as number systems, ratios, probability, and statistics to SOLVE real-time aptitude and placement-oriented problems	3
CO2	**ANALYZE** numerical and logical reasoning problems including series, blood relations, directions, and puzzles to MAKE accurate and time-efficient decisions	4
CO3	**DEMONSTRATE** effective communication, critical thinking, and collaboration skills while PARTICIPATING in group discussions using appropriate strategies and etiquette.	4
CO4	PREPARE and PRESENT structured self-introductions, resumes, and responses to HR, behavioral, and ethical interview questions with professional confidence	5
CO5	**EXHIBIT** interview readiness by **APPLYING** technical knowledge, virtual interview skills, and follow-up strategies to **IMPROVE** employability and placement success.	5

Syllabus

Unit I	**Foundations of Numerical Ability**	**12 hrs**
Speed Maths Techniques, Number Systems, LCM and HCF , Pipes and cisterns ,Ratios and proportions		
Unit II	**Numerical Problem-Solving Skills**	**6 hrs**
Statistics , Progressions ,Permutations & combinations ,Probability		
Unit III	**Logical Reasoning**	**10 hrs**
Blood Relations ,Number series + Letter series,Directions ,Puzzle Test		
Unit IV	**Group Discussion**	**6 hrs**
Introduction to Group Discussion, Communication Skills,Role of Participants in a GD GD Techniques & Strategies, Critical Thinking & Argumentation, Teamwork & Collaboration Skills,GD Etiquette & Do's and Don'ts, Practice Sessions		
Unit V	**Personal Interview Skills**	**6 hrs**
Introduction to Personal Interviews, Interview Formats, Self-Introduction / Tell Me About Yourself, Resume Preparation & Resume-Based Questions, HR Questions, Behavioral Interviewing, Technical Interview Skills, Ethical & Integrity-Based Questions, Virtual Interview Skills, Follow-up Strategies.		

Textbook:

1. Quantitative Aptitude for Competitive Examinations – R.S. Aggarwal

(Strong foundation for number systems, ratios, probability, etc.)

2. A Modern Approach to Logical Reasoning – R.S. Aggarwal

(Covers blood relations, series, puzzles, and reasoning concepts.)

3. Fast Track Objective Arithmetic – Rajesh Verma

(Helpful for speed maths techniques and shortcut methods.)

4. How to Prepare for Quantitative Aptitude for CAT – Arun Sharma

(Advanced problem-solving and analytical thinking.)

5. Group Discussion: Theory and Practice – Dr. S. S. Raghav

(Structured understanding of GD skills and strategies.)

6. Cracking the Coding Interview / Interview Preparation Guide – Gayle Laakmann McDowell

(Good support for interview preparation and structured responses.)

Reference Books:

1. Verbal and Non-Verbal Reasoning – R.S. Aggarwal

(Additional practice for logical reasoning and analytical skills.)

2. Quantitative Aptitude Quantum CAT – Sarvesh Verma

(Higher difficulty level questions and conceptual clarity.)

3. Soft Skills: Personality Development for Life Success – Prashant Sharma

(Supports GD, communication, and interview readiness.)

4. The Art of Communicating – Thich Nhat Hanh

(Useful for communication skills, listening, and confidence building.)

Research Paper

1. A Review on Employability Skills
https://www.researchgate.net/publication/271293771_A_Review_on_Employability_Skills

2. Developing Career-Related Skills through Project-Based Learning
https://www.sciencedirect.com/science/article/abs/pii/S0191491X24000579

Semester -VI

Course Category	Program Core Course 1	Course Code	CE124PC601
Course Title: Artificial Intelligence			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Advanced Data Structures and Algorithms (CE124PC401)

Course Objectives:

1. To introduce students to the fundamental concepts of Artificial Intelligence, its applications, and ethical considerations.
2. To understand problem solving using various search strategies for AI.
3. To introduce adversarial search strategies used in game playing and constraint satisfaction techniques.
4. To develop an understanding of how logical agents, use First-Order Logic and reasoning techniques such as forward and backward chaining to represent, engineer, and apply knowledge in problem-solving environments.
5. To understand the technological foundations and societal implications of Emerging trends in AI.

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

CO1	Describe the basic principles of Artificial Intelligence and illustrate their applications in real world scenarios.
CO2	Develop smart problem-solving systems by employing suitable search and heuristic techniques.
CO3	Apply adversarial search and solve problems using constraint satisfaction techniques for structured environments.
CO4	Apply First-Order Logic and reasoning methods to design and analyze intelligent systems.
CO5	Demonstrate the ability to represent complex real-world problems using suitable and logically constrained knowledge representation methods.

Syllabus

Unit I	Introduction to AI	8 Hrs
Introduce to the fundamentals of AI, history, applications, and challenges. Definition and History of AI, Applications and Impact of AI in Various Domains, Types of AI: Narrow AI, General AI, and Super AI, Intelligent Agents, Agents and Environments, Concept of Rationality, Nature of Environments, Structure of Agents. AI in Problem Solving: State Space Representation, AI vs Human Intelligence. **Case study:** Design aspects of AI Applications such as sentiment analysis, Obstacle detection etc.		
Unit II	**Problem Solving and Computational Thinking**	**8 hrs**
Solving Problems by Searching, Problem-Solving Agents, Example Problems, Search Algorithms, Informed (Heuristic) Search Strategies, Heuristic Functions, Search in Complex Environments, Local Search and Optimization Problems, Decomposition. Case Study: AI for problem solving in various domain such as Smart Manufacturing (4IR Context)		

Unit III	Adversarial Search and Constraint Satisfaction	8 Hrs
Game Theory, Optimal Decision in Games, Minimax Algorithm and Alpha-Beta Pruning, Monte Carlo Tree Search, Constraint Satisfaction problem: Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem. Case Study: Sustainability perspective in AI application.		
Unit IV	**Knowledge and Reasoning**	**7Hrs**
Logical Agents, Wumpus World First-Order Logic, Knowledge Engineering in First-Order Logic, Forward and Backward Chaining, Artificial Intelligence **Case Study**: AI Driven interactive media application and advances in chatbots.		
Unit V	**Emerging AI Topics and Applications**	**8 Hrs**
Limits of AI, Ethics of AI, Future of AI, AI Components, Generative AI (GPT, DALL·E), Explainable AI (XAI), Federated Learning, Edge AI, Agentic AI and Applications **Case Study**: Impacts of Generative AI and Agentic AI		

Text Books:

1. Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth edition, Pearson, 2020, ISBN: 9780134610993

2. Deepak Khemani, "A First Course in Artificial Intelligence", First edition, McGraw Hill Education (India), 2013, ISBN: 9781259029981

3. Elaine Rich, Kevin Knight and Shivashankar B. Nair, "Artificial Intelligence", Third edition, Tata McGraw Hill, 2009, ISBN: 9780070087705

References Books:

1. Nilsson Nils J, *"Artificial Intelligence: A New Synthesis"*, Morgan Kaufmann Publishers Inc., San Francisco, CA, ISBN: 978-1-55-860467-4
2. Patrick Henry Winston, *"Artificial Intelligence"*, Addison-Wesley Publishing Company, ISBN: 0201-53377-4

3. Andries P. Engelbrecht, *Computational Intelligence: An Introduction*, 2nd Edition, Wiley India, ISBN: 978-0-470-51250-0
4. Dr. Lavika Goel, *"Artificial Intelligence: Concepts and Applications"*, Wiley publication, ISBN: 9788126519934
5. Dr. Nilakshi Jain, *"Artificial Intelligence, As per AICTE: Making a System Intelligent"*, Wiley publication, ISBN: 9788126579945

E-Resources

MOOCs:

1. NPTEL Course-Introduction to Artificial Intelligence by Prof. Anupam Basu, Prof. S. Sarkar at https://nptel.ac.in/courses/106/105/106105079/

2. NPTEL Course-Introduction to AI by Prof. P. Mitra, Prof. S. Sarkar at https://nptel.ac.in/courses/106/105/106105078/

3. NPTEL Course-Artificial Intelligence: Search Methods for Problem Solving by Prof. Deepak Khemani at https://nptel.ac.in/courses/106/106/106106126/

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 2	Course Code	CE124PC602
Course Title: Artificial Intelligence Lab			

		Teaching Scheme			Evaluation Scheme						
						Theory Marks			Practical Marks		
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass	
0	0	2		2	CCE	-	-	-	50	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Companion Course : Advanced Data Structures and Algorithms (CE124PC401)

Course Objectives:

1. Implement intelligent agents and basic AI applications using suitable programming tools.
2. Develop problem-solving systems using uninformed and informed search techniques.
3. Design and implement adversarial search and constraint satisfaction problem-solving methods.
4. Apply logical and probabilistic reasoning techniques to build knowledge-based systems.
5. Explore and implement emerging AI techniques including Generative AI, Explainable AI, and ethical AI considerations through practical applications.

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

CO1	Implement intelligent agents and basic AI applications to solve structured problems.
CO2	Apply uninformed and informed search algorithms to develop efficient problem solving systems.
CO3	Design AI solutions using adversarial search strategies and constraint satisfaction techniques.
CO4	Develop knowledge-based systems using logical reasoning and probabilistic Inference methods.
CO5	Build AI-based applications incorporating modern AI concepts such as Generative AI, Explainable AI, and ethical considerations.

CO	Topic	Assignment 1	2hrs
CO1	Simple Reflex & Model-Based Agents	**Aim:** To implement a simple rational agent that can make decisions in a defined environment, demonstrating the concept of rationality and agent structure. **Problem Statement:** You are a **"Room Cleaner Agent"** in a 2x2 grid representing rooms. Each room can either be dirty or clean. Your agent starts in a random room. Your goal is to clean all dirty rooms and then turn yourself off.	
		Assignment 2	
CO1	Narrow AI Edition	**Aim:** To implement a simple demonstration of Narrow AI capabilities through a decision-making game **Problem Statement:** Create a "20 Questions" style game where the computer tries to guess an animal the user is thinking of. The computer will ask a series of yes/no questions based on predefined features (e.g., "Does it have fur?", "Does it fly?", "Is it a predator?")	
		Assignment3	
CO2	Informed Search Algorithms (A*)	**Aim:** To implement the A* Search Algorithm using a Manhattan distance heuristic to find the most efficient path in a weighted environment. **Problem Statement:** You are a **"Delivery Drone"** in a city grid. Some paths are "high-traffic" (high cost) and others are "express lanes" (low cost). You know the GPS coordinates of your destination. Use $f(n) = g(n) + h(n)$ to find the mathematically optimal path to the delivery goal.	
		Assignment 4	
CO2	Informed Search Algorithms (A*)	**Aim**: To implement the *A* Search Algorithm* using a Manhattan Distance heuristic to find the most efficient sequence of moves to solve an 8-puzzle from any solvable initial state. **Problem Statement:** You are a "Tile Controller" for a 3x3 grid containing 8 numbered tiles and one empty slot (blank). Each move—sliding a tile into the blank space—is considered a "step" in the state space. Your goal is to reach a specific Goal Configuration with the minimum number of steps.	
		Assignment 5	
CO2	The Peak Climber (Local Search & Optimization)	**Aim:** To solve the **8-Queens Problem** using **Backtracking** to find an optimal configuration in a complex state space. **Problem Statement:** You are the "Royal Guard." You must place 8 Queens on a chessboard so that no two queens threaten each other. Instead of searching from an empty board, you start with all 8 queens placed randomly and must "tweak" their positions to reduce "conflicts."	
		Assignment 6	
CO3	Constraint	**Aim:** To implement a **Graph Coloring** algorithm (typically using Backtracking) to assign colors to the vertices of a graph such that	

	Satisfaction Problems (Graph Coloring)	no two adjacent vertices share the same color, using the minimum number of colors possible (the Chromatic Number). **Problem Statement:** You are a "Network Frequency Planner" tasked with assigning communication frequencies to a set of wireless towers (nodes). Due to interference, any two towers that are within range of each other (connected by an edge) cannot use the same frequency (color).
		Assignment 7
CO4	Adversarial Search and Game Theory using the **Minimax Algorithm**	**Aim:** To implement a perfect-play AI agent for a zero-sum game (Tic-Tac-Toe) that evaluates all possible future moves to ensure it never loses, effectively minimizing the maximum possible loss. **Problem Statement:** You are the "Game Strategist" for a 3X3 grid. Two players, X and O, take turns marking spaces. Your goal is to develop an AI that functions as the "Max" player, seeking to reach a state with a score of +1 (Win), while the opponent "Min" seeks a score of -1 (Loss).
		Assignment 8
CO5	Logic-Based Reasoning and Automated Inference in a Partially Observable Environment.	**Aim:** To design a "Knowledge-Based Agent" that can navigate a dangerous 4X4 grid, collect gold, and return to the start safely by using logical deduction to avoid pits and the deadly Wumpus. **Problem Statement:** You are an "Explorer" in a dark cave (the Wumpus World). The environment is partially observable, meaning you can only perceive information from your current square.
		Assignment 9
CO5	Case Study: Emerging AI	- Impacts of Generative and Agentic AI - Explainable AI and Ethical Considerations - Agentic AI and Edge AI
		Assignment 10
CO5	Mini Project: Expert System	Knowledge Engineering and Inference **Aim:** To build a rule-based Expert System using Forward or Backward Chaining. **Problem Statement:** Develop a **"Medical Diagnostic System"** or **"Financial Advisory System."** The system must take user symptoms/inputs, apply a set of "If-Then" logical rules from a Knowledge Base, and provide a reasoned conclusion or recommendation.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 3	Course Code	CE124PC603
Course Title: Finite Automata and Algorithmic Analysis			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	**T**	**P**	***SL**	**Cr**	**Exam**	**Max**	**Min Marks for Pass**		**Max**	**Min for Pass**
3	**0**	**0**		**3**	**CCE**	**50**	**20**	**40**	**-**	**-**
Total Hours					**ESE**	**50**	**20**			
39 HOURS	**-**	**-**	**51 HOURS**	**90 HOURS**		**100**				

Prerequisites: Mathematical Foundations of Computer Engineering(CE124PC303)

Course Objectives:

1. To study the skills to model and design computational systems using formal languages, Finite Automata, and regular expressions.
2. To analyse grammars and computational models, and design Pushdown Automata.
3. To design Turing Machines for advanced language processing and algorithmic solutions.
4. To analyse the asymptotic performance of algorithms and to study the performance analysis of backtracking algorithms in terms of time and space complexity.
5. To analyse and evaluate the performance of the Branch and Bound algorithm for solving optimization problems.

Course Outcomes: After successful completion of the course units the student will

CO1	Understand formal languages and alphabets, design Finite Automata and their variants, and construct regular expressions while exploring their properties.
CO2	Design and simplify Context-Free Grammars and construct corresponding Pushdown Automata to model Context-Free Languages effectively.
CO3	Design Turing Machines to solve various computational problems and model theoretical concepts in computer science.
CO4	Analyse the asymptotic performance of algorithms and analyse the performance of backtracking algorithm.
CO5	Analysing the performance of branch and bound algorithm for given problem.

Syllabus

Unit I	Finite Automata and Regular Expression	8 Hrs
Introduction to Finite Automata **FA without output**: Deterministic and Nondeterministic FA (DFA and NFA), epsilon- NFA. Minimization of DFAs. **FA with output**: Moore and Mealy machines Introduction to Regular Expressions, Operators of RE, RE to FA **Case Study:** Design a FSM for Spell Checker		
Unit II	**Context Free Grammar (CFG) and Context Free Language(CFL) and PDA**	**8 hrs**
Formal Definition of Context Free Grammar, Context Free Language (CFL), Ambiguous Grammar **Simplification of CFG**: Eliminating Є-productions, unit productions, **Normal Forms:** Chomsky Normal Form, Greibach Normal Form, Pumping Lemma for CFL Formal definition of PDA, PDA and Context Free Language, Equivalence of PDA and CFG **Case Study:** Create CFG for parenthesis matching		

Unit III	Turing Machines (TM)	8 Hrs
Turing Machine Model, Formal definition of Turing Machines, Language Acceptability by Turing Machines, Design of TM, Variants of Turing Machines, Halting Problem of TM, Halting vs Looping, Reducibility. **Case Study: Design a** String Reverser using TM		
Unit IV	**Introduction To Analysis of Algorithm**	**8 Hrs**
Asymptotic Notation, Amortized Analysis, Time-Space trade-off. **Backtracking:** Principle, Control Abstraction, N-Queen's Problem and its Analysis, State-Space Tree. **Case Study:** Optimal Scheduling of university exam using graph colouring/ Map colouring for adjacent regions.		
Unit V	**Branch and Bound**	**7 Hrs**
Branch and Bound: Principle, Control Abstraction, Travelling Sales Person Problem, 0/1 Knapsack Problem.NP Hard and NP Complete Problem. Case Study: Optimal assignment of human resources for client project.		

Text Books

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D.Ullman, "Introduction to Automata Theory Languages and Computation", Addison-Wesley,ISBN 0-201-44124-1
2. Parag Himanshu Dave, Himanshu Bhalchandra Dave, "Design And Analysis of Algorithms", Pearson Education, ISBN 81-7758-595-9

Reference Books

1. Ellis Horowitz,Sartaj Sahni, and Sanguthevar Rajasekaran,"Computer Algorithms",ISBN 0-7167-8316
2. Daniel Cohen, "Introduction to Computer Theory", Wiley & Sons, ISBN 97881265133454
3. John Martin, "Introduction to Languages and The Theory of Computation", 2nd Edition, McGrawHill Education, ISBN-13: 978-1-25-900558-9, ISBN-10: 1-25-900558-5
4. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations," Analysis

and Internet Examples‖, Wiley, ISBN 978-81-265-0986-7

e-Resources

NPTEL:

1. Theory of Computation, by Prof. Raghunath Tewari available at https://nptel.ac.in/courses/106104148
2. Design and Analysis of Algorithms, by Prof. Abhiram G Ranade, Prof. Ajit A Diwan, Prof. Sundar Viswanathan available at https://nptel.ac.in/courses/106101059

*** Self-Learning hours mentioned in the curriculum is mandatory for all the students to complete for all the respective courses**

Course Category	Program Core Course 4	Course Code	CE124PC604
Course Title: System Programming and Operating System			

Teaching Scheme					Evaluation Scheme					
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks	
						Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Computer Organization and Architecture [CE124PC304]

Course Objectives:

1. To introduce the fundamental concepts of system Programming
2. To analyse the structure, design, and working principles of various system software components
3. To develop the ability to design and evaluate system software tools compilers, interpreter
4. To describe operating system mechanisms, including process management, CPU scheduling.
5. To comprehend process synchronization and memory management and to apply OS concepts to solve problems related to deadlocks

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

CO1	Analyze and synthesize System Software and its functionality.
CO2	Design and analyze the algorithms for macro processors, compiler
CO3	Differentiate between various types of system software and evaluate their roles in program Linking and Loading
CO4	Apply operating system concepts to manage processes, CPU scheduling, synchronization
CO5	Analyze process synchronization and memory management techniques

Syllabus

Unit I	Introduction to System Programming	8 Hrs
Introduction: Software types, Software hierarchy, Components of system software, machine structure, interfaces-user interface, system interface, levels of system software, **Assembler:** Assembler: Elements of assembly language programming, Assembly Language Statements and Benefits. Design of the assembler, types of assemblers, two-pass assemblers, one-pass assemblers, Design of Two Pass Assembler-Algorithm/Flowchart, Types of Assembly Language Statements, Intermediate code forms. **CASE Study:** Debugging Assembly language code using GDB		
Unit II	**Macro processor, Compiler and Interpreter**	**8 hrs**
Macro processor: Introduction, macro definition and call, macro expansion, nested macro calls,Design of Two Pass Macro Processor-Algorithm/Flowchart, Advanced Macro facility, concept of single pass microprocessor. **Compilers:** Introduction to Compiler phases with example. Lexical, Analyser, Syntax Analysis, Sematic Analysis, Intermediate Code Generation and its types, Code optimization and Target Code generation **Interpreters:** Compiler Vs. Interpreter, phases and working. **CASE Study:** LEX and YACC tools /LLVM		
Unit III	**Linker and Loader**	**8 Hrs**
Linker and Loader: Linker: Relocation and linking concepts, Design of Linker-Scheme for relocation and scheme for linking. **Loader:** Introduction to Loader, Compile and Go, General loader Schemes, Absolute Loaders, Subroutine Linkage, relocating loader, direct linking loader, Overlay Structure, design of Absolute loader, Design of Direct Linking Loader, Self-relocating programs, Static and Dynamic Linking **CASE Study**: Loading Concept in JAVA		
Unit IV	**Operating System**	**7Hrs**
Introduction to operating systems: Operating System Structure**,** Functions and Services **Process Management:** Process concept, Process State Transition Diagram, Process Control Block. **Threads:** Threads, Thread life cycle, Multithreading model **Process scheduling:** CPU Scheduling - Scheduling Criteria, Scheduling Algorithms, Multiple -Processor Scheduling. **CASE Study**: Process Management in Linux: Process System Calls		
Unit V	**Synchronization and Memory Management**	**7 Hrs**
Synchronization - The Critical Section Problem, Synchronization Hardware, Semaphores, and Classical Problems of Synchronization, Critical Regions, Monitors **Deadlocks** - System Model, Deadlocks Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, and Recovery from Deadlock **Memory Management and Virtual Memory** - Logical versus Physical Address Space, Swapping, Contiguous Allocation, Paging, Segmentation, Segmentation with Paging, Demand Paging, Page Replacement, Page Replacement Algorithms. **CASE Study:** Memory management in Linux /Windows/Android		

Text Books:

1. John Donovan, “System Programming”, McGraw Hill, ISBN 978-0--07-460482-3. Edition 1991 Reprint 2025
2. Dhamdhere D.,” Systems Programming and Operating Systems”, McGraw Hill, ISBN 0 - 07 - 463579 – 4 Second Edition
3. . Silberschatz, Galvin, Gagne, Operating System Principles, 9th Edition, Wiley, ISBN 978-1-118-06333-0

References Books:

1. Leland Beck, “System Software: An Introduction to systems programming”, Pearson
2. John R. Levine, Tony Mason, Doug Brown, “Lex & Yacc”, 1st Edition, O’REILLY, ISBN 81-7366-062-X.
3. Alfred V. Aho, Ravi Sethi, Reffrey D. Ullman, “Compilers Principles, Techniques, and Tools”, Addison Wesley, ISBN 981-235-885-4

e-Resources

1. **NPTEL Course on Introduction to Operating System by Prof. Chester Rebeiro available at https://nptel.ac.in/courses/106106144**

Course Category	Program Elective Course 2	Course Code	CE124PE605A
Course Title: Real Time Operating System			

Teaching Scheme					Evaluation Scheme					
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks	
						Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Students are expected to have basic knowledge of Operating Systems.

Course Objectives: After successful completion of the course the student will be able to

1. To Understand the fundamental concepts, characteristics, and applications of real-time operating systems.
2. To Analyze real-time task models, timing constraints, and scheduling requirements.
3. To Study and compare real-time scheduling algorithms for uniprocessor and multiprocessor systems.
4. To Understand resource sharing, synchronization, and inter-process communication mechanisms in RTOS.
5. To Apply RTOS concepts to design and analyze real-time embedded system applications using commercial RTOS examples.

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

CO1	Learn the real-time system concepts, task characteristics, timing constraints, and applications of RTOS.
CO2	Analyze and compare real-time scheduling algorithms for different task models and system requirements.
CO3	Apply resource access control and inter-process communication techniques to solve synchronization problems in RTOS
CO4	Evaluate multiprocessor scheduling and real-time communication protocols for distributed real-time systems.
CO5	Design and analyze RTOS-based embedded applications using appropriate commercial real-time operating systems.

Syllabus

Unit I	Introduction to real-time operating systems (RTOS)	8 Hrs

Hard versus soft real-time systems and their timing constraints. Temporal parameters of real-time process: Fixed, Jittered and sporadic release times, execution time. Types of real-time tasks, Precedence constraints and data dependency among real-time tasks, other types of dependencies for real-time tasks. Functional parameters and Resource parameters of real-time process, Real-time applications: Guidance and control, Signal processing, Multimedia, real-time databases,
Case Study: Missile Guidance and Control System

Unit II	Real Time Task Scheduling	8 hrs

Real-time task and task states, task and data. Approaches to real-time scheduling: clock driver, weighted round-robin, priority-driven- Fixed priority and dynamic priority algorithms –Rate Monotonic (RM), Earliest-Deadline-First (EDF), Latest-Release-Time (LRT), Least-Slack-Time First (LST). Static and Dynamic systems, on-line and off-line scheduling, Scheduling aperiodic and sporadic real-time tasks. Case Study : ECG Monitoring System in ICU

Unit III	Resource access control & Inter-process Communication	8 Hrs

Resources and resource access control-Assumption on resources and their usage, Enforcing mutual exclusion and critical sections, resource conflicts and blocking, Effects of resource contention and resource access control - priority inversion, priority inheritance. Inter-process communication-semaphores, message queues, mailboxes and pipes.
Case Study : Mars Rover Control System

Unit IV	Multiprocessor Scheduling in RTOS	7Hrs

Multiprocessor Scheduling, resource access control and synchronization in Real-time Operating system. Real-time communication: Model, priority-based service disciplines for switched networks, weighted round-robin service disciplines, Medium access-control protocols for broadcast networks, internet and resource reservation protocols, real-time protocols.
Case Study : Autonomous Drone Swarm System

Unit V	RTOS Based Designs & RTOS Examples	8 Hrs

Basic design using a real-time operating system: Design considerations, Design Examples and case studies of real-time systems: Design Examples: Automatic Chocolate vending machine, adaptive cruise control system in a car, Orchestra robots, smart card. RTOS Examples : Capabilities of commercial real-time operating systems, QNX/Neutrino, Microc/OS-II, VxWorks, Windows CE and RTLinux.
Case Study : Adaptive Cruise Control (ACC) in Car.

Text Books:

1. Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition,McGraw-Hill, ISBN: 13: 9780070151253
2. Jane W. S. Liu, *"Real-Time Systems"*, Pearson Education,ISBN-13: 9780130996510
3. David E. Simon, "An Embedded Software Primer", Pearson Education, ISBN: 8177581546
4. Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw Hill, ISBN: 13: 9780070482845

Reference Books:

1. Jean J. Labrosse, *"µC/OS-II: The Real-Time Kernel"*, R&D Publications, ISBN-13: 9781578201037.
2. Dr. K. V. K. K. Prasad, "Embedded Real-Time Systems: Concepts: Design and Programming", Black Book, Dream tech Press, ISBN: 10: 8177224611,13: 9788177224610
3. Doug Abbott, *"Linux for Embedded and Real-Time Applications"*, 2nd Edition, Newnes, 2011, ISBN-13: 9780750685832

e-Resources

1. NPTEL Course on Introduction to Real Time Operating System available by Prof. Rajib Mall **https://nptel.ac.in/courses/106105172**

Course Category	Program Elective Course 2	Course Code:	CE124PE605B
Course Title: Soft Computing			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Machine Learning (CE124PE507C)

Course Objectives: After successful completion of the course the student will be able to:

1. To provide a clear understanding of soft computing principles, techniques and their role in addressing computational challenges.
2. To apply neural network architectures and learning algorithms for pattern recognition and prediction applications.
3. To apply fuzzy logic concepts, including fuzzy sets, inference mechanisms, and defuzzification methods, in the design of basic fuzzy-based systems.
4. To analyze genetic algorithms and identify suitable strategies for optimization and search problems.
5. To apply evolutionary computing and swarm-based optimization techniques to solve engineering optimization problems.

Course Outcomes: After successful completion of the course units the student will:

CO1	**Describe** soft computing principles, techniques and their characteristics for various computational problems.
CO2	**Apply** neural network architectures and learning algorithms for pattern recognition and prediction tasks.
CO3	Understand the Fuzzy logic and **Implement** fuzzy algorithms for solving real life problems
CO4	**Analyze** genetic algorithms to determine suitable approaches for optimization and search problems.
CO5	**Apply** evolutionary and swarm intelligence algorithms to solve optimization and engineering applications.

Syllabus

Unit I	Introduction to Soft Computing	7 Hrs
Introduction to Soft Computing: Concept of computing systems, Soft Computing vs. Hard Computing, Types of Soft Computing Techniques- Artificial Neural Network, Fuzzy Logic., Evolutionary computing and Hybrid systems, Characteristics of Soft computing, Applications of Soft Computing, Requirements of Soft Computing. Case Study: Adaptive Street Lighting System.		
Unit II	**Artificial Neural Network**	**8 Hrs**
An Introduction to Artificial Neural Networks: Biological neurons and its working, Neural network architectures: single layer and multilayer feed forward networks, recurrent networks.; Important Terminologies: Weights, Bias, Threshold, Learning, etc.; Learning Methods: Supervised and Unsupervised; Perceptron Network, Back propagation network; Applications of ANNs to solve some real-life problems. Case Study: License Plate Character Recognition using ANN.		
Unit III	**Genetic Algorithm**	**8 Hrs**
Introduction to Fuzzy Logic: Classical Sets, Operations on Fuzzy sets, Properties of fuzzy sets, Membership functions: Features, fuzzification, methods of membership value assignments; Fuzzy relations, Fuzzy rules, Fuzzy propositions, Fuzzy implications and Fuzzy inferences; Defuzzification techniques, Some applications of Fuzzy logic. Case Study: Smart Parking Allocation System using Fuzzy Logic.		
Unit IV	**Genetic Algorithm**	**8 Hrs**
Introduction To Basic Terminologies in Genetic Algorithm: Individuals, Genes, Fitness, Populations; Simple GA; General Genetic Algorithm; Operators in Genetic Algorithm: Encoding, Selection, Crossover (Recombination), Mutation; Stopping Condition for GA Flow; Constraints in Genetic Algorithms; Problem Solving Using Genetic Algorithm; Holland Classifier System: The Production System, The Bucket Brigade Algorithm and Rule Generation; Advantages and Limitations of Genetic Algorithms; Applications of Genetic Algorithms. Case Study: Use Genetic Algorithm to design a solution to the Traveling Salesman Problem.		
Unit V	**Evolutionary Computing**	**8 Hrs**
Problem Solving as A Search Task, Hill Climbing and Simulated Annealing, Evolutionary Computing, Evolution Strategies, Evolutionary Programming, Genetic Programming, Selected Applications from The Literature: A Brief Description, Scope of Evolutionary Computing, Introduction to Evolutionary Single-Objective Optimization, Particle Swarm Optimization: Introduction, inspiration, mathematical model, standard and binary PSO. Artificial hummingbird algorithm. Case Study: Study of Engineering application of Artificial hummingbird algorithm.		

Text Books:

1. S.N.Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley Publications, Third Edition, 2019, ISBN: 978-8126577132
2. Rajasekaran, S., Pai, G. A. Vijayalakshmi, Neural Networks, Fuzzy Systems and Evolutionary Algorithms: Synthesis and Applications, PHI Learning Pvt. Ltd., Second Edition, Twentieth Reprint (2/E), 2018, ISBN: 978-8120353343
3. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing A Computational Approach to Learning and Machine Intelligence", Prentice Hall, First

Edition, 1997, ISBN: 978-0132610667.

References Books:

1. Seyedali Mirjalili, Evolutionary Algorithms and Neural Networks Theory and Applications, Studies in Computational Intelligence‖, Vol 780, Springer, First Edition, 2019, ISBN 978- 3-319-93024-4
2. David E. Goldberg, Genetic Algorithms, Pearson Education India, First Edition, 2013**,** ISBN: 978-8131709191
3. Simon O. Haykin, Neural Networks and Learning Machines, Prentice Hall, Third Edition, 2011, ISBN: 978-0131471399
4. Randy L. Haupt and sue Ellen Haupt, Practical Genetic Algorithms, John Wiley & Sons, Second Edition, 2002, ISBN: 978-0471455653
5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley Publications, Third Edition, March 2010, ISBN: 978-0470743768

e-Resources

1. NPTEL Course – Introduction of Soft Computing, by Prof. Debidas Samanta available at https://nptel.ac.in/courses/106105173

2. NPTEL Course – Neural Network and Applications, by Prof. Somnath Sengupta, available at https://nptel.ac.in/courses/117105084

3. NPTEL Course – Fuzzy Logic and Neural Networks, by Dilip Kumar Pratihar, available at https://nptel.ac.in/courses/127105006

Course Category	Program Elective Course 2	Course Code:	CE124PE605C
Course Title: Game Theory			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites:

1. Linear Algebra and Differential Calculus(BSC2401L09)
2. Mathematical Foundations of Computer Engineering(CE124PC303)

Course Objectives:

1. To understand fundamental concepts, structure, and logic of game theory.
2. To analyze strategic-form games and determine equilibrium concepts such as Nash equilibrium.
3. To evaluate outcomes in extensive-form games using backward induction and subgame perfection
4. To understand and model repeated interactions with complete and incomplete information.
5. To apply Bayesian reasoning in static and dynamic games, auctions, and mechanism design.

Course Outcomes: After successful completion of the course units, the student will:

CO1	**Understand** the fundamentals of game theory, game design logic, and various game representations.
CO2	**Analyze** strategic-form games and compute pure and mixed strategy Nash equilibria.
CO3	**Apply** extensive-form game techniques including backward induction and subgame perfect equilibrium.
CO4	**Evaluate** repeated games with complete or incomplete information and apply trigger strategies
CO5	**Apply** Bayesian game concepts to static and dynamic scenarios, including auctions, mechanism design, and sequential decision-making.

Syllabus

Unit I	Fundamentals of Game Theory	8 Hrs

Introduction to Game, Game History, Game Architecture, Game Logic, Game View for the Human Player, Game Views for AI Agents, game idea visualization and storytelling, and game documentation.

Case study : Design and Development of Mobile Puzzle Game

Unit II	Strategic Games	8 hrs

Theory Strategic games; the Prisoner's Dilemma, Bach or Stravinsky?, Brass Paradox, Matching Pennies, The stag Hunt, Nash Equilibrium, Best response functions, Dominated actions, Equilibrium in single population. Mixed Strategy Equilibrium Introduction, Mixed strategy Nash equilibrium, The formation of players' beliefs, finding all mixed strategy Nash equilibria, games in which each player has a continuum of actions.

Case study: Pricing competition between two Coffee Shops

Unit III	Extensive-Form Games	8 Hrs

Extensive games with perfect information, Strategies and outcomes, Nash equilibrium, Subgame perfect equilibrium, Finding subgame perfect equilibria of finite horizon games, Backward induction.

Case Study : Salary Negotiation between Company and Candidate

Unit IV	Repeated Games	7Hrs

Infinitely/finitely repeated games, Pareto Perfection and Renegotiation, Proofness in Repeated Games, Repeated Games with incomplete Public Information, Trigger strategies, Fork Theorem with Imperfect Public Information.

Case Study : Two Rival Supermarkets and Long-Term Discounts in Retail Industries such as Competition between two Supermarkets

Unit V	Static and Dynamic Games with incomplete information	8 Hrs

Static Games : Bayesian Nash equilibrium, Applications in auctions, Different auction formats, Revenue and efficiency properties of different auctions, Bayesian Games and Mechanism Design Principle,

Dynamic Games: Introduction Perfect Bayesian Equilibrium in Multi-stage games, Extensive-Form and Strategic, Form Refinements, Reputation Effects, Sequential Bargaining under Incomplete Information.

Case Study: Online Smartphone Auction on E-commerce Websites.

Text Books:

1. Game Theory by Mischael Maschler, Eilon Solan, Shmuel Zamir Cambridge University Press, 2020 , 2nd Edition ISBN:9781108636049.
2. An Introduction to Game Theory, Martin Osborne, Oxford University Press, 1st Indian Edition, 2009, Seventh impression, ISBN – 0195128958.

References Books:

1. (IGT) Martin Osborne, *An Introduction to Game Theory*, Oxford University Press, 2003.
2. Ronald Cohn Jesse Russell, Algorithmic Game Theory, VSD Publishers, 2012, First Edition.

3. Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, “Algorithmic Game Theory”, Cambridge University Press, 2007, First Edition.

e-Resources

1. NPTEL Course- An Introduction to Game Theory by Prof. Aditya K Jagannatham and Prof. Vimal Kumar, available at **https://nptel.ac.in/courses/110104063**
2. NPTEL Course - Game Theory by Prof. K.S. Mallikarjuna Rao, available at **https://onlinecourses.nptel.ac.in/noc19_ge32/preview**

Course Category	Program Elective Course 2 Lab	Course Code	CE124PE606A
Course Title: Real Time Operating System Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Computer Organization & Architecture[CE124PC304]

Course Objectives: This course aims to build the

1. To provide hands-on experience with real-time operating system environments and RTOS kernels.
2. To enable students to create, manage, and schedule real-time tasks using RTOS APIs.
3. To develop practical understanding of inter-task communication and synchronization mechanisms in RTOS.
4. To familiarize students with Linux/RT-Linux and POSIX-based real-time programming concepts
5. To design, implement, and analyze real-time embedded applications using RTOS principles.

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

CO1	Create, delete, and manage real-time tasks and analyze their states in an RTOS environment.
CO2	Implement and evaluate priority-based scheduling and timing constraints in real-time systems.
CO3	Apply inter-task communication mechanisms such as message queues, mailboxes, and pipes.
CO4	Use synchronization primitives like semaphores and mutexes to handle concurrency and priority inversion.
CO5	Develop and test real-time applications using Linux/RT-Linux and POSIX threads.

CO	Topic	Assignment 1
CO1	RTOS Fundamentals	Study of RTOS environment, kernel features, task states, and task life cycle using an RTOS (µC/OS-II / FreeRTOS / RT-Linux).
		Assignment 2
CO1	RTOS Fundamentals	Write a program to create multiple real-time tasks with different priorities and demonstrate **priority-based preemptive scheduling** in an RTOS environment.
		Assignment 3
CO2	Task Management & Scheduling	Write a program to simulate **Round Robin task scheduling** in a real-time environment. Create multiple tasks and assign time slices to each task. Analyze task execution order and response time.
		Assignment 4
CO2	Task Management & Scheduling	Write a program to implement **inter-task communication using message queues or mailboxes** in RTOS and analyze data sharing between tasks
		Assignment 5
CO3	Inter-Task Communication (IPC)	Write a program to demonstrate **inter-task communication using pipes**. Create two tasks where one task generates data and sends it through a pipe while the second task receives and processes the data. Analyze communication delay and synchronization between tasks.
		Assignment 6
CO3	Inter-Task Communication (IPC)	Write a program to demonstrate **semaphore and mutex mechanisms** for task synchronization and to handle **critical section and priority inversion** problems
		Assignment 7
CO4	Synchronization Mechanisms	Write a program to implement the **Producer–Consumer problem using semaphores** in an RTOS environment. Demonstrate synchronization between producer and consumer tasks and avoid race conditions.
		Assignment 8
CO4	Synchronization Mechanisms	Write a program to implement **RTOS time management services** such as delays, timers, and periodic tasks, and analyze deadline compliance.
		Assignment 9
CO5	Linux / RT-Linux Programming	Write a program using **POSIX threads (pthreads)** to create multiple threads with different priorities. Demonstrate real-time scheduling policies such as **SCHED_FIFO or SCHED_RR** and analyze thread execution behavior.
		Assignment 10
CO5	Linux / RT-Linux Programming	Write a program using **POSIX threads** in Linux/RT-Linux to demonstrate **thread creation, mutex locking, semaphore signaling, and real-time behavior.**

Mini Project 1	
CO1,CO2,CO3, CO4,CO5	**RTOS-Based Traffic Signal Control System:**Design and implement a real-time traffic signal control system where each signal phase is treated as a real-time task with strict timing constraints
OR	
Mini Project 2	
CO1, CO2, CO3, CO4,CO5	**RTOS-Based Temperature Monitoring and Control System:** Develop a real-time embedded application using RTOS to monitor temperature sensors and control cooling/heating devices using periodic tasks and synchronization.
OR	
Mini Project 3	
CO1, CO2, CO3, CO4,CO5	**RTOS-Based Smart Home Automation System:** Design a smart home system using RTOS where lighting, security, and appliance control run as concurrent real-time tasks using IPC and priority management.

Text Books:

1. Raj Kamal, "Embedded Systems: Architecture, programming and Design", 2nd Edition,McGraw-Hill, ISBN: 13: 9780070151253
2. Jane W. S. Liu, *"Real-Time Systems"*, Pearson Education,ISBN-13: 9780130996510
3. David E. Simon, "An Embedded Software Primer", Pearson Education, ISBN: 8177581546
4. Sriram V. Iyer, Pankaj Gupta, "Embedded Real-time Systems Programming", Tata McGraw Hill, ISBN: 13: 9780070482845

Reference Books:

1. Jean J. Labrosse, *"µC/OS-II: The Real-Time Kernel"*, R&D Publications, ISBN-13: 9781578201037.
2. Dr. K. V. K. K. Prasad, "Embedded Real-Time Systems: Concepts: Design and Programming", Black Book, Dream tech Press, ISBN: 10: 8177224611,13: 9788177224610
3. Doug Abbott, *"Linux for Embedded and Real-Time Applications"*, 2nd Edition, Newnes, 2011, ISBN-13: 9780750685832

e-Resources

NPTEL Course on Introduction to Real Time Operating System available by Prof. Rajib Mall
https://nptel.ac.in/courses/106105172

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Program Elective Course 2 Lab	Course Code	CE124PE606 B
Course Title: Soft Computing Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Program Elective Course 1 Lab (CE124PE508)

Course Objectives:

1. To introduce students to the fundamentals of fuzzy logic and enable hands-on implementation of fuzzy set operations and inference systems.
2. To provide practical exposure to artificial neural networks for solving classification and pattern recognition problems.
3. To Familiarize students with metaheuristic optimization techniques for solving complex routing and optimization problems.
4. To develop understanding of evolutionary algorithms for Pareto-based solution generation.
5. To enable students to design and simulate intelligent real-world systems using appropriate soft computing techniques.

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

CO1	Implement fuzzy set operations and fuzzy inference systems.
CO2	Design and implement Perceptron and ANN models using backpropagation.
CO3	Apply Genetic Algorithm and swarm-based optimization techniques (ACO, ABC) to solve optimization problems.
CO4	Analyze and compare different soft computing techniques.
CO5	Develop intelligent solutions for real-world problems using bio-inspired algorithms.

CO	Topic	Assignment 1
CO1	Fuzzy Logic	Write a program to implement basic fuzzy set operations such as union, intersection, and complement for given fuzzy sets.
		Assignment 2
CO1	Fuzzy Logic	Write a program to implement a simple fuzzy inference system using IF–THEN rules and demonstrate fuzzy reasoning.
		Assignment 3
CO2	Artificial Neural Network	Write a program to implement Perceptron net for AND function with bipolar inputs and targets.
		Assignment 4
CO2	Artificial Neural Network	Write a program to implement artificial neural network with back propagation.
		Assignment 5
CO3	Metaheuristic Approaches	Write a program to implement Ant Colony Optimization for solving a shortest path or routing problem using Genetic Algorithm.
		Assignment 6
CO3	Metaheuristic Approaches	Write a program to implement ABC (Artificial Bee Colony) optimization Technique using Genetic Algorithm.
		Assignment 7
CO4	Evolutionary Algorithms	Write a program to implement **Genetic Algorithm** for solving the 0/1 Knapsack problem.
		Assignment 8
CO4	Evolutionary Algorithms	Write a program to implement **Genetic Algorithm** for solving a string matching problem.
		Assignment 9
CO5	Intelligent real world systems	Write a program to design and simulate an intelligent system for solving real-world problems using **hybrid soft computing techniques (GA + PSO).**
		Assignment 10
CO5	Intelligent real world systems	Write a program to design and simulate an intelligent system for **task scheduling** using **Particle Swarm Optimization (PSO).**
		Mini Project (Any one)
CO1, CO2, CO3, CO4, CO5	Fuzzy Logic Artificial Neural Network	**1)Adaptive Street Lighting System:** Develop a street lighting system that adapts light intensity using uncertain inputs such as traffic density, ambient light, and time of day. Implement and simulate the system. <u>Simulation Steps:</u> • Input values (traffic, light, time) • Fuzzification • Apply rules • Compute output • Display light intensity <u>Expected Output:</u> • Dynamic adjustment of light intensity Example: a) High traffic + Night → High brightness b) Low traffic + Day → Low brightness **2)Handwritten Digit Recognition using ANN**: Design and implement a handwritten digit classifier from image data using a Feedforward Artificial Neural Network.

		Simulation Steps: • Load dataset (e.g., MNIST dataset) • Preprocess data (normalize pixel values, flatten images) • Split data into training and testing sets • Design ANN model: Input layer (784 neurons) Hidden layers (e.g., 64, 32 neurons) Output layer (10 neurons) • Train the model using training data • Test the model using test data : Evaluate accuracy Predict digit for new input image Expected Output: • Model correctly classifies digits (0–9) • Accuracy typically: ~90% to 98% (depending on model) • Example: Input image → Output: "5" Confusion matrix showing classification performance

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Program Elective Course 2 Lab	Course Code	CE124PE606C
Course Title: Game Theory Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Linear Algebra and Differential Calculus (Group A) BSC2401L09 , Advanced Graphics Programming (CE124PE507A), Mathematical Foundations of Computer Engineering(CE124PC303)

Course Objectives:

1. To introduce fundamental concepts of game theory including players, strategies, payoffs, and game classifications through practical analysis.
2. To enable students to model strategic interactions using payoff matrices, game trees, and mathematical representations.
3. To develop the ability to analyze strategic games and determine equilibrium solutions such as Nash equilibrium and saddle points.
4. To apply game theory concepts to cooperative, repeated, and evolutionary games for solving real-world engineering problems.
5. To enhance analytical and decision-making skills by implementing game-theoretic models in applications such as auctions, networking, security, and resource allocation.

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

CO1	Understand basic concepts, classifications, and representations of games
CO2	Analyze strategic games and compute Nash equilibrium
CO3	Solve zero-sum and cooperative game models.
CO4	Apply game theory to sequential and repeated decision-making
CO5	Model real-world engineering problems using game-theoretic approaches

CO	Topic	Assignments
		Assignment 1
CO1	Game Representation	Represent a real-world situation :- Players,Strategies,Payoff matrix Analyze whether the game is competitive or cooperative.
		Assignment 2
CO1	Dominance Principle	To simplify a game matrix using dominance principle.
		Assignment 3
CO2	Nash Equilibrium (in Pure Strategy)	Find Nash Equilibrium in a two player game with pure strategies.
		Assignment 4
CO2	Prisoner's Dilemma Simulation	Simulate the prisoner's dilemma and analyze equilibrium strategies
		Assignment 5
CO3	Zero-sum game (Minimax/Maximin)	Solve a two person zero-sum game using the minimax and maximin principle
		Assignment 6
CO3	Mixed Strategy Games	Find Mixed Strategy Equilibrium in a two-person zero-sum game
		Assignment 7
CO4	Backward Induction	Solve an extensive-form game using: • Backward induction • Find subgame perfect equilibrium
		Assignment 8
CO4	Repeated Game Simulation	Simulate repeated interaction between two players: Compare single-shot vs repeated outcomes Implement trigger strategies
		Assignment 9
CO5	Bayesian Game Analysis	Model a game with incomplete information: Define player beliefs ,Find Bayesian Nash equilibrium
		Assignment 10
CO5	Auction Design	Implement different auction types: First-price auction, Second-price (Vickrey) auction. Compare: Revenue , Efficiency
		Mini Project
CO1, CO2, CO3, CO4, CO5	Zero-sum Game OR Cooperative / Repeated Games	1.**Cyber Security Defense–Attack Game :** Model attacker and defender strategies in a cyber-security scenario. (Key Concepts Used: Minimax principle , Saddle point, Zero-sum games , Expected Outcome: Optimal defense strategy,Risk minimization analysis) OR 2. **Traffic Signal Control using Game Theory:** Model traffic intersections as players optimizing waiting time. (Key Concepts Used: Repeated games, Cooperation strategies, Equilibrium analysis , Expected Outcome: Reduced average waiting time, Strategy optimization)

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Program Elective Course 3	Course Code	CE124PE607A
Course Title: Computer Vision			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites:

1.Mathematical Foundation of Computer Engineering, (CE124PC303)

Course Objectives:

1. To provide the computer vision fundamentals
2. To explain the mathematical transforms necessary for image processing
3. To explain the image enhancement techniques
4. To explain the compression techniques for the images

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

CO1	Understand the fundamental concepts in computer vision
CO2	Apply image preprocessing techniques to enhance image quality
CO3	Implement various edge detection operators to real-world applications
CO4	Implement and compare supervised, unsupervised segmentation and classification techniques
CO5	Analyse the image compression techniques and evaluate image compression standards.

Syllabus

Unit I	Introduction to Computer Vision	7 Hrs

Digital Image Processing, Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Digital Image Fundamentals – Image Acquisitions, Image Enhancement, Image Sampling and Quantisation, Rotation

Case study - Digital Image Processing in Satellite Imaging

Unit II	Transformations and Filtering	8 hrs

Image Pre-processing: Image Filtering, Grayscale Conversion, Noise Reduction, Normalisation, Basics of Intensity Transformations and Spatial Filtering, Intensity

Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering

Case study - Noise Reduction in Medical MRI Images

Unit III	**Edge Detection**	**8 Hrs**

Introduction to Edge Detection- Definition, Types, Applications, Edge Detection Operators - Sobel operator, Prewitt operator, Roberts Cross operator, Canny edge detector

Case study - Lane Detection in Autonomous Vehicles

Unit IV	**Segmentation and Classification**	**8 Hrs**

Grouping, super pixels, Unsupervised and Supervised segmentation methods: Thresholding, Clustering, Support Vector Machine, Convolutional Neural Networks and image classification

Case study - Brain Tumor Detection Using CNN

Unit V	**Image Compression**	**8 Hrs**

Introduction, Need for image compression, Redundancy in images, Classification of image compression schemes, Huffman coding, Arithmetic coding, Predictive coding, Transformed based compression- Discrete Cosine Transform (DCT), Image compression standards, Video Compression Standards.

Case study - Image Compression in Social Media Platforms

Text Books:

1. Computer Vision-A modern approach, by D. Forsyth and J. Ponce, Prentice, 2nd Edition, 2012, ISBN: 9780136085928
2. Hall Robot Vision, by B.K.P.Horn, McGraw-Hill.2e, 1st Edition, 1986, ISBN: 9780070303492
3. R. Gonzalez, R.E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education, India, 2014

Reference Books:

1. M. Tekalp, "Digital Video Processing", Prentice-Hall 2nd edition 2015. ISBN-13: 9780133991000, ISBN-10: 0133991008
2. Forsyth, David A., and Jean Ponce. Computer Vision: a Modern Approach. Upper Saddle River, NJ: Prentice Hall, 2003. ISBN-13: 9780136085928, ISBN-10: 0130851981 Engineering Chemistry, Wiley India Pvt. Ltd.
3. Richard Szeliksy "Computer Vision: Algorithms and Applications" 2nd edition 2022. ISBN: 9783030343743.
1. Deep Learning, Goodfellow and Yoshua Bengio, Aaron Courville, 2016, MIT press. ISBN: 9780262035613

e-Resources

MOOCs:

1. Computer Vision and Image Processing - Fundamentals and Applications, By Prof. M. K. Bhuyan, available at https://onlinecourses.nptel.ac.in/noc23_ee39/preview
2. Deep Learning for Computer Vision, By Prof. Vineeth N Balasubramanian, available at https://onlinecourses.nptel.ac.in/noc21_cs93/preview

Course Category	Program Elective Course 3	Course Code	CE124PE607A
Course Title: Advanced Network Systems			

Teaching Scheme					Evaluation Scheme					
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks	
						Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Computer Networks and Security (CE124PC503)

Course Objectives:

1. To understand advanced computer networking architectures and protocols.
2. To analyze network performance using traffic modeling and queuing theory.
3. To study wireless, mobile and ad-hoc networking technologies.
4. To understand modern networking paradigms such as SDN and NFV.
5. To explore multimedia, optical and next-generation networking technologies.

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

CO1	Explain advanced networking architecture and transport mechanisms.
CO2	Analyze network performance using traffic modeling and queuing theory.
CO3	Apply concepts of wireless, mobile and ad-hoc networking.
CO4	Illustrate Software Defined Networking (SDN) and Network Function Virtualization (NFV) architectures.
CO5	Evaluate multimedia, optical and emerging networking technologies.

Syllabus

Unit I	Network Performance Modeling and Queuing Theory	8 Hrs

Review of probability concepts, Random variables and probability distributions, Generating functions, Poisson, Markov, renewal and semi-Markov processes ,Characteristics of queuing systems, Little's Law, Markovian and non-Markovian queueing systems, Embedded Markov chain applications, M/G/1 and G/M/1 queue models, Networks of queues (open and closed

queueing networks), Priority queues and queues with vacations, Queues with modulated arrival processes, Discrete-time queues, Introduction to matrix-geometric methods, Applications in computer and communication networks

Case Study: Enterprise Network Design for a Multi-Branch Organization

Unit II	Wireless Networks and Mobile IP	7 hrs

Infrastructure of wireless networks, Types of wireless networks, Wireless LAN technologies, EEE 802.11 wireless standards, Cellular networks architecture, Wireless communication technologies: 3G, 4G, 5G, Mobile IP concepts and mobility management, Wireless Mesh Networks (WMNs)

Case Study: Improving Performance of a Campus LAN Using VLANs

Unit III	Mobile Ad-hoc and Sensor Networks	7 Hrs

Overview of Wireless Ad-hoc Networks (MANETs), Routing in Ad-hoc networks, Routing protocols for Ad-hoc networks, Wireless Sensor Networks (WSN), Sensor network protocol structures, Communication energy model, Clustering protocols, Routing protocols in sensor networks

Case Study: Routing Optimization in an ISP Backbone Networks

Unit IV	Software Defined Networking and Network Virtualization	7 Hrs

Comparison between traditional networks and SDN, SDN architecture and working principles, SDN controller and switch design, Controller–switch communication protocols, OpenFlow protocol, Control overhead and handoff algorithms, Network Function Virtualization (NFV) architecture, NFV orchestration and use cases, NFV support for 5G networks

Case Study: Managing Network Congestion During Online Streaming Events

Unit V	Multimedia, Optical and Overlay Networks	10 Hrs

Advanced Networking and Multimedia Communication: Virtual Private Networks (VPNs), Multiprotocol Label Switching (MPLS), overlay networks and tunnelling; IP telephony and VoIP architecture including signaling protocols and real-time media transport. Multimedia communication: streaming audio/video, RTP and RTSP protocols, distributed multimedia networking, and Stream Control Transmission Protocol (SCTP), Optical Networks and WDM Systems : Optical network architecture, optical networking devices, large-scale optical switches and routers, wavelength allocation techniques in WDM systems, and case study of an all-optical switch. Edge Computing and Edge Networking: Concept, architecture, components, and challenges of edge computing and edge networking.

Case Study: Securing Cloud-Based Corporate Networks

Reference Books:Text Books:

1. Computer Networking: A Top-Down Approach – James F. Kurose and Keith W. Ross, 8th Edition, Pearson, 2021.
2. Computer and Communication Networks – Nader F. Mir, 2nd Edition, Pearson.

References Books:

1. Data Communications and Networking – Behrouz A. Forouzan, 6th Edition, McGraw Hill, 2022.
2. Computer Networks – Andrew S. Tanenbaum and David J. Wetherall, 6th Edition, Pearson, 2021.
3. An Engineering Approach to Computer Networking – Srinivasan Keshav, Pearson Education.
4. Campus Network Design Fundamentals – Diane Teare and Catherine Paquet, Cisco Press.
5. The Internet and Its Protocols – Adrian Farrel, Morgan Kaufmann.

e-Recourses:

1. NPTEL Course on Computer Networks and Internet Protocol by Prof. Soumya Kanti Ghosh and Prof. Sandip Chakraborty available at https://nptel.ac.in/courses/106105183
2. NPTEL Course on Advanced Computer Networks by Prof. Neminath Hubballi and Prof. Sameer G. Kulkarni available at https://nptel.ac.in/courses/106106243

Course Category	Program Elective Course 3	Course Code	CE124PE607C
Course Title: Data Mining and Warehousing			

Teaching Scheme					Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
3	0	0		3	CCE	50	20			
Total Hours					ESE	50	20	40	-	-
39 HOURS	-	-	51 HOURS	90 HOURS		100				

Prerequisites: Data Engineering **(**CE124PC501)	
Course Objectives: 1. To provide a strong foundation in data mining concepts, functionalities, and pre-processing techniques. 2. To enable students to understand and apply association rule mining algorithms for discovering frequent patterns. 3. To introduce data warehouse concepts and architectures for supporting analytical decision-making. 4. To develop skills in multidimensional data modelling and OLAP operations. 5. To equip students with knowledge of clustering techniques and outlier analysis for exploratory data analysis	
Course Outcomes: After successful completion of the course the student will be able to	
CO1	Explain fundamental concepts of data mining, system architecture, applications, and data pre-processing techniques.
CO2	Analyse and implement association rule mining techniques and frequent itemset generation algorithms such as Apriori and FP-Growth.
CO3	Describe data warehouse concepts, architecture, characteristics, and ETL processes.
CO4	Design multidimensional data models and perform OLAP operations using various schema designs and OLAP server architectures.
CO5	Apply appropriate clustering and outlier detection techniques to analyze different types of data, including high-dimensional data.

Syllabus

Unit I	Fundamentals of Data Mining	5 Hrs

Introduction to Data Mining, Data Mining Functionalities, Classification of Data Mining Systems, Architecture of a Typical Data Mining System, Applications of Data Mining Concept Hierarchy Generation .

Case Study: Customer Recommendation System

Unit II	Association Rule Mining – Algorithms and Optimization	6 hrs

Association Rule Mining – Algorithms and Optimization Association Rule Mining: Problem Definition, Frequent Itemset Generation, The Apriori Principle, Support and Confidence Measures, Association Rule Generation, Apriori Algorithm,Partition-Based Algorithms, FP-Growth Algorithm, Efficient and Scalable Frequent Itemset Mining Methods,Compact Representation of Frequent Itemsets, Maximal Frequent Itemsets, Closed Frequent Itemsets

Case Study: Market Basket Analysis

Unit III	Data Warehouse Fundamentals	5 Hrs

Introduction to Data Warehousing, Operational Databases vs Data Warehouses, Characteristics of Data Warehouses, Data Warehouse Architecture and Component, Extraction–Transformation–Loading (ETL) Process

Case Study: Business Intelligence System

Unit IV	Multidimensional Data Modelling and OLAP	5 Hrs

Logical (Multidimensional) Data Modeling, Schema Design-Star Schema, Snowflake Schema, Fact Constellation, Fact Table Concepts-Fully Additive, Semi-Additive, Non-Additive Measures, Factless Fact Tables, Dimension Table Characteristics, OLAP Cube, OLAP Operations (Roll-up, Drill-down, Slice, Dice, Pivot), OLAP Server Architecture-ROLAP, MOLAP, HOLAP

Case Study: Sales Analysis System.

Unit V	Cluster Analysis	5 Hrs

Cluster Analysis Overview, Types of Data in Cluster Analysis, Categorization of Major Clustering Methods, Partitioning Methods, Hierarchical Clustering Methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High-Dimensional Data, Constraint-Based Cluster Analysis, Outlier Analysis

Case Study: Customer Segmentation

Text Books:

1. Han, Jiawei Kamber, Micheline Pei and Jian, "Data Mining: Concepts and Techniques", Elsevier Publishers, ISBN:9780123814791, 9780123814807.
2. Parag Kulkarni, "Reinforcement and Systemic Machine Learning for Decision Making" by Wiley-IEEE Press, ISBN: 978-0-470-91999-6

References Books:

1. Alex Berson, Stephen J. Smith , "Data Warehousing, Data Mining & OLAP" , McGRAW-HILL (ISBN 0-07-006272-2)
2. Pang-Ning Tan Michael Steinbach Anuj Karpatne Vipin Kumar, "Introduction to Data Mining", Pearson Addison-Wesley, ISBN, 9332586055, 9789332586055

e-Recourses:

1. **NPTEL Course on** Data Mining: **by Prof. Pabitra Mitra**
   Link: https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2. **NPTEL Course on** Data Mining for Decision Making by **Prof. Varun Datta** Link: https://onlinecourses.nptel.ac.in/noc26_cs14/preview

Course Category	Program Elective Course 3 Lab	Course Code	CE124PE608
Course Title: Computer Vision Lab			

Teaching Scheme					Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Mathematical Foundation of Computer Engineering, (CE124PC303)

Course Objectives:

1. To introduce the fundamental concepts and components of digital image processing systems.
2. To develop understanding of image pre-processing, enhancement, and spatial filtering techniques.
3. To provide knowledge of edge detection, segmentation, and image classification methods.
4. To familiarize students with supervised and unsupervised learning approaches in image analysis.
5. To understand image and video compression techniques and relevant compression standards.

Course Outcomes: After successful completion of the course units the student will

CO1	Understand fundamental concepts of digital image processing, image acquisition, and components of image processing systems.
CO2	Apply image pre-processing techniques such as filtering, noise reduction, histogram processing, and intensity transformations.
CO3	Implement edge detection and image segmentation methods using classical and machine learning approaches.
CO4	Apply supervised and unsupervised techniques including SVM and CNN for image segmentation and classification.
CO5	Analyze and implement image compression techniques including coding methods and transform-based compression, and evaluate image and video compression standards.

CO	Topic	Assignment 1
CO1	Study and Implementation of Fundamental Steps in Digital Image Processing	Study the components of an image processing system and implement fundamental steps including image acquisition, sampling, quantization, and basic image transformations.
		Assignment 2
CO1	Image Enhancement and Geometric Transformations	Implement image enhancement techniques and perform geometric transformations such as rotation on digital images, and analyze their impact on image quality.
		Assignment 3
CO2	Image Pre-processing Techniques and Intensity Transformations	Implement image pre-processing techniques including grayscale conversion, normalization, intensity transformation functions, and histogram processing, and analyze their effect on image quality.
		Assignment 4
CO2	Image Filtering and Spatial Filtering Techniques	Apply image filtering and noise reduction techniques using spatial filtering methods, and evaluate the performance of different filters on noisy images.
		Assignment 5
CO3	Study and Implementation of Edge Detection Operators	Study the concept, types, and applications of edge detection and implement Sobel, Prewitt, and Roberts Cross operators on sample images to compare their performance.
		Assignment 6
CO3	Canny Edge Detection and Performance Analysis	Implement the Canny edge detection algorithm and compare its results with other edge detection operators based on accuracy, noise sensitivity, and edge localization.
		Assignment 7
CO4	Image Segmentation using Thresholding, Clustering, and Superpixel Techniques	Implement image segmentation methods including thresholding, clustering, grouping, and superpixel generation, and compare their effectiveness on different types of images.
		Assignment 8
CO4	Supervised and Unsupervised Image Segmentation using SVM and CNN	Apply supervised and unsupervised segmentation techniques using Support Vector Machine and Convolutional Neural Networks, and perform image classification with performance analysis.
		Assignment 9
CO5	Image Compression Techniques using Coding Methods	Study the need for image compression and different types of redundancies in images, and implement lossless compression techniques such as Huffman coding, Arithmetic coding, and Predictive coding with performance comparison.
		Assignment 10
CO5	Transform-Based Image Compression and Compression Standards	Implement transform-based compression using Discrete Cosine Transform (DCT), and analyze image and video compression standards with respect to efficiency and quality.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Program Elective Course 3 Lab	Course Code	CE124PE608
Course Title: Advanced Network Systems Lab			

		Teaching Scheme			Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Computer Networks and Security (CE124PC503)

Course Objectives:

1. To provide understanding of modern networking architectures including wireless networks, MANETs, WSNs, SDN, and NFV
2. To develop knowledge of routing protocols, mobility management, virtualization, and programmable network design.
3. To introduce real-time communication systems such as VoIP, multimedia streaming, and transport protocols used in distributed networks.
4. To familiarize students with high-speed networking technologies including VPN, MPLS, optical networks, and WDM systems.
5. To understand emerging paradigms such as 5G networks and edge computing, along with their architectural components and challenges.

Course Outcomes: After successful completion of the course units the student will

CO1	Understand and compare traditional, wireless, ad-hoc, and software-defined networking architectures, including SDN, NFV, and next-generation network models.
CO2	Analyze routing, mobility management, clustering, and energy-efficient communication protocols in MANETs, WSNs, and cellular networks (3G, 4G, 5G).
CO3	Apply concepts of virtualization, controller–switch communication, OpenFlow, MPLS, VPNs, and tunneling in programmable and scalable network design.
CO4	Evaluate real-time communication systems including VoIP, RTP/RTSP, streaming protocols, SCTP, and distributed multimedia networking.
CO5	Analyze advanced networking infrastructures such as optical networks, WDM systems, edge computing, and large-scale switching architectures for high-speed and low-latency communication systems.

CO	Topic	Assignment 1
CO1	Stochastic Processes and Queueing System Modeling	To simulate non-Markovian queuing models using discrete-time events to calculate system throughput and mean waiting time using Little's Law.
		Assignment 2
CO1	Advanced Queueing Models and Applications in Networks	To simulate M/G/1 and G/M/1 queuing models using Little's Law and design a fault-tolerant multi-branch enterprise network architecture.
		Assignment 3
CO2	Wireless Network Infrastructure and WLAN Technologies	Study the infrastructure and types of wireless networks, analyze Wireless LAN technologies and IEEE 802.11 standards, and explain cellular network architecture.
		Assignment 4
CO2	Advanced Wireless Communication and Mobility Management	Analyze wireless communication technologies including 3G, 4G, and 5G, and study Mobile IP concepts, mobility management techniques, and Wireless Mesh Networks.
		Assignment 5
CO3	Routing in Wireless Ad-hoc Networks (MANETs)	Study the architecture of Mobile Ad-hoc Networks (MANETs) and analyze different routing protocols used in ad-hoc networks, comparing their performance and suitability for dynamic environments.
		Assignment 6
CO3	Wireless Sensor Networks and Energy-Efficient Routing	Examine the structure of Wireless Sensor Networks (WSNs), communication energy models, clustering protocols, and routing protocols, and analyze their role in energy-efficient data transmission.
		Assignment 7
CO4	Software Defined Networking (SDN) Architecture and Protocols	Set up a basic SDN environment using Mininet and an SDN controller, implement OpenFlow-based communication between controller and switches, and analyze network behavior.
		Assignment 8
CO4	Network Function Virtualization (NFV) Architecture and Applications	Deploy a simple virtual network function using virtualization tools and study NFV architecture, orchestration, and its role in supporting 5G networks.
		Assignment 9
CO5	VPN and MPLS Network Simulation with VoIP	Configure and analyze VPN and MPLS-based networking using simulation tools, and study VoIP communication by implementing signaling and real-time media transport protocols such as RTP/RTSP and SCTP.

		Assignment 10
CO5	WDM, Optical Routers and Edge Computing	Study optical network components including WDM systems, optical switches, and routers through simulation or case study, and analyze edge computing architecture, components, and networking challenges**.**
CO4, CO5	**MINI PROJECT**	1. Design and simulation of an SDN-based intelligent traffic management system using OpenFlow and Mininet. 2. Implementation of energy-efficient routing protocols in Wireless Sensor Networks (WSNs) for smart environmental monitoring. 3. Simulation of MPLS-based VPN network with integrated VoIP communication for real-time data transmission. 4. Tools: NS-2 / NS-3, MATLAB,GNS3 / Cisco Packet Tracer, Wireshark,Mininet.

Rubrics for Continuous Evaluation

Component	**Level**	**Parameters**	**Marks**	**Total**	**Passing**
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Program Elective Course 3 Lab	Course Code	CE124PE606
Course Title: Data Mining and Warehousing Lab			

Teaching Scheme					Evaluation Scheme						
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks		
						Max	Min Marks for Pass		Max	Min for Pass	
0	0	0	2	2	CCE	-	-	-	50 -	20	40
Total Hours					ESE	-	-		50	20	
-	-	26 HOURS	34 HOURS	60 HOURS		-	-		100		

Prerequisites: Fundamentals of Data Structures [CE124PC301] , Programming and Problem Solving[ESC2402L08]

Course Objectives:

1. To introduce students to the fundamental concepts of data mining and data warehousing.
2. To develop understanding of data preprocessing, association rule mining, clustering, and outlier detection techniques.
3. To enable students to design multidimensional data models and data warehouse schemas.
4. To provide practical knowledge of OLAP operations and warehouse architectures.
5. To equip students with the ability to apply data mining techniques to real-world datasets for decision-making.

Course Outcomes: After successful completion of the course units the student will

CO1	Understand the fundamental concepts of data mining, data warehousing, ETL processes, and multidimensional data modeling.
CO2	Apply data preprocessing techniques to clean, transform, reduce, and prepare datasets for mining.
CO3	Implement and analyze association rule mining algorithms such as Apriori and FP-Growth.
CO4	Design data warehouse schemas and perform OLAP operations using appropriate server architectures.
CO5	Apply clustering techniques and outlier detection methods to analyze and interpret real-world datasets.

Programming Tools Recommended :	For Data Warehouse Project : MySQL or SQLite Microsoft Excel (for simple OLAP operations) For Coding :Jupyter Notebook

CO	Topic	Assignment 1
CO1	Data Preprocessing Techniques in Data Mining	Implement data preprocessing techniques on a real-world dataset to clean, transform, reduce, and discretize the data. Prepare the final dataset suitable for applying data mining algorithms
		Assignment 2
CO1	Association Rule Mining using Apriori Algorithm	Apply the Apriori algorithm on a transactional dataset to generate frequent itemsets and association rules. Analyze the impact of different support and confidence values on the generated rules.
		Assignment 3
CO2	Frequent Itemset Generation and Association Rule Mining using Apriori Algorithm	Implement the Apriori algorithm on a transactional dataset to generate frequent itemsets and association rules using support, confidence, and the Apriori principle.
		Assignment 4
CO2	Efficient Frequent Itemset Mining using FP-Growth, Maximal and Closed Itemsets	Implement FP-Growth and analyze efficient frequent itemset mining methods by identifying maximal and closed frequent itemsets and comparing performance with Apriori.
		Assignment 5
CO5	Study of Data Warehousing Concepts, Characteristics, and Architecture	Study and analyze the concepts of data warehousing, compare operational databases with data warehouses, and explain the architecture and components of a data warehouse system.
		Assignment 6
CO6	Implementation of ETL Process for Data Warehouse Development	Design and implement a basic ETL process to extract, transform, and load data from operational sources into a data warehouse structure.
		Assignment 7
CO7	Multidimensional Data Modeling and Schema Design in Data Warehousing	Design a multidimensional data model for a given case study and implement Star Schema, Snowflake Schema, and Fact Constellation schema by identifying fact tables, dimension tables, and different types of measures (fully additive, semi-additive, non-additive), including factless fact tables.
		Assignment 8
CO8	OLAP Cube Design and OLAP Operations	Create an OLAP cube for a given dataset and perform OLAP operations such as roll-up, drill-down, slice, dice, and pivot, and analyze the working of ROLAP, MOLAP, and HOLAP server architectures.
		Assignment 9
CO9	Implementation of Partitioning and Hierarchical Clustering Methods	Perform cluster analysis on a given dataset by applying partitioning and hierarchical clustering methods, analyze different types of data used in clustering, and interpret the quality of the generated clusters.
		Assignment 10
CO10	Advanced Clustering Techniques and Outlier	Implement density-based, grid-based, or model-based clustering methods on a dataset, analyze clustering in high-dimensional

	Analysis	data, and perform outlier detection with proper interpretation of results.
CO4, CO5	**MINI PROJECT**	1. Market Basket Analysis: Analyze customer purchase patterns using Apriori and FP-Growth to generate association rules. or 2. Data Warehouse & OLAP: Design a sales data warehouse and perform multidimensional analysis using OLAP operations. or 3. Clustering & Outlier Detection: Segment customers using clustering techniques and identify unusual data patterns. **Dataset** : Create a small sample dataset. Or Download from sources like Kaggle or UCI Machine Learning Repository.

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Course Category	Multidisciplinary Minor 4	Course Code	CE124MD609
Course Title: Data Science with Python			

Teaching Scheme					Evaluation Scheme					
L	T	P	*SL	Cr	Exam	Theory Marks			Practical Marks	
						Max	Min Marks for Pass		Max	Min for Pass
2	0	0		2	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
26 HOURS	-	-	24 HOURS	60 HOURS		100				

Prerequisites:. Fundamental understanding of Python programming[ESC2402L08]

Course Objectives:

1. Understand the fundamentals of Python programming and its role in data science applications.
2. Apply Python libraries such as NumPy and Pandas for data manipulation, cleaning, and analysis.
3. Perform exploratory data analysis (EDA) using statistical methods and visualization techniques.
4. Implement basic data science and machine learning techniques to analyze real-world datasets.
5. Develop practical skills in data visualization and interpretation to support data-driven decision making.

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

CO1	Explain core concepts of Python programming relevant to data science problems.
CO2	Use Python libraries (NumPy, Pandas) to preprocess, clean, and transform datasets.
CO3	Perform exploratory data analysis using statistical measures and visualization tools.
CO4	Apply basic machine learning techniques using Python for classification or prediction tasks.
CO5	Interpret and present analytical results effectively using appropriate plots and reports.

Syllabus

Unit I	Python Fundamentals	4 hrs
Python language basics: syntax, variables, data types, Input/output, operators, expressions, Control structures: `if`, `else`, loops (`for`, `while`), Functions, modules, packages, Data structures: lists, tuples, dictionaries, sets, Object-oriented programming: classes & objects, inheritance, File handling, exception handling Case study: Simulation on any data set		
Unit II	**Python for Data Science**	**5hrs**
Essential Libraries-NumPy — arrays, vectorized operations, Pandas — data frames, indexing, data cleaning, transformations, Matplotlib/Seaborn — basic plots and visualization, Scikit-Learn — machine learning toolbox (regression, classification), Data Preprocessing & Wrangling-Cleaning data: handling missing values, Mapping and transforming data types, Aggregation, grouping, Preparing datasets for models Case study: NumPy for calculations		
Unit III	**Exploratory Data Analysis (EDA)**	**5hrs**
Summary statistics, Histogram, box plot, scatter plot, Correlation and descriptive insights, Using Pandas & visualization tools for data understanding, **Statistical Foundations**-Descriptive statistics (mean, variance, median), Probability basics, Hypothesis testing, Correlation & distributions Case Study: Exploratory Data Analysis (EDA) on above Dataset		
Unit IV	**Machine Learning Basics**	**4hrs**
Linear Regression, Logistic Regression, Classification basics, Clustering (e.g., k-means), Train/test evaluation concepts Case Study: Customer Segmentation (K-Means Clustering)		
Unit V	**Data Visualization and Data Analytics Life Cycle**	**6hrs**
Plotting with Matplotlib / Seaborn, Visual interpretation of data trends, Histograms, bar charts, density plots, Data Analytics Life Cycle- Discovery → Data Preparation → Model Planning, Model Building → Communication → Operationalization Case study: Analysis/Customer Segmentation on Dataset Note: Use any one data set for above case studies		

Text Books:

1. J. VanderPlas, *Python Data Science Handbook: Essential Tools for Working with Data*. Sebastopol, CA, USA: O'Reilly Media, 2016.
2. W. McKinney, *Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython*, 2nd ed. Sebastopol, CA, USA: O'Reilly Media, 2018.

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References Books:

1. M. Harrison, *Learning the Pandas Library*. Birmingham, U.K.: Packt Publishing, 2016.
2. M. Pradhan and U. D. Kumar, *Machine Learning Using Python*. New Delhi, India: BPB Publications, 2019.
3. W. McKinney and Pandas Development Team, *Pandas: Powerful Python Data Analysis Toolkit*. Sebastopol, CA, USA: O'Reilly Media, 2018.

4. V. P. Heuring and H. F. Jordan, *Computer System Design and Architecture*, 3rd ed. Boston, MA, USA: Pearson, 2018.

e-Resources

1. **NPTEL: *Python for Data Science* by Rengaswamy, R. (n.d.).** **https://nptel.ac.in/courses/106/106/106106212/**

Course Category	Vocational and Skill Enhancement Course 4	Course Code	CE124VS610
Course Title: Cyber Security and Data Protection-2			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	**T**	**P**	***SL**	**Cr**	**Exam**	**Max**	**Min Marks for Pass**		**Max**	**Min for Pass**
1	**0**	**2**		**2**	**CCE**	**50**	**20**	**40**	**-**	**-**
Total Hours					**ESE**	**50**	**20**			
13	**-**	**26 HOURS**	**34 HOURS**	**60 HOURS**		**100**				

Prerequisites: Programming and Problem Solving **[ESC2402L08]**

Course Objectives:

1. Understand advanced cyber security concepts and threat landscapes affecting modern computing systems.
2. Apply cryptographic techniques and secure communication protocols to protect data and information systems.
3. Analyze and design secure network and system architectures using modern security tools and practices.
4. Identify, assess, and mitigate vulnerabilities in web, application, and cloud environments.
5. Develop skills in cyber forensics, incident response, and emerging security technologies.

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

CO1	Explain advanced cyber security concepts, attack methodologies, and threat modeling techniques.
CO2	Apply cryptographic algorithms and secure communication protocols to ensure confidentiality and integrity.
CO3	Analyze and secure networks, operating systems, and endpoints using appropriate security mechanisms.
CO4	Detect and mitigate vulnerabilities in web applications and cloud-based systems.
CO5	Perform basic cyber forensics and incident response activities while adhering to legal and ethical standards.

Unit I	Cyber Security Fundamentals & Threat Landscape	2 Hrs
Cyber security concepts and objectives, Types of cyber threats: malware, ransomware, spyware, zero-day attacks, Attack vectors and threat modelling, Cyber kill chain and MITRE ATT&CK framework, Vulnerabilities, exploits, and risk assessment, Cyber security standards and frameworks (ISO 27001, NIST) Case Study: Ransomware Attack/Data Breach		
Unit II	**Cryptography and Secure Communication**	**3 Hrs**
Review of cryptographic principles, Symmetric and asymmetric cryptography, Hash functions and digital signatures, Public Key Infrastructure (PKI), Key management and certificate authorities, Secure communication protocols (SSL/TLS, HTTPS, SSH) Case study: SSL/TLS Vulnerability/MD5 Collision Attack		
Unit III	**Exploratory Data Analysis (EDA)**	**3 Hrs**
Network security architecture, Firewalls, IDS, IPS, Virtual Private Networks (VPN), Wireless security (WPA2, WPA3), Endpoint security and hardening, Secure operating systems and access control models Case study: Corporate Network Security Breach/VPN Security		
Unit IV	**Web, Application & Cloud Security**	**2 Hrs**
Web application vulnerabilities (OWASP Top 10), Secure coding practices, Web security testing tools, Cloud security challenges and solutions, Security in virtualized and containerized environments, Identity and access management in cloud systems Case study: Web Application Vulnerability/ SQL Injection Attack		
Unit V	**Advanced Security Topics & Cyber Forensics**	**2 Hrs**
Malware analysis and reverse engineering (introductory), Ethical hacking and penetration testing concepts, Security incident response and management, Digital forensics process and tools, Cyber laws, cyber ethics, and compliance, Emerging trends: AI in cyber security, blockchain security Case study: Malware Analysis/ Ethical Hacking		

Text Books:

1. W. Stallings, Cryptography and Network Security: Principles and Practice, 8th ed. Harlow, U.K.: Pearson, 2022.
2. J. Graham, R. Olson, and R. Howard, Cyber Security Essentials, 1st ed. Boca Raton, FL, USA: Auerbach Publications, Taylor & Francis Group, 2010..

References Books:

1. C. P. Pfleeger and S. L. Pfleeger, *Security in Computing*, 5th ed. Boston, MA, USA: Pearson, 2015.
2. J. López and G. Tsudik, Eds., Applied Cryptography and Network Security, Lecture Notes in Computer Science (LNCS), vol. 3531. Berlin, Germany: Springer, 2005.
3. N. Ferguson, B. Schneier, and T. Kohno, Cryptography Engineering: Design Principles and Practical Applications. Indianapolis, IN, USA: Wiley Publishing, 2010.

e-Resources

1. "Cryptography and Network Security," by S. Mukhopadhyay Available: https://nptel.ac.in/courses/106105162

Course Category	Non Credit Course7	Course Code	CE124NC611
Course Title: Human Right			

	Teaching Scheme				Evaluation Scheme					
						Theory Marks			Practical Marks	
L	T	P	*SL	Cr	Exam	Max	Min Marks for Pass		Max	Min for Pass
0	0	2		2	CCE	50	20	40	-	-
Total Hours					ESE	50	20			
26 HOURS	-	-	34 HOURS	60 HOURS		100				

Prerequisites:	
Course Objectives: 1. To introduce the constitutional framework of rights and duties, emphasizing their role in democratic governance. 2. To explore the intersection of human rights with climate change, conservation, and environmental sustainability. 3. To analyze the impact of geopolitics, judicial activism, and security concerns on human rights protection. 4. To develop research and reporting skills through DPR preparation on human rights issues. 5. To inculcate ethical awareness in digital ownership, plagiarism, intellectual property, and global initiatives for digital protection.	
Course Outcomes: After successful completion of the course, student will be able to	
CO1	Describe constitutional rights and duties, and evaluate their significance in promoting responsible citizenship.
CO2	Explain the link between human rights and environmental issues such as climate change, conservation, and sustainability.
CO3	Apply critical thinking to assess the role of geopolitics, judicial activism, and security frameworks in human rights protection.
CO4	Prepare structured reports (DPRs) on human rights issues, demonstrating research, analysis, and documentation skills.
CO5	Demonstrate ethical practices in digital ownership, plagiarism prevention, and responsible use of digital resources.

CO	Assignment 1
CO1	**Fundamental Rights in the Constitution**: Prepare a detailed report on the Fundamental Rights enshrined in the Indian Constitution, highlighting their significance and limitations. Include at least two landmark case studies where these rights were upheld or challenged.
	Assignment 2
	Fundamental Duties in the Constitution: Write an essay on the Fundamental Duties of Indian citizens, explaining their role in promoting responsible citizenship and sustainable governance. Provide examples of how these duties are relevant in contemporary society.
	Assignment 3
CO2	Human Rights & Climate Change: Conduct a case study on the impact of climate change on vulnerable communities (e.g., coastal regions, farmers). Discuss how environmental degradation threatens basic human rights such as health, livelihood, and shelter.
	Assignment 4
	Geopolitics and Human Rights: Prepare a presentation analyzing how geopolitical conflicts (wars, refugee crises, sanctions) affect human rights globally. Use at least one recent example to support your analysis.
	Assignment 5
CO3	Detailed Project Report (DPR): Draft a DPR on a chosen human rights issue (e.g., child labor, gender equality, digital privacy). Include objectives, methodology, data sources, and expected outcomes.
	Assignment 6
	Conservation of Natural Resources: Write a report on how conservation of natural resources ensures the right to life and livelihood. Include examples of Indian policies or initiatives supporting conservation.
	Assignment 7
CO4	Environmental Rights: Analyze judicial pronouncements in India that recognize the right to a clean environment as a fundamental right. Discuss at least two landmark cases.
	Assignment 8
	Judicial Activism: Prepare a case study on landmark judgments where judicial activism strengthened human rights (e.g., Vishaka Guidelines, Right to Privacy case).
	Assignment 9
CO5	Security & Vulnerability: Write a critical essay on balancing national security concerns with individual rights. Use examples from counter-terrorism laws or surveillance policies.
	Assignment 10
	National & International Human Rights Bodies: Prepare a comparative report on the role of the National Human Rights Commission (NHRC) in India and the United Nations Human Rights Council (UNHRC).

Text Books:

1. Balancing Human Rights, Social Responsibility, and Digital Ethics – Maja Pucelj & Rado Bohinc, IGI Global, August 2024.
2. Human Rights in the Digital Domain – Edited by Tiina Pajuste, Cambridge University Press, October 2025.
3. International Human Rights Law and Practice – Updated edition, Oxford University Press, 2024.
4.

References Books:

1. Human Rights in the Digital Domain – Cambridge University Press, 2025 (Open Access, CC-BY-NC 4.0).
2. Balancing Human Rights, Social Responsibility, and Digital Ethics – IGI Global, 2024.
3. Handbook of Human Rights and Technology – Routledge, 2024.

e-Resources

1. **Climate Change and the Right to Education Lab for Youth : Faculty from Global Campus of Human Rights:**
   https://copilot.microsoft.com/chats/7zGHk7vPwyXesXNDYBeSk#:~:text=Course%20Link-,(gchumanrights.org%20in%20Bing),-Human%20Dignity%20and

2. **Human Rights Due Diligence for Decent Work (2025 Edition): Experts from International Labour Organization (ILO):**
   https://copilot.microsoft.com/chats/7zGHk7vPwyXesXNDYBeSk#:~:text=Course%20Link-,(ilo.org%20in%20Bing),-International%20Women%E2%80%99s%20Health

Course Category	Non Credit Course 8	Course Code	CE124NC612
Course Title: Aptitude & Technical Mastery for Placements 4			

Teaching Scheme				Evaluation Scheme				
L	T	P	Cr	Exam	Theory Marks		Practical Marks	
					Max	Min Marks for Pass	Max	Min for Pass
0	0	40	0	CCE ESE	-	-	50	20
Total Hours: 40								

Prerequisites: Basic Mathematical Knowledge, Basic Logical Thinking Ability, Basic Communication Skills,Problem-Solving Interest,Awareness of Placement Process

Course Objectives: Purposes of the course are

1. To UNDERSTAND basic quantitative and numerical aptitude concepts.
2. To LEARN logical reasoning and problem-solving techniques.
3. To DEVELOP effective group discussion skills.
4. To IMPROVE communication and interview performance.
5. To PREPARE students for placement and recruitment processes.

Course Outcomes: After successful completion of the course units the student will

CO	CO Statement	BTL
CO1	APPLY quantitative aptitude concepts to solve placement-based numerical problems.	3
CO2	ANALYZE logical reasoning questions to make accurate and quick decisions.	4
CO3	DEMONSTRATE effective communication and teamwork during group discussions.	4
CO4	PREPARE and PRESENT confident responses in personal interviews.	5
CO5	EXHIBIT overall placement readiness using professional and interview skills.	5

Syllabus

Unit I	Analytical Mathematics	12 hrs
Partnerships , Geometry 2D , Geometry - 3D, Percentages		
Unit II	**Numerical Problem Solving**	**6 hrs**
Simplifications & Approximations , Surds and Indices , Logarithms, Alligations & Mixtures		
Unit III	**Logical Thinking & Problem Solving**	**10 hrs**
Inequalities, Seating arrangement, Mirror and water images , Alphabet Series + Analogy, Number Puzzles		
Unit IV	**Group Interaction Skills**	**6 hrs**
Types of Group Discussions, Topic Analysis & Content Building, Evidence-Based Arguments, Speaking & Vocal Modulation Skills, Handling Dominant or Silent Participants, Time Management in GD, Conflict Resolution in GD, Leadership in GD		
Unit V	**Interview Preparation Skills**	**6 hrs**
Grooming & Professional Appearance, Company & Role Research , Questions to Ask the Interviewer, Handling Difficult Situations, Communication Mastery for Interviews Interview Psychology , Body Language Interpretation, Personal Branding for Interviews Salary Negotiation Basics, Red Flags & How to Avoid Them		

Textbook:

1. Quantitative Aptitude for Competitive Examinations – R.S. Aggarwal
2. How to Prepare for Quantitative Aptitude for CAT – Arun Sharma
3. Fast Track Objective Arithmetic – Rajesh Verma
4. Quantitative, Analytical, Logical & Verbal Aptitude for Campus Placement – Joseph M. Mathew

Reference Books:

1. Business Communication – Bovee, Thill & Chaturvedi
2. Technical Communication – Raman Sharma
3. Improve Your Communication Skills – Alan Barker
4. How to Prepare for Group Discussion and Interview – Hari Mohan Prasad & Rajnish Mohan
5. Resumes and Interviews: The Art of Winning – M. Ashraf Rizvi

Research Paper

1. **Review on Employability Skills**

https://www.researchgate.net/publication/271293771_A_Review_on_Employability_Skills

2. **Soft Skills and Software Development: A Reflection from the Software Industry**

https://arxiv.org/abs/1507.06873

Rubrics for Continuous Evaluation

Component	Level	Parameters	Marks	Total	Passing
Continuous Comprehensive Evaluation (CCE)	Progressive Evaluation	Attendance	12	50	20
		Implementation of Assignments	18		
		Quality of Journal	10		
		Viva-Voce	10		
	End Evaluation	Practical Examination	50	50	20

Multiple Entry and Multiple Exit

As per Nep 2020 policy, students have the provision of **Multiple entry and Multiple Exit options.**

The following are the details of the additional credits which the students have to additionally complete for the applicable exit options.

1. The additional 8 Credits for Exit option courses, that are based on Internships/ Skill Courses / mini projects and So on is as stated below.
   The structure of the Exit course will be as below

Course Basket	Details	Qualification Title	4 Credits	4 Credits
EXIT 0	After FY BTech with Eligible Credits	One Year UG Certificate in Engg./ Tech	Internship in Industry/ Incubation Centre	Domain Specific Mini Project
EXIT 1	After SY BTech with Eligible Credits	Two Years UG Diploma in Engg./ Tech	Internship in Industry/ Incubation Centre	Domain Specific Mini Project
EXIT 2	After TY BTech with Eligible Credits	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	Internship in Industry/ Incubation Centre	Domain Specific Mini Project

Credit Framework

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	One Year UG Certificate in Engg./ Tech.	40	44	2	1
5.0	Two Years UG Diploma in Engg./ Tech.	80	88	4	2
5.5	Three Years Bachelor's Degree in Vocation (B. Voc.) or B. Sc. (Engg./ Tech.)	120	132	6	3
	4-Years Bachelor's degree				

*** Concerned Students must Mandatorily complete additional 8 credits in 4 weeks' time for the available Exit options as per the UGC Guidelines

a. **Multiple Exits:** Students will have the flexibility to enter a programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs. ·

   i. Students exiting the First Year programme after securing minimum 40 credits will be awarded UG Certificate in the relevant Discipline /Subject provided they secure 8 credits in work-based vocational courses or internship / Apprenticeship offered during summer vacation in addition to 4 credits from skill-based courses earned during the first and second semester.

   ii. Students exiting the Second Year Programme after securing minimum 80 credits will be awarded UG Diploma in the relevant Discipline /Subject provided they secure additional 8 credits in skill-based vocational courses (skill-based courses, internship, mini projects etc) offered during summer vacation after the second year.

   iii. Students exiting the 3-year UG program will be awarded B.Voc. in the relevant Discipline /Subject upon securing minimum 120 credits with additional 8 credits in skill-based vocational courses (skill-based courses, internship, mini projects etc.) offered during summer vacation after the sixth semester.

   iv. Exit options shall be provided with Certification, Diploma and B. Vocational degrees to the students at the end of the second, fourth and sixth semester, respectively, in the four-year degree programme. Students will receive a Bachelor's degree with the single minor on successfully completing all eight semesters of the UG Programmes either at a stretch or with opted exits and re-entries. In addition to this, student will receive a Bachelor's degree with Double Minor/Honours/ Research subject to earning additional 18 credits.

b. **Re-entry or Lateral Entry:** Students, opting for exits at any level, will have the option to re-enter the programme from where they had left off, in the same or in a different higher education institution within four years of exit and **complete the degree programme within the stipulated maximum period of eight years from the date of admission to first year UG**.

c. Re-entry at various levels for lateral entrants in academic programmes shall be based on the earned and valid credits as-deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher & Technical Education Institutions (RHTEI) and proficiency test records.

d. Lateral entry into the programme of study leading to the UG Diploma/ B. Vocational/ UG Bachelor's Degree with single minor/ UG Bachelor's Degree with Double Minor/ Honours /Research will be based on the validation of prior learning outcomes achieved and subject to availability based on intake capacity.