

SEMESTER 5

**COMPUTER SCIENCE AND ENGINEERING
(DATA SCIENCE)**

SEMESTER S5

COMPUTER NETWORKS

(Common to CS/CD/CM/CR/CA/AD/AI/CB/CN/CU/CI)

Course Code	PCCST501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce the core concepts of computer networking.
2. To develop a big picture of the internetworking implementation on Linux-based systems.
3. To impart an overview of network management concepts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Overview of the Internet, Protocol layering (Book 1 Ch 1) Application Layer: Application-Layer Paradigms, Client-server applications - World Wide Web and HTTP, FTP. Electronic Mail, DNS. Peer-to-peer paradigm - P2P Networks, Case study: BitTorrent (Book 1 Ch 2)	6
2	Transport Layer: Services, Protocols, UDP, TCP (Book 1 Ch 3). <i>Hands-on: Sockets Introduction, Elementary TCP Sockets, TCP Client/Server Example, I/O Multiplexing: The select and poll Functions (Book 2 Ch 3 to 6), Elementary UDP Sockets (Book 2 Ch 8), Advanced I/O Functions (Book 2 Ch 14)</i> Network Layer: Introduction, Network-layer protocols, Unicast routing, Multicast routing - Multicasting Basics, Intra domain and inter-domain routing, Next generation IP (Book 1 Ch 4), Quality of Service (Book 1 Ch 8) <i>Hands-on: Linux Kernel Implementation of Routing Table and Caches, Routing Cache Implementation Overview, Adding new entry in the Routing Table using ip command (Book 3 Ch 14)</i>	18

3	Data-Link Layer: Data link control (DLC), Multiple access protocols (MAC), Link-layer addressing, Ethernet protocol, Connecting devices (Book 1 Ch 5) Wireless LANs, Mobile IP (Book 1 Ch 6) <i>Hands-on: Datalink Provider Interface, SOCK_PACKET and PF_PACKET (Book 2 Ch 29)</i>	11
4	SNMP, ASN.1 (Book 1 Ch 9) Physical Layer: Data and signals, Digital transmission, Analog transmission, Bandwidth utilization, Transmission media (Book 1 Ch 7)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the internetworking design in terms of protocol stack and the role of various application layer protocols	K2
CO2	Illustrate the functions of the transport layer from connectionless and connection-oriented perspectives	K3
CO3	Identify how the network layer achieves host-to-host connectivity and caters to the diverse service requirements of the host applications	K3
CO4	Explain the nuances of the data link layer design and demonstrate the various data link link layer protocols	K3
CO5	Describe the fundamental characteristics of the physical layer and understand how the physical layer supports the functionalities of the top layers	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3	2										3
CO3	3	2			2							3
CO4	3	2										3
CO5	3											3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks: A Top-Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
3	TCP/IP Architecture, design, and implementation in Linux	Sameer Seth M. Ajaykumar Venkatesulu	Wiley	1/e, 2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networking: A Top-Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022
2	Computer Networks, A Systems Approach	L. L. Peterson and B. S. Davie	Morgan Kaufmann	5/e, 2011

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/106/105/106105183/

SEMESTER S5

DESIGN AND ANALYSIS OF ALGORITHMS

(Common to CS/CD/CM/AM/CB/CN/CU/CG)

Course Code	PCCST502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs 30 Min.
Prerequisites (if any)	PCCST303	Course Type	Theory

Course Objectives:

1. To gain a foundational understanding of algorithms and their analysis.
2. To develop problem-solving skills using various algorithm design paradigms like divide and conquer, dynamic programming, etc.
3. To understand the concepts of tractable and intractable problems, and different complexity classes (P, NP, NP-hard, NP-complete).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Algorithms – Characteristics, Criteria for Analysing Algorithms; Time and Space Complexity - Best, Worst, and Average Case Complexities; Asymptotic Notations and their properties; Time and Space Complexity Calculation of simple algorithms; Analysis of Recursive Algorithms - Recurrence Equations, Solution of Recurrence Equations : Iteration Method, Recursion Tree Method, Substitution method and Master's Theorem (proof not expected); Balanced Search Trees - AVL Trees (Insertion and deletion operations with all rotations in detail, algorithms not expected)	11

2	Disjoint Sets - Disjoint set operations, Union and find algorithms, Analysis of union by rank with path compression, Connected components of a Graph; Graphs – Representations, Traversals : BFS, DFS and their analysis, Strongly Connected Components; Topological Sorting. Divide and Conquer Strategy – Control Abstraction, Merge Sort, Strassen’s Matrix Multiplication, Analysis.	11
3	Greedy Strategy - Control Abstraction, Fractional Knapsack; Minimum Cost Spanning Tree – Kruskal’s and Prim’s, Analysis; Shortest Path Problem – Dijkstra’s Algorithm, Analysis; Dynamic Programming - Control Abstraction, Optimality Principle, Matrix Chain Multiplication, Analysis; All Pairs Shortest Path Algorithm - Floyd-Warshall Algorithm, Analysis; Backtracking - Control Abstraction, N – Queens Problem, Algorithm.	11
4	Branch and Bound - Control Abstraction, Travelling Salesman Problem, Algorithm; Complexity - Tractable and Intractable Problems; Complexity Classes : P, NP, NP- Hard and NP-Complete Classes; NP Completeness proof - Clique Problem and Vertex Cover Problem; Approximation algorithms - Bin Packing; Randomized Algorithms - Definitions of Monte Carlo and Las Vegas algorithms; Randomized version of Quick Sort algorithm with analysis.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none">• Each question carries 9 marks.• Two questions will be given from each module, out of which 1 question should be answered.• Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze any given algorithm and express its time and space complexities in asymptotic notations.	K4
CO2	Solve the recurrence equations using Iteration, Recurrence Tree, Substitution and Master's Method to compute time complexity of algorithms.	K3
CO3	Illustrate the operations of advanced data structures like AVL trees and Disjoint sets.	K3
CO4	Illustrate the representation, traversal and different operations on Graphs.	K3
CO5	Demonstrate Divide-and-conquer, Greedy Strategy, Dynamic programming, Branch-and Bound and Backtracking algorithm design techniques.	K2
CO6	Classify a problem as computationally tractable or intractable, and discuss strategies to address intractability.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyze, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2								3
CO2	3	3	3									2
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3	2								2
CO6	3	3	3	2								2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	T.H.Cormen, C.E.Leiserson, R.L.Rivest, C. Stein,	Prentice-Hall India	4/e, 2018
2	Fundamentals of Computer Algorithms	Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran,	Orient Longman Universities Press	2/e, 2008
3	Computer Algorithms, Introduction to Design and Analysis	Sara Baase and Allen Van Gelder	Pearson Education	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design and Analysis of Algorithms	Michael T. Goodrich Roberto Tamassia	Wiley	1/e, 2021
2	Algorithm Design	Jon Kleinberg, Eva Tardos	Pearson Education	1/e, 2005
3	Algorithms	Robert Sedgewick, Kevin Wayne	Pearson Education	4/e, 2011
4	Fundamentals of Algorithmics	Gilles Brassard, Paul Bratley	Pearson Education	1/e, 1996
5	The Algorithm Design Manual	Steven S. Skiena	Springer	2/e, 2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106131/
2	https://www.coursera.org/learn/dynamic-programming-greedy-algorithms
3	https://online.stanford.edu/courses/soe-yescalgorithms1-algorithms-design-and-analysis-part-1
4	https://online.stanford.edu/courses/soe-ycs0001-algorithms-design-and-analysis-part-2

SEMESTER S5

DATA ANALYTICS

Course Code	PCCDT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To equip students with the knowledge and skills necessary to analyze and interpret complex data sets to extract useful patterns and relationships between data.
2. To teach how to handle data effectively, perform exploratory data analysis, build predictive models and communicate findings through data visualization.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Data Analytics-Analytics Process Model, Analytical Model Requirements. Data Analytics Life Cycle overview, Probability calculus - probability distributions, Hypothesis Testing - Basic definitions. Proximity measures - Data Objects, Attribute types, Dissimilarity and Similarity measures Statistical Description of data - Central tendency, Dispersion, Range, Quartiles, Variance, Standard Deviation, and Interquartile Range.	11
2	Association of Two Variables-Summarizing the Distribution of Two Discrete Variables, Contingency Tables for Discrete Data, Joint, Marginal, and Conditional Frequency Distributions, Graphical Representation of Two Nominal or Ordinal Variables, Measures of Association for Two Discrete Variables, Association Between Ordinal and Continuous Variables, Visualization of Variables from Different Scales.	11

3	Data Preprocessing – Cleaning, Integration, Reduction, Transformation, Discretization Mining Frequent Patterns - Associations, Correlations, and Apriori Algorithms. Classification - General Approach to Classification, ID3, Attribute selection measures, Naive Bayesian Classification. Clustering-K-Means, Agglomerative versus Divisive Hierarchical Clustering, BIRCH, DBSCAN.	11
4	Text Processing - Boolean retrieval, Example IR problem, inverted index, processing Boolean queries, tokenization, stemming, phrase queries, vector space model, finite automata and language model, query likelihood model, naïve bayes text classification.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the key concepts of data analytics	K2
CO2	Describe the tools to analyse, summarize, and visualize associations between two variables and various measures of association	K2
CO3	Use the concepts of association rule mining and the basic clustering and classification algorithm on small datasets.	K3
CO4	Explain the basics of text analytics and text classification	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Statistics and DataAnalysis	Christian Heumann, Michael Schomaker	Springer	1/e, 2016
2	Data Mining Concepts and Techniques	Jiawei Han, Micheline Kamber	Elsevier	3/e, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction To Data Mining	Pang-Ning Tan, Michael Steinbach, Vipin Kumar	Pearson Education	1/e, 2016
2	Analytics in a Big Data World: The Essential Guide to Data Science and its Business Intelligence and Analytic Trends	Bart Baesens	John Wiley Sons	1/e, 2014
3	Mining Text Data	Charu C. Aggarwal, ChengXiang Zhai	Springer	1/e, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106107220
2	https://archive.nptel.ac.in/courses/106/105/106105174/
3	https://nptel.ac.in/courses/110106072
4	https://archive.nptel.ac.in/courses/106/105/106105158/

SEMESTER S5

BIG DATA PROCESSING

Course Code	PBCDT504	CIE Marks	60
Teaching Hours/Week (L:T:P:R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide an overview of storage, retrieval and processing of big data.
2. To introduce the tools and techniques employed to handle Big Data using technologies such as Map Reduce, Hadoop, Hbase, Pig, Hive and Spark.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Big data and Hadoop Distributed File System:- Evolution of Big data, Big data characteristics, RDBMS and Big Data. History of Hadoop, Hadoop Ecosystem and Core Components, HDFS Architecture: Blocks, Name nodes and Data nodes, Using HDFS Files - Basic File system Operations, Hadoop Specific File Types. Anatomy of a file read and write.	11
2	MapReduce Programming:- Data Processing with MapReduce: Execution Pipeline, Runtime Coordination and Task Management in MapReduce, Designing MapReduce implementations: Using MapReduce as a framework for parallel processing, Face Recognition Example: Simple Data Processing with MapReduce, Inverted Indexes Example, Road Enrichment Example. Projects using R, Python, Java	11

3	HBase and Stream Data Model:- HBase Architecture, HBase Schema Design, Introduction to Stream Concepts, Stream Data Model and Architecture, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream.	11
4	Hive, Pig, Spark:- Hive - Features, Data types and file formats, primitive and collection data types, HiveQL-Creating tables, Dropping Tables, Alter table. Pig : Data Model, Pig Latin: Structure, Functions, Spark: Storage layers for spark, Core spark concepts, RDD basics, RDD Operations. Projects using R,Python,Java	11

Suggestion on Project Topics

Log File Analysis: Collect log files from web servers or applications and analyze them to extract useful information like error rates, traffic patterns, and popular pages.

Sentiment Analysis on Social Media Data: Collect tweets or social media posts and perform sentiment analysis to understand public opinion on a particular topic or product.

Recommendation System: Build a recommendation system based on user behavior data, such as purchase history or viewing patterns.

Word Count with MapReduce: Implement the classic word count problem where you count the frequency of each word in a large set of text documents.

Course Assessment Method (CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the principles of big data and distributed systems, including the characteristics of large datasets and the fundamentals of building and maintaining reliable, scalable, distributed systems.	K2
CO2	Infer the mechanisms of distributed storage and processing, with a specific focus on the role of HDFS (Hadoop Distributed File System) in effective data storage.	K3
CO3	Model the distributed processing of large data sets across clusters using simple programming models.	K3
CO4	Identify and understand the fundamentals of stream computing and the usage of HBase.	K2
CO5	Apply the fundamental features and components of Hive, Pig, and Spark for data processing.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3	3	3							3
CO4	3	3	3	3	2							3
CO5	3	3	3	3	3							3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Professional Hadoop Solutions	Boris Lublinsky, Kevin T. Smith, Alexey Yakubovich	Wrox	1/e, 2013
2	The Art of R Programming: A Tour of Statistical Software Design	Norman Matloff	No Starch Press	1/e, 2011
3	Learning Spark, Lightning-Fast Data Analytics	Holden Karau, Andy Konwinski, Patrick Wendell, Matei Zaharia	O'Reilly	2/e, 2020
4	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Capriolo	O'Reilly	1/e, 2012
5	Mining of Massive Datasets	Jure Leskovec, Anand Rajaraman and Jeffrey David Ullman,	Cambridge University Press	3/e, 2020
6	BIG DATA, Black Book	Black Book TM	DreamTech Press	1/e, 2016
7	R for Everyone: Advanced Analytics and Graphics	Jared P. Lander	Pearson Education	2/e, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Big Data and Analytics	Seema Acharya, Subhasni Chellappan	Wiley	2/e, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/r5k-_RLIpuA https://onlinecourses.nptel.ac.in/big data computing

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S5

SOFTWARE PROJECT MANAGEMENT

(Common CS/CD/CM/CR/CA/AD/AM)

Course Code	PECST521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs.30 Min.
Prerequisites (if any)	PECST411	Course Type	Theory

Course Objectives:

1. To learn the techniques to effectively plan, manage, execute, and control projects within time and cost targets with a focus on Information Technology and Service Sector.
2. To learn agile project management techniques such as Scrum and DevOps.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Project scheduling and feasibility study :- Project Overview and Feasibility Studies - Identification, Market and Demand Analysis, Project Cost Estimate, Financial Appraisal; Project Scheduling - Project Scheduling, Introduction to PERT and CPM, Critical Path Calculation, Precedence Relationship, Difference between PERT and CPM, Float Calculation and its importance, Cost reduction by Crashing of activity.	8
2	Resource Scheduling, Cost Control and Project management Features :- Cost Control and Scheduling - Project Cost Control (PERT/Cost), Resource Scheduling & Resource Levelling; Project Management Features - Risk Analysis, Project Control, Project Audit and Project Termination.	8
3	Agile Project Management :- Agile Project Management - Introduction, Agile Principles, Agile methodologies, Relationship between Agile Scrum, Lean, DevOps and IT Service Management (ITIL); Other Agile Methodologies - Introduction to XP, FDD, DSDM, Crystal.	9

4	<p>Scrum and DevOps in project management :-</p> <p>Scrum - Various terminologies used in Scrum (Sprint, product backlog, sprint backlog, sprint review, retro perspective), various roles (Roles in Scrum), Best practices of Scrum, Case Study; DevOps - Overview and its Components, Containerization Using Docker, Managing Source Code and Automating Builds, Automated Testing and Test-Driven Development, Continuous Integration, Configuration Management, Continuous Deployment, Automated Monitoring, Case Study.</p>	11
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand how effectively plan, and schedule projects within time and cost targets	K2
CO2	Apply project estimation and evaluation techniques to real world problem	K3
CO3	Discuss different Agile Project Methodologies	K2
CO4	Apply various SCRUM practices in project management.	K3
CO5	Demonstrate the techniques used in DevOps.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3								2	2
CO2	3	3	3								2	2
CO3	3	3	3								2	2
CO4	3	3	3								2	2
CO5	3	3	3								2	2

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Succeeding with Agile: Software Development Using Scrum	Mike Cohn	Addison-Wesley	1/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Agile Product Management with Scrum	Roman Pichler	Addison-Wesley	1/e, 2010
2	Agile Project Management with Scrum	Ken Schwaber	Microsoft Press	1/e, 2004

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/noc/courses/noc19/SEM2/noc19-cs70/
2	https://www.youtube.com/watch?v=TPEgII1OiIU
3	https://www.youtube.com/watch?v=7Bxdds2siU8

SEMESTER S5

ARTIFICIAL INTELLIGENCE

Course Code	PECST522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To lay a solid foundation of the important abstractions, techniques, and reasoning for intelligent systems.
2. To enable the learners to understand the basic principles of Reinforcement Learning.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Artificial Intelligence:- Introduction, Foundation and history of AI Agents and Environments; The concept of rationality; The nature of environments, Structure of agents. Problem solving Agents Well-defined problems and solutions, Formulating problems; Example problems- vacuum world, 8-puzzle, 8-queens.	8
2	Searching:- Depth First Search, Breadth First Search, Iterative Deepening Search. Heuristic Search strategies - Heuristic functions, The effect of heuristic accuracy on performance; Generate and test, Greedy best first search, A* algorithm, Constraint satisfaction problems, Adversarial search - Games, Optimal Decision in games, The minimax algorithm, Alpha-beta pruning.	10
3	Knowledge-Based Agents :- The Wumpus World, Logic, Propositional Logic, Reasoning Patterns in Propositional Logic, First order logic, Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining.	8

4	Reinforcement Learning :- Learning from Rewards, Passive Reinforcement Learning, Active Reinforcement Learning, Generalization in Reinforcement Learning, Policy Search, Apprenticeship and Inverse Reinforcement Learning, Applications of Reinforcement Learning	10
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Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain how intelligent agents can solve problems.	K2
CO2	Use the different types of search methods to solve various problems.	K3
CO3	Formulate knowledge representation and examine resolution in propositional logic and first order logic.	K3
CO4	Utilize reinforcement learning techniques to create intelligent agents.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2
CO3	2	2	2	2	-	-	-	-	-	-	-	2
CO4	3	2	2	2	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	AI – A Modern Approach	Stuart Russel, Peter Norvig	Pearson Education	4/e, 2021
2	Artificial Intelligence	Kevin Knight, Elaine Rich, Shivashankar B. Nair	Tata McGraw-Hill	3/e, 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Artificial Intelligence and Expert Systems	Dan W. Patterson	Pearson Education	1/e, 2015
2	Artificial Intelligence: Structures and Strategies for Complex Problem Solving	George F. Luger	Pearson Education	6/e, 2009
3	Artificial Intelligence : Making a System Intelligent	Nilakshi Jain	Wiley	1/e, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=X_Qt0U66aH0
2	https://www.youtube.com/watch?v=te1K8on1Pk0
3	https://www.youtube.com/watch?v=SEJhMO1IXZs
4	https://youtu.be/YaPSPu7K9S0?si=DizMPlZ9uVSy50iG

SEMESTER S5

DATA PRIVACY AND SECURITY

Course Code	PECDT523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a fundamental understanding of data security, encryption and confidentiality.
2. To introduce students to the concepts of hash functions, digital signatures and data hiding within text and images.
3. To provide learners an overview of legal and ethical issues in data.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Security and Ciphers Introduction: Security goals, Cryptographic Attacks, Services and Mechanism, Techniques. Traditional Symmetric Key Ciphers: Introduction, Substitution Ciphers, Transposition Ciphers, Stream and Block Ciphers. Introduction to Modern Symmetric-Key Ciphers: Modern Block Ciphers, Modern Stream Ciphers.	12
2	Symmetric and Asymmetric encryption algorithms Data Encryption Standard (DES): Introduction, DES Structure, DES Analysis, Multiple DES, Security of DES. Advanced Encryption Standard (AES): Introduction, Transformations, Key Expansion, AES Ciphers, Analysis of AES. Asymmetric-Key Cryptography: Introduction, RSA Cryptosystem, Rabin Cryptosystem, Elgamal Cryptosystem, Elliptic Curve Crypto systems.	12
3	Hash Functions, Digital Signature and Data Hiding Cryptographic Hash Functions: Introduction, Iterated Hash function, SHA-512, WHIRLPOOL. Digital Signature: Comparison, Process, Services, Attacks on	12

	Digital Signature, Digital Signature Standard. Data Hiding in Text: Basic Features, Applications of Data Hiding, Watermarking, Intuitive Methods, Simple Digital Methods, Data Hiding in Text, Innocuous Text, Mimic Functions. Data Hiding in Images: LSB Encoding, BPCS Steganography, Lossless Data Hiding, Spread Spectrum Steganography, Data Hiding by Quantization, Patchwork , Signature Casting in Images, Transform Domain Methods, Robust Data Hiding in JPEG Images, Robust Frequency Domain Watermarking, Detecting Malicious Tampering.	
4	Privacy, Legal and Ethical Issues Privacy: Privacy Concepts, Privacy Principles and Policies, Authentication and Privacy, Data Mining, Privacy on the Web, E-Mail Security, Impacts on Emerging Technologies. Legal and Ethical Issues in Computer Security: Protecting Programs and Data, Information and the Law, Rights of Employees and employers, Redress for Software Failures, Computer Crime, Ethical Issues in Computer Security.	12

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> 2 Questions from each module. Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none"> Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate a thorough understanding of core data security concepts, including the operation and application of different symmetric key ciphers to effectively safeguard information.	K2
CO2	Apply a range of encryption standards to achieve robust data protection and confidentiality, ensuring secure transmission and storage of sensitive information.	K3
CO3	Gain proficiency in the use of hash functions for data security and master techniques for embedding and concealing data within text and images to safeguard sensitive information.	K2
CO4	Acquire a comprehensive understanding of privacy principles, authentication methods and security protocols for web and email communications, ensuring secure and private digital interactions.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2		-			-		3
CO2	2	2	3	3	2	2	-			-		3
CO3	3	2	2	2	3	2	-			-		3
CO4	3	3	3	2	2	3	-			-		3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryptography and Network Security	Behrouz A. Forouzan, Dedeeep Mukhopadhyay	TMH	2/e, 2013
2	Data Privacy and Security	Salomon, David	Springer	1/e, 2003
3	Security in Computing	Charles Pfleeger, Shari Lawrence Pfleeger	PHI	5/e, 2015
Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Information Security: Principles and Practice	Mark Stamp	Wiley Inter Science	2011
2	Computer Security: Art and Science	Matt Bishop	Addison Wesley	1/e, 2002
3	Cryptography and Network Security	William Stallings	Pearson Education	7/e, 2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/106105162
2	https://nptel.ac.in/courses/106105162
3	https://nptel.ac.in/courses/106105162

SEMESTER S5

DATA COMPRESSION

(Common to CS/CD/CM/CR/AD/AI/AM/CN/CI)

Course Code	PECST524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To introduce students to basic applications, concepts, and techniques of Data Compression.
2. To develop skills for using recent data compression software to solve practical problems in a variety of disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Compression Techniques :- Data Compression Approaches - Variable-Length Codes, Run-Length Encoding, Space - Filling Curves, Dictionary-Based Methods, Transforms, Quantization. Huffman Encoding - Huffman Decoding, Adaptive Huffman Coding, Facsimile Compression. Run Length Encoding (RLE), RLE Text compression, Dictionary based Coding- LZ77, LZ78, LZW and Deflate: Zip and Gzip compression.	10
2	Advanced Techniques :- Arithmetic Coding - The Basic Idea, Implementation, Underflow; Image Compression- Introduction, Approaches to Image Compression, History of Gray Codes, Image Transforms, Orthogonal Transforms, The Discrete Cosine Transform, Intermezzo: Statistical Distributions, JPEG, Human Vision and Color, The Wavelet Transform, Filter Banks, WSQ, Fingerprint Compression	10

3	Video Compression :- Video Compression - Analog video, Digital Video, Motion Compensation. MPEG standards MPEG, H.261	8
4	Audio Compression :- Audio Compression - Companding, The Human Auditory System, Heinrich Georg Barkhausen, Linear Prediction, μ -Law and A-Law Companding, Shorten	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the fundamental approaches in data compression techniques	K2
CO2	Illustrate various classical data compression techniques	K3
CO3	Illustrate various text and image compression standards	K3
CO4	Describe the video compression mechanisms to reduce the redundancy in video	K3
CO5	Understand the fundamental principles of audio data compression	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3										3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3										3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Concise Introduction to Data Compression	David Salomon	Springer	1/e, 2008
2	Data compression: The Complete Reference	David Salomon	Springer	3/e, 2004
3	Introduction to Data Compression	Khalid Sayood	Morgan Kaufman	1/e, 2003

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fractal and wavelet Image Compression techniques	Stephen Welstead,	PHI	1/e, 1999
2	Multimedia System	Sleinreitz	Springer	1/e, 2006
3	The Data Compression Book	Mark Nelson, Jean-loup Gailly	BPB Publications	1/e, 1996

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	An Introduction to Information Theory by Prof. Adrish Banerjee zt IIT Kanpur https://onlinecourses.nptel.ac.in/noc22_ee49/preview

SEMESTER S5

COMPUTATIONAL BIOLOGY

Course Code	PEADT526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Develop exposure in Computational Tools and Techniques for Biological Data Analysis
2. To equip students with hands-on experience in applying computational tools and software to biological problems and to familiarize them to current research trends in computational biology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to biomolecules, DNA, RNA, and Protein: The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, translation, introduction to structure of prokaryotic and eukaryote gene	9
2	Introduction to Biological Databases: NCBI, Genbank, Bio sequence formats:FASTA, Sequence alignment: Global Alignment and Local Alignment, Dot Matrix Method, Dynamic Programming Method, Gap Penalties, Amino Acid Scoring Matrices: PAM and BLOSUM, Database Similarity Searching, BLAST, Needleman and Wunsch and Smith–Waterman Method, Multiple Sequence Alignment, scoring function, Clustal,	10
3	Transcriptional Regulatory Networks, Genes and DNA Regulatory Regions, Genetic Interaction Map, Protein Interaction Networks, Experimental methodologies to obtain Protein Interaction Data, Computational methods to Predict Protein: Protein Interactions, Visualization of Protein Interaction Networks, Metabolic Networks, Interacting Partners, Mathematical Representation.	10

4	Next-Generation Sequencing (NGS) Technologies, Illumina Reversible Dye-Terminator Sequencing, Ion Torrent Semiconductor Sequencing, Pacific Biosciences Single Molecule Real-Time (SMRT) Sequencing, RNA-sequencing (RNA Seq), Protein-DNA Interaction Analysis (ChIP-Seq), Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Mapping Approaches and Algorithms	9
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Course Assessment Method

(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the structure and function of DNA, RNA proteins, Gene structure and process of transfer of information from DNA to protein	K2
CO2	Identify biological data formats and databases and employ similarity searching tools and algorithms to align sequences to highlight the similarity	K3
CO3	Demonstrate Networks in Biology, types of networks and its representation	K3
CO4	Explain Next Generation sequencing Technologies and DNA Protein interaction analysis	K3
CO5	Apply computational tools and algorithms to analyze NGS data.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Bioinformatics	Lesk, Arthur M	Oxford University Press	5/e, 2019
2	Bioinformatics and Computational Biology A Primer for Biologists	Basant K. Tiwary	Springer Nature Singapore	1/e, 2022
3	Bioinformatics An Introduction	Jeremy Ramsden	Springer London	1/e, 2016
4	An Introduction to Bioinformatics Algorithms	Neil C. Jones, Pavel Pevzner	MIT Press	1/e, 2004
6	Next-Generation Sequencing Data Analysis	Wang, Xinkun	CRC Press	1/e, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Bioinformatics and Computational Biology: A Primer for Biologists	Tiwary, Basant K	Springer	1/e, 2022
2	Quickstart Molecular Biology: An Introductory Course for Mathematicians, Physicists, and Computational Scientists	Benfey, Philip N.	Cold Spring Harbor Laboratory Press	1/e, 2014
3	Bioinformatics	Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart	John Wiley & Sons	4/e, 2020
4	Essentials of Bioinformatics	Shaik, Noor Ahmad, et al	Springer	1/e, 2019
5	Applied bioinformatics	Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer	Springer, Verlag	1/e, 2008
6	Bioinformatics: Methods and Applications	S C Rastogi, N Mendiratta and P Rastogi	PHI Learning Private Limited	4/e, 2013
7	Fundamental Concepts of Bioinformatics	D E Krane and M L Raymer	Pearson Education	1/e, 2006
8	Bioinformatics: Sequence and Genome Analysis	Bradley E. Shapiro and Jennifer J. Dudock	Garland Science	1/e, 2007

Video Links (NPTEL, SWAYAM...)

Module No.	
1	https://onlinecourses.swayam2.ac.in/cec21_bt04/preview
2	https://onlinecourses.nptel.ac.in/noc20_bt08/preview
3	https://onlinecourses.nptel.ac.in/noc23_bt34/preview
4	https://onlinecourses.nptel.ac.in/noc23_bt34/preview

SEMESTER S5

COMPUTER GRAPHICS & MULTIMEDIA

(Common to CS/CD/CR/CA/AD)

Course Code	PECST527	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide strong technological concepts in computer graphics including the three-dimensional environment representation in a computer, transformation of 2D/3D objects and basic mathematical techniques and algorithms used to build applications.
2. To give a good understanding of the multimedia frameworks for audio/video domains and different compression algorithms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Computer graphics - Basics of Computer Graphics and its applications. Video Display devices - LED, OLED, LCD, PDP and FED and reflective displays. Random and Raster scan displays and systems. Line and Circle drawing Algorithms - Line drawing algorithms- Bresenham's algorithm, Liang-Barsky Algorithm, Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's Circle drawing algorithm.	10
2	Geometric transformations - 2D and 3D basic transformations - Translation, Rotation, Scaling, Reflection and Shearing, Matrix representations and homogeneous coordinates. Filled Area Primitives - Scan line polygon filling, Boundary filling and flood filling.	8
3	Transformations and Clipping Algorithms - Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping	8

	<p>algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms.</p> <p>Three dimensional graphics - Three dimensional viewing pipeline. Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm.</p>	
4	<p>Fundamental of Multimedia - Introduction to Multimedia, Authoring and Tools, Graphics and Image Data Representations, Popular File Formats, Fundamental Concepts and types of Video, Basics of Digital Audio and its types.</p> <p>Compression Methods - Lossless Compression Algorithms- Run-Length Coding, Arithmetic Coding. Lossy Compression Algorithms- Transform Coding, JPEG and JPEG-LS Standard Image Compression, H.261. Video Compression Technique.</p>	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks <p style="text-align: center;">(8x3 =24 marks)</p>	<ul style="list-style-type: none"> ● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. <p style="text-align: center;">(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles of computer graphics and displays	K2
CO2	Illustrate line drawing, circle drawing and polygon filling algorithms	K3
CO3	Illustrate 2D and 3D basic transformations and matrix representation	K3
CO4	Demonstrate different clipping algorithms and 3D viewing pipeline.	K3
CO5	Summarize the multimedia features and specific compression algorithms.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3	3								3
CO3	3	3	3	3								3
CO4	3	3	3	3								3
CO5	3	3	3									3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Graphics : Algorithms and Implementations	D. P. Mukherjee, Debasish Jana	PHI	1/e, 2010
2	Computer Graphics with OpenGL	Donald Hearn, M. Pauline Baker and Warren Carithers	PHI	4/e, 2013
3	Fundamentals of Multimedia	Ze-Nian Li and Mark S. Drew	Pearson	2003

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Flat Panel Displays	Jiun-Haw Lee, I-Chun Cheng, Hong Hua, Shin-Tson Wu	Wiley	1/e, 2020
2	Computer Graphics and Multimedia	ITL ESL	Pearson	1/e, 2013
3	Computer Graphics	Zhigang Xiang and Roy Plastock	McGraw Hill	2/e, 2000
4	Principles of Interactive Computer Graphics	William M. Newman and Robert F. Sproull	McGraw Hill	1/e, 2001
5	Procedural Elements for Computer Graphics	David F. Rogers	McGraw Hill	1/e, 2017
6	Computer Graphics	Donald D Hearn, M Pauline Baker	Pearson	2/e, 2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1, 2, 3	Computer Graphics By Prof. Samit Bhattacharya at IIT Guwahati https://onlinecourses.nptel.ac.in/noc20_cs90/preview
4	Web Based Technologies and Multimedia Applications by Prof. P. V. Suresh at Indira Gandhi National Open University https://onlinecourses.swayam2.ac.in/nou20_cs05/preview

SEMESTER S5

ADVANCED COMPUTER ARCHITECTURE

Course Code	PECST528	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBCST404	Course Type	Theory

Course Objectives:

1. To introduce the advanced processor architectures including parallelism concepts in Programming of multiprocessor and multicomputers.
2. To provide detailed understanding about data flow in computer architectures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Introduction – The impact of hardware and software technology trends Self review – Instruction set Architecture, Memory addressing, addressing modes Class of Computers, Concept of Computer Hardware and Organization (P15, 5th Edition) Measuring, Reporting and Summarizing Performance, Benchmarks – Desktop and Server Amdahl's Law, Processor Performance Equation</p> <hr/> <p><i>Beyond the books</i> – Visit www.spec.org. Explore the High Performance Computing benchmarks and compare the results submitted by different vendors for the same benchmark. Are you able to appreciate the need for benchmarks to compare performance? What are retired benchmarks? Can you write a paper and publish results based on a retired benchmark?</p>	
2	<p>Review the basic Concepts of Parallel Processing and Pipelining Instruction Level Parallelism, data dependencies and hazards Different types of dependences, Compiler Techniques for ILP, Branch Prediction – Correlating</p>	

	branch predictor Dynamic Scheduling – Idea, Introduction to Tomasulo’s scheme. Register Renaming Hardware Speculation, Reorder Buffers Multiple issue and static scheduling, VLIW	
3	Data Level Parallelism. Vector Processors – How do they work, Memory Banks, Stride, Scatter Gather. SIMD-comparison with vector GPU, Comparison of loops in C vs CUDA NVIDIA GPU Memory structure Vector Processor vs GPU, Multimedia SIMD computers vs GPU Multiprocessor Architecture, Centralized shared memory architecture Cache coherence and snooping protocol (Implementation details – not required). Performance of Symmetric Shared-Memory Processors. Distributed Shared Memory and Directory based protocol – basics. Synchronization – Basic Hardware Primitives. Memory Consistency Models – Sequential and relaxed	
4	Warehouse Scale Computers – Goals and requirements. Programming frameworks for Batch processing – Map reduce and Hadoop Computer Architecture of Warehouse-scale computers Moore’s Law, Dennard Scaling, Dark Silicon and the transition towards Heterogeneous Architectures Asymmetric multi-core architecture – Static and Dynamic (Overall idea, example processors) Functional Heterogeneous Multicore architecture – GPUs, Accelerators, Reconfigurable Computing Beyond the textbook – Identify the processor used in your PC and mobile phone. Study about its architecture, is it homogeneous or heterogeneous, does it use GPUs, what information can you gather about it from the manufacturer’s website – Discuss in the class	

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none">• 2 Questions from each module.• Total of 8 Questions, each carrying 3 marks <p>(8x3 =24 marks)</p>	<ul style="list-style-type: none">• Each question carries 9 marks.• Two questions will be given from each module, out of which 1 question should be answered.• Each question can have a maximum of 3 subdivisions. <p>(4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Enumerate the different classes of computers and where they are used in everyday life.	K2
CO2	Compute the effect of hardware/software enhancements on the speedup of a processor using Amdahl's law.	K3
CO3	Interpret possible dependencies that can cause hazards in a given block of code.	K3
CO4	Summarize different strategies followed to ensure Instruction Level Parallelism.	K2
CO5	Compare different strategies followed to ensure Instruction Level Parallelism and different strategies followed to ensure Data Parallelism.	K3
CO6	Illustrate the need for memory consistency models and cache coherence protocols and explain the principle behind it.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3	3								3
CO5	3	3	3	3								3
CO6	3	3	3	3								3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer architecture: A Quantitative Approach.	Hennessy, J. and Patterson, D	Morgan Kaufman	5/e, 2012
2	The Dark Side of Silicon: Energy Efficient Computing in the Dark Silicon Era	Kanduri, Anil, et al.	Springer	1/e, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Architecture	Gérard Blanchet Bertrand Dupouy	Wiley	1/e, 2013
2	Advanced Computer Architectures	Sajjan C Shiva	Taylor & Fancis	1/e, 2018
3	Computer Architecture	Charles Fox	no starch press	1/e, 2024

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://archive.nptel.ac.in/courses/106/103/106103206/

SEMESTER S5

DATA MINING

(Common to CS/CD/CM/CA/AM)

Course Code	PECST525	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a thorough understanding of the key processes and concepts involved in data mining and data warehousing within application domains
2. To enable students to understand the different data preprocessing techniques, fundamentals and advanced concepts of classification, clustering, association rule mining, text mining and web mining, and apply these techniques in real-world scenarios

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Data Mining Fundamentals :- Data Mining - concepts and applications, Knowledge Discovery in Database Vs Data mining, Architecture of typical data mining system, Data Mining Functionalities Data warehouse - Differences between Operational Database Systems and Data Warehouses, Multidimensional data model- Warehouse schema, OLAP Operations, Data Warehouse Architecture	8
2	Data Preprocessing :- Data Preprocessing - Need of data preprocessing, Data Cleaning- Missing values, Noisy data, Data Integration and Transformation Data Reduction - Data cube aggregation, Attribute subset selection,	9

	Dimensionality reduction, Numerosity reduction, Discretization and concept hierarchy generation.	
3	<p>Classification And Clustering :-</p> <p>Classification - Introduction, Decision tree construction principle, Information Gain, Gini index, Decision tree construction algorithm - ID3, Neural networks, back propagation, Evaluation measures - accuracy, precision, recall, F1 score</p> <p>Clustering - Introduction to clustering, distance measures, Clustering Paradigms, Partitioning Algorithm - k means, Hierarchical Clustering, DBSCAN</p>	9
4	<p>Association Rule Analysis And Advanced Data Mining :-</p> <p>Association Rule Mining - Concepts, Apriori algorithm, FP Growth Algorithm</p> <p>Web Mining - Web Content Mining, Web Structure Mining- Page Rank, Web Usage Mining- Preprocessing, Data structures, Pattern Discovery, Pattern Analysis</p> <p>Text Mining - Text Data Analysis and information Retrieval, Basic measures for Text retrieval, Text Retrieval methods, Text Indexing Technique</p>	10

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Students must be asked to identify problems involving large datasets and identify the right solution from the concepts already learned. A comparison of the results with a similar approach also need to be performed to assess the Knowledge Level 5.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> • 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks) 	<p>2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions.</p> <p>Each question carries 9 marks. (4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the key process of data mining and data warehousing concepts in application domains.	K2
CO2	Apply appropriate pre-processing techniques to convert raw data into suitable format for practical data mining tasks	K3
CO3	Illustrate the use of classification and clustering algorithms in various application domains	K3
CO4	Comprehend the use of association rule mining techniques	K3
CO5	Explain advanced data mining concepts and their applications in emerging domains	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										2
CO2	3	3	3	3	2							2
CO3	3	3	3	3	2							2
CO4	3	3	3	3	2							2
CO5	2	2										2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Mining Concepts and Techniques	Jaiwei Han, Micheline Kamber	Elsevier	3/e, 2006
2	Data Mining: Introductory and Advanced Topics	Dunham M H	Pearson Education	1/e, 2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach	Addison Wesley	1/e, 2014
2	Data Mining: Concepts, Models, Methods, and Algorithms	Mehmed Kantardzic	Wiley	2/e, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/ykZ-_UGcYWg?si=qiqynQyjI1sNNiHE
2	https://youtu.be/NSxEiohAH5o?si=ZIJHMiRvpFcNQNMA
3	https://youtu.be/VsYKqOokgaE?si=rgndBZqpzB29LUGg
4	https://youtu.be/N_whCVtfL9M?si=VPMH9NP4vdAaiuPe

SEMESTER S5

ADVANCED GRAPH ALGORITHMS

Course Code	PECST595	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GAMAT401 PCCST303 PCCST502	Course Type	Theory

Course Objectives:

1. To gain proficiency in designing and implementing sophisticated graph algorithms for analyzing large-scale networks, and apply these techniques to real-world problems such as social network analysis and transportation optimization.
2. To develop the ability to critically evaluate and enhance advanced graph algorithms for dynamic and evolving graphs, using real-world case studies to illustrate their application and performance in complex scenarios.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	<p>Maximum Flow Algorithms - Dinic's Algorithm, Push-Relabel Algorithm. Applications - network bandwidth allocation, data center resource management.</p> <p>Minimum Cost Flow - Cycle-Canceling Algorithm, Capacity Scaling Algorithm. Applications - transportation logistics, network routing with cost constraints.</p> <p>Assignments:</p> <ol style="list-style-type: none">1. Network Bandwidth Allocation - Optimize bandwidth allocation in a communication network using Dinic's Algorithm. <p>Implement Dinic's Algorithm to solve a network flow problem where you are given a communication network represented as a directed graph with capacities on edges. Your goal is to maximize</p>	9

	<p>the flow from a source node to a sink node. Use a real-world network dataset (e.g., a telecommunications network with nodes and link capacities).</p> <p>2. Logistics Optimization - Optimize the transportation of goods in a supply chain network using the Capacity Scaling Algorithm.</p> <p>Use the Capacity Scaling Algorithm to address a logistics problem where you need to minimize transportation costs in a supply chain network. The network is represented as a graph where nodes represent locations (warehouses, distribution centers, etc.), and edges represent transportation routes with associated costs. Use a dataset representing a supply chain network with nodes, edges, and costs.</p>	
2	<p>Strongly Connected Components (SCC) - Tarjan's Algorithm, Kosaraju's Algorithm. Applications - analyzing web page link structures, understanding connected components in social networks.</p> <p>Dynamic Graph Connectivity - Dynamic connectivity algorithms, Eulerian and Hamiltonian paths. Applications - real-time network monitoring, dynamic route planning.</p> <p>Assignments:</p> <p>1. Web Page Link Analysis - Objective: Analyze strongly connected components (SCC) in a web graph using Tarjan's Algorithm.</p> <p>Implement Tarjan's Algorithm to find SCCs in a web graph where nodes represent web pages and edges represent hyperlinks. SCCs help in understanding the structure of the web and identifying clusters of interconnected pages. Use a real-world web graph dataset with nodes and edges.</p> <p>2. Dynamic Route Planning - Manage and analyze routes in a transportation network that evolves over time using dynamic connectivity algorithms.</p> <p>Implement dynamic connectivity algorithms to handle a transportation network where edges and nodes may be added or removed over time. The goal is to maintain and update the connectivity information efficiently. Use a dataset representing a transportation network with dynamic updates.</p>	9
3	<p>Graph Matching - Edmonds' Algorithm for finding maximum matchings. Applications - job assignment, network design.</p> <p>Graph Coloring - Colorings for special classes of graphs (e.g., planar graphs, interval graphs). Applications - frequency assignment in wireless networks,</p>	9

	<p>scheduling problems</p> <p>Assignments:</p> <ol style="list-style-type: none"> 1. Job Assignment Optimization - Solve job assignment problems using Edmonds' Algorithm. Implement Edmonds' Blossom Algorithm to address job assignment problems where you need to match workers to jobs in a way that maximizes the overall efficiency or minimizes the cost. Use a dataset with job assignments and associated costs or efficiencies. 2. Frequency Assignment - Allocate frequencies in wireless communication systems using graph coloring techniques. Apply graph coloring techniques to allocate frequencies to transmitters in a wireless communication network to avoid interference. The goal is to minimize the number of frequencies used while ensuring that adjacent transmitters do not use the same frequency. Use a dataset representing a network of transmitters with potential interference. 	
4	<p>Graph Partitioning and Community Detection - Kernighan-Lin Algorithm, Spectral Partitioning. Applications - social network community detection, large-scale data clustering.</p> <p>Parameterized Algorithms for Graph Problems - Fixed-parameter tractability for vertex cover, feedback vertex set. Applications - network security, bioinformatics.</p> <p>Assignments:</p> <ol style="list-style-type: none"> 1. Social Network Community Detection - Detect communities in a social network using the Kernighan-Lin Algorithm. Apply the Kernighan-Lin Algorithm to detect communities in a social network where nodes represent individuals and edges represent relationships. The goal is to find clusters of highly interconnected individuals. Use a social network dataset with nodes and edges representing social connections. 2. Network Security Analysis - Identify critical nodes in a network using parameterized algorithms to assess network security. Use parameterized algorithms to identify critical nodes and vulnerabilities in a network. These nodes are crucial for the network's connectivity, and their removal would impact the network's security and robustness. Use a dataset representing a network with nodes and edges, along with possible vulnerabilities. 	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Internal Ex</i>	<i>Evaluate</i>	<i>Analyse</i>	<i>Total</i>
5	15	10	10	40

Criteria for Evaluation(Evaluate and Analyse): 20 marks

Assignment evaluation pattern:

- Correctness and Accuracy (30%) - Correct Solution and Implementation.
- Effectiveness and Efficiency (25%) - Algorithm Efficiency and Performance Metrics.
- Analytical Depth (25%) - Problem Understanding and Solution Analysis.
- Justification and Comparisons (20%) - Choice Justification and Comparative Analysis.

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
<ul style="list-style-type: none"> ● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks (8x3 =24 marks) 	<p>2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 9 marks. (4x9 = 36 marks)</p>	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop and implement advanced algorithms for network flow, graph connectivity, and matching, and evaluate their performance on real-world datasets.	K3
CO2	Analyze and compare the efficiency and effectiveness of various graph algorithms, including those for network optimization and community detection.	K4
CO3	Apply advanced graph algorithms to solve practical problems such as network optimization, job assignment, and frequency allocation, demonstrating their utility in real-world scenarios.	K3
CO4	Formulate and solve complex graph-related problems using appropriate algorithms, including those for graph traversal, minimum spanning trees, and network security analysis.	K5
CO5	Critically assess the strengths and limitations of different graph algorithms, and effectively communicate findings and recommendations through detailed reports and presentations.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								2
CO2	3	3	3	3								2
CO3	3	3	3	3								2
CO4	3	3	3	3								2
CO5	3	3	3	3	3							2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Algorithms	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein	The MIT Press Cambridge	4/e 2023
2	Algorithms	Robert Sedgewick and Kevin Wayne	Addison-Wesley	4/e, 2023
3	Graph Algorithms	Shimon Even	Cambridge University Press	2/e, 2011
4	Graph Theory	Reinhard Diestel	Springer	4/e, 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Guide to Graph Algorithms	Mingyu Xiao and Ton Kloks	Springer Verlag, Singapore;	1 st , 2022
2	Network Science	Albert-László Barabási and Márton Pósfai	Cambridge University Press	1 st , 2016
3	Modern Graph Theory	Bela Bollobas	Springer-Verlag New York Inc	1 st , 1998
4	Network Flows: Theory, Algorithms, and Applications	Ravindra Ahuja, Thomas Magnanti, and James Orlin	Pearson	1 st , 1993
5	Introduction to Graph Theory	Douglas B. West	Pearson	2 nd , 2020
6	Modern Graph Theory Algorithms with Python: Harness the power of graph algorithms and real-world network applications using Python	Colleen M Farrelly and Franck Kalala Mutombo	Packt Publishing	2024

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
2	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
3	https://onlinecourses.nptel.ac.in/noc21_cs48/preview
4	https://onlinecourses.nptel.ac.in/noc21_cs48/preview

SEMESTER S5

NETWORKS LAB

(Common to CS/CD/CM/CB/CU/CI)

Course Code	PCCSL507	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To provide hands-on experience in network programming using Linux System calls and network monitoring tools.
2. To comprehend the implementation of network protocols and algorithms, and configuration of network layer services using network simulators.

Expt. No.	Experiments
Warm up	
1	Familiarize Linux networking commands - ifconfig, ifplugstatus, iftop, ping, ip, traceroute, mtr, netstat, whois, nmap, nmcli, speedtest-cli, bmon, nslookup, tcpdump
Wireshark based	
2	<p>Start your web browser and clear the browser's cache memory. Open Wireshark and start capturing. Then visit any webpage of your choice. Type http in the filter field of the Wireshark and click Apply so that only HTTP messages are displayed. After enough packets have been captured, select the Capture from the pull-down menu and select Stop to stop capturing.</p> <p>Using the captured information, determine the following:</p> <ol style="list-style-type: none">(a) the source IP address and destination IP address of the first GET message(b) the medium format, the language, the encoding, and the character set that the client can accept. (Use the first GET message)(c) the URL of the website and the user agent (Use the first GET message)(d) the source IP address and destination IP address of the first response message(e) the status codes for the first response message.(f) when the HTML file that you are retrieving was last modified at the server

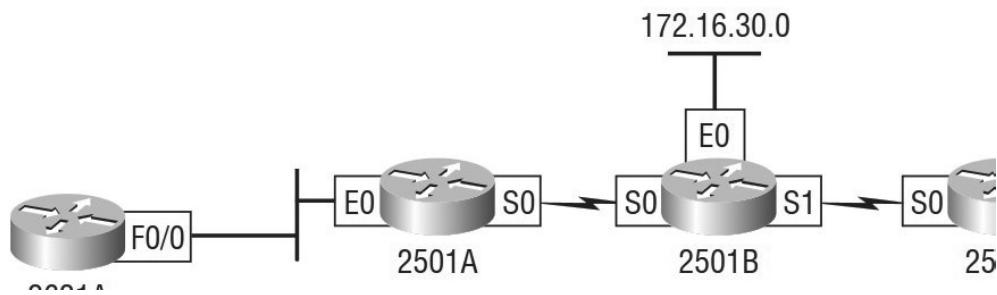
	<p>(g) value of the content-length field of the first response message</p> <p>(h) how long it took from the time the GET message was sent until the response message was received.</p> <p>(Use the timestamps of a GET message and that of the corresponding response message. By default, the time column's value is the amount of time in seconds since Wireshark tracing began.)</p> <p>(i) the HTTP version of your browser.</p>
3	<p>Compose an e-mail and address it to yourself, but do not send it yet. Open the Wireshark and start capturing. Go to your e-mail user agent and send the e-mail. In the Wireshark window, type smtp in the filter field and click Apply. Stop capturing and save the captured file.</p> <p>Using the captured information, answer the following:</p> <p>(a) All SMTP packets have the same two IP addresses. Which one is the IP address of your computer? Which host does the other IP address represent?</p> <p>(b) All SMTP packets have the same two port numbers. Which one is the port number of the SMTP client process? In which range is the client port number?</p> <p>(c) What is the port number of the SMTP server process?</p> <p>(d) Examine the SMTP commands or SMTP response codes in each SMTP packet and write down their meanings.</p> <p>(e) There is an IMF packet that is encapsulated inside an SMTP packet. What is the content of this packet?</p>
4	<p>First, clear the DNS record from the cache memory of your computer. For this, use ipconfig/flushdns on Windows or systemd-resolve --flush-caches on Linux. Next, clear your browser's cache memory. Open the Wireshark and start capturing. In your browser visit your college website. Wireshark starts to capture packets. Type dns in the filter field and press Apply so that only DNS messages are displayed. Stop capturing and save the captured file.</p> <p>Using the captured information, answer the following questions:</p> <p>(a) Locate the first DNS query message resolving your college website. What is the packet number (This “packet number” is assigned by Wireshark for listing purposes only; it is NOT a packet number contained in any real packet header.) in the trace for the DNS query message?</p> <p>(b) Is this query message sent over UDP or TCP?</p> <p>(c) Now locate the corresponding DNS response to the initial DNS query. What is the packet number in the trace for the DNS response message? Is this response message received via UDP or TCP?</p> <p>(d) What are the source and destination port numbers for the DNS query message?</p>

	<p>(e) What are the source and destination port numbers for the DNS response message?</p> <p>(f) To what IP address is the DNS query message sent?</p> <p>(g) What is the query message ID number? What is the response message ID number? What is the purpose of this field?</p> <p>(h) What is the length of the flag field in a DNS message?</p> <p>(i) Which bit in the flag field determines whether the message is a query or a response?</p> <p>(j) Which bits are used only in the response message? What is the function of these bits in the response message?</p> <p>(k) How many question records, answer records, authority records, and additional records are present in the query message?</p> <p>(l) How many question records, answer records, authority records, and additional records are present in the response message?</p>
Socket programming based	
5	<p>Client-Server communication using TCP:- The client inputs an integer N and creates a square matrix of order N by populating the matrix with random numbers in the range [1,50]. It then sends the matrix to the server which identifies the matrix type (upper triangular, lower triangular, diagonal). The server then informs the type (as a string) to the client which it prints.</p>
6	<p>Client-Server communication using UDP:- You are very good at communicating in the “new generation” English language with all sorts of abbreviations like tbh, ig, etc. Now design a client-server application as follows: The client inputs a new-generation English sentence from the user and sends it to the server. The server then translates the received sentence to formal English and sends the translated sentence back to the client which it prints.</p> <p><u>Sample string sent to the server</u></p> <p>Really idc about this stupid server as it is of no use irl but atm, I will design one, tbf to the professor.</p> <p><u>Translated string sent back to the client</u></p> <p>Really I don't care about this stupid server as it is of no use in real life but at the moment, I will design one, to be fair to the professor.</p> <p>You may consider only the following abbreviations: tbh, ig, tbf, atm, irl, lol, asap, omg, ttyl, idk, nvm</p>
7	Implement a multi-user chat server using TCP as the transport layer protocol.
8	Implement a concurrent Time Server application using UDP to execute the program at a remote server. The client sends a time request to the server which sends its system time

	back. The client then displays the received time value.
9	Develop a concurrent file server that will provide the file requested by the client if it exists. If not, the server sends an appropriate message to the client. The server should also send its process ID (PID) to clients for displaying along with the file contents or with the message.
10	Develop a packet-capturing application using raw sockets.

Cisco's Packet tracer based

11	<p>Familiarizing router commands</p> <ul style="list-style-type: none"> (a) Knowing the current mode (user or privileged), switching to privileged mode (b) Switching to configuration mode (c) Obtaining router information such as type, OS, memory stats, interface details etc. (d) Viewing the status of any routing protocols currently configured (e) Showing the routing table (f) Saving the running configuration (g) Viewing the command history (h) Viewing the router clock (i) Viewing the list of hosts (j) Displaying the statistics for all the interfaces (Both detailed and brief views) (k) Knowing the controller type (DTE or DCE) (l) Configuring serial and ethernet interfaces - enabling the interface, setting IP address, mask, and clock rate
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router	Interface	IP
2621	F0/0	172.16.10.1
2501A	E0	172.16.10.2
2501A	S0	172.16.10.3
2501B	E0	172.16.10.4
2501B	S0	172.16.10.5
2501B	S1	172.16.10.6

Figure 1: A sample network along with the interface addresses (all interfaces use a /24 mask)

12	Set up static routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using ping .
13	Implement RIPv2 routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using ping .
14	Implement OSPF routing for the network shown in Figure 1. Once the routes are set up, display the routing table and verify the connectivity using ping .
15	You are the network administrator of your college. A small portion of your campus network is shown in Figure 2. You want to allow only Host_B to communicate with the network 172.16.10.0. Verify your settings by the following checks: (a) Pinging Host_A from Host_B (b) Pinging Host_A from Lab_B and Lab_C

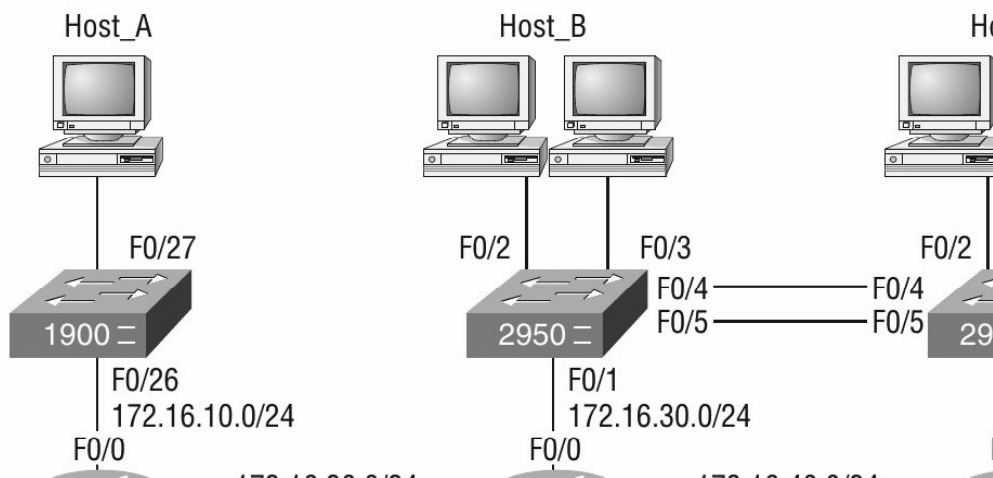


Figure 2: A portion of your college campus network

16	<p>You are the network administrator of your college. The college is assigned a network address 140.80.0.0. There are 20 subnets in your college network. The Central Computing Facility (CCF) resides in the 4th subnet. The department of CSE is organizing an inter-department hackathon for which the registration closed yesterday. The registration was through the hackathon website hosted on a server which is assigned the 7th address in the 16th subnet. As the network administrator, your job now is to block students from accessing the hackathon website from CCF.</p> <p>[The server provides other services than the website hosting as well. Make sure you block only the website access. Other services should not be denied.]</p>
17	Figure 3 shows an IPv6-based network. Interconnect the different subnets using RIPng.

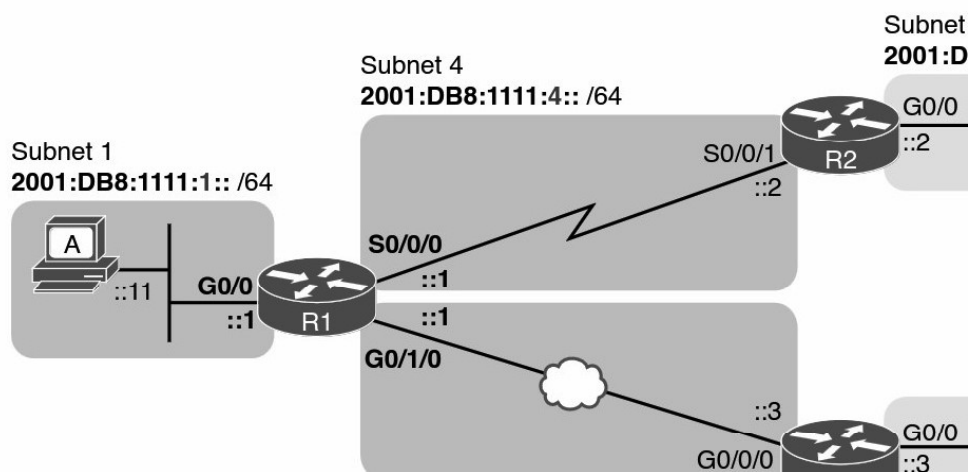


Figure 3: An IPv6 network

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- **Submission of Record:** Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- **Endorsement by External Examiner:** The external examiner shall endorse the record

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the working of application layer protocols by analyzing the pertinent headers in actual data packets captured using network monitoring tools.	K3
CO2	Exploit the client server paradigm to develop real time networking applications using transport layer protocols.	K3
CO3	Employ IPv4 and IPv6 addressing, subnetting to efficiently design networks.	K3
CO4	Simulate core networking concepts using a network simulator.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							3
CO2	3	3	3	3		2						3
CO3	3	3	3	3								3
CO4	3	3	3	3	3							3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Unix Network Programming, Volume 1: The Sockets Networking API	W. Richard Stevens, Andrew M. Rudoff, Bill Fenner	Pearson Education	3/e, 2004
2	CCNA Cisco certified network associate study guide Exam 640-802 6	Todd Lammle	Wiley	6/e, 2007
3	Beej's Guide to Network Programming: using Internet Sockets	Brian "beej Jorgensen" Hall	Amazon Digital Services	2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Networks: A Top- Down Approach	Behrouz A Forouzan	McGraw Hill	SIE, 2017
2	Computer Networking: A Top- Down Approach Featuring Internet	J. F. Kurose and K. W. Ross	Pearson Education	8/e, 2022

Video Links (NPTEL, SWAYAM...)	
No.	Link ID
1	https://nptel.ac.in/courses/106106091

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.

- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S5

DATA ANALYTICS LAB

Course Code	PCCDL508	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCCST503	Course Type	Lab

Course Objectives:

1. To impart the knowledge on the Big Data Technologies for processing the Different types of Data. Configure Hadoop and perform File Management Tasks
2. To enable the learner to analyze big data using machine learning techniques

Expt. No.	Experiments
1	Set up and install Hadoop and explore the various shell commands in Hadoop and implement file management tasks.
2	Implement a word count program using Map Reduce to find the number of occurrences of specific keywords from an input file.
3	Using the structure of the Word Count program, write a Hadoop program that calculates the average word length of all words that start with each character.
4	Write a Map Reduce program for removing stop words from the given text files
5	Implement matrix multiplication with Hadoop Map Reduce
6	Implement Pig Latin scripts to sort, group, join, project, and filter data.
7	Implementing Database Operations on Hive
8	Write an R program to find the factorial and check for palindromes.
9	Implement a program to find variance, covariance and correlation between different types of attributes

10	Write an R program to solve linear regression and make predictions.
11	Write an R program to solve logistic regression.
12	Implement SVM and Decision tree Classifier using R
13	Implement KNN and Naive Bayes Classifier using R
14	Implement a Spark program that does the following: i) Count the total number of observations included in the dataset ii). Count the number of years over which observations have been made iii) Display the oldest and the newest year of observation
15	Implement clustering techniques using SPARK.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Configure Hadoop and perform File Management Tasks	K3
CO2	Implement different tasks using Hadoop Map Reduce programming model	K3
CO3	Apply different data processing tools like Pig and Hive to real time issues like weather dataset and sales of a company	K3
CO4	Implement data extraction from files and analyze big data using machine learning techniques in R.	K3
CO5	Illustrate the knowledge of Spark to analyze data in real-life scenarios.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				3			2		1		3
CO2	3	3	2	1	3			2		1		3
CO3	3	3	2	1	3			2		1		3
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Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mastering Apache Spark	Mike Frampton	Packt Publishing	1/e,2015
2	Hadoop: The Definitive Guide	Tom White	O'reilly Media	4/e, 2015
3	Machine Learning with Spark	Nick Pentreath	Pract Publishing	1/e, 2015
4	Big Data Analytics with Spark: A Practitioner's Guide to Using Spark for Large Scale Data Analysis	Mohammed Gulle	Apress	1/e.2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Big Data Fundamentals: Concepts, Drivers & Techniques	Thomas Erl, Wajid Khattak, and Paul Buhler	Pearson	1/e,2016
2	Programming Pig Dataflow Scripting with Hadoop	Alan Gates	O'Reilly	1/e. 2011
3	Programming Hive	Jason Rutherglen, Dean Wampler, Edward Capriolo	O'Reilly	1/e, 2012
4	BIG DATA	Black Book TM	DreamTech	1/e,2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Big Data Computing: https://nptel.ac.in/courses/106104189
2	Data Science on Apache Spark. Databricks. https://databricks.com/blog/2015/06/01/databricks-launches-moocdata-science-on-spark
3	Advanced R Programming for Data Analytics in Business: https://nptel.ac.in/courses/110104513

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- Completeness, clarity, and accuracy of the lab record submitted