



ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)

B.M.S. COLLEGE OF ENGINEERING, BENGALURU - 19
(Autonomous College under VTU)

**Department of ARTIFICIAL INTELLIGENCE & DATA
SCIENCE**

**Scheme and
Syllabus III to VIII
Semester
For the Batch Admitted in the Year 2023**

**ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು - 560 019**

B.M.S. COLLEGE OF ENGINEERING, BENGALURU - 19
Bull Temple Road, Bengaluru - 560 019



B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

DEPARTMENT OF Artificial Intelligence & Data Science

Vision of the Institute

Promoting Prosperity of mankind by augmenting Human Resource Capital through Quality Technical Education Training.

Mission of the Institute

Accomplish Excellence in the field of Technical Education through Education, Research and Service needs of society

Vision of the Department

Develop globally competent professionals in the field of Artificial Intelligence
& Data Science for the betterment of self and society.

Mission of the Department

State of the art curriculum design and infrastructure facilities to impart quality
Promote high quality research through industry academia collaborations
Inculcate professional ethics and promote sustainable solutions for society



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Semester-III

No.	Course Type	Code	Course Title	Credits			Total Credits	Total Hours
				L	T	P		
1	BS	23MA3BSSDM	Statistics and Discrete Mathematics	2	1	0	3	4
2	ES	23DC3ESCOA	Computer Organization & Architecture	3	0	0	3	3
3	PC	23DC3PCDSC	Data Structures	3	0	1	4	5
4	PC	23DC3PCDBM	Database Management Systems	3	0	1	4	5
5	PC	23AI3PCIAI	Introduction to AI	3	0	1	4	5
6	PC	23DS3PCFDS	Foundations of Data Science	3	0	0	3	3
7	AE	23DC3AEFWD	Full Stack Web Development	0	0	1	1	2
		23DS3AEDAE	Data Analytics with Excel					
		23DS3AELAT	Technical Writing					
8	NCMC	23NCMC3NS1	NSS	0	0	0	0	1
		23NCMC3YG1	YOGA					
		23NCMC3PE1	Physical Edu. (Sports and Athletics)					
	TOTAL			17	1	4	22	28

PC-15, ES-3, BS-3, AE-1



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Sem	III		
Course Title:	Computer Organization and Architecture		
Course Code:	23DC3ESCOA	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Basic Structure of Computers and Instruction Set Architecture: Functional Units, Basic Operational Concepts, Number Representation and Arithmetic Operations, Memory Locations and Addresses, Memory Operations, Instructions, and Instruction Sequencing, Addressing Modes, Stored program concept.	8
2	Introduction to Assembly Language Concepts, Stacks, Subroutines, Additional Instructions, Basic Input/Output: Accessing I/O Devices, Interrupts, Bus Structure, Bus Operation, Arbitration	8
3	Memory System: Basic Concepts, Semiconductor RAM Memories, Read-only Memories, Direct Memory Access, Memory Hierarchy, Cache Memories: Mapping Functions, Virtual Memory	8
4	Arithmetic: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Unsigned Numbers, Multiplication of Signed Numbers Fast Multiplication: Bit-Pair Recoding of Multipliers, Carry-Save Addition of Summands, Summand Addition Tree using 3-2 Reducers, Integer Division, Floating- Point Numbers and Operations: Arithmetic Operations on Floating-Point Numbers, Guard Bits and Truncation, Implementing Floating-Point Operations	8
5	Basic Processing Unit: Some Fundamental Concepts, Instruction Execution, Hardware Components, Instruction Fetch and Execution Steps, Hardwired Control Parallel Computer Architecture: Processor Architecture and Technology Trends, Flynn's Taxonomy of Parallel Architectures, Memory Organization of Parallel Computers: Computers with Distributed Memory Organization, Computers with Shared Memory Organization, Thread-Level Parallelism: Simultaneous Multithreading, Multicore Processors	8

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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Computer Organization and Embedded Systems	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian	6th Edition	McGraw-Hil	2012
2.	Parallel Programming for Multicore and Cluster Systems	Thomas Rauber, Gudula Runger	2nd Edition	Springer	2013
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Computer Organization and Design - The Hardware /Software Interface	David A. Patterson, John L. Hennessy	5th Edition	Elsevier	2014
2.	Computer Organization & Architecture	William Stallings	11th Edition	Pearson	2018

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Computer Architecture and Organization	NPTEL	2022	https://onlinecourses.nptel.ac.in/noc22_cs88/preview

Course Outcomes*At the end of the course the student will be able to*

CO1	Apply the concepts of basic functional units to demonstrate the working of computational system.
CO2	Analyze the issues of the processor architecture to improve the efficiency in computer design.
CO3	Design Memory modules and Arithmetic Logic unit for a given specification by analyzing performance issues.
CO4	Analyze simultaneous multithreading and multicore processing in achieving parallelism.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3											1		
CO2		3												
CO3			2											
CO4				1							1			



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DEPARTMENT OF ARTIFICIAL INTELLIGENCE & DATA SCIENCE

Proposed Assessment Plan (for 50 marks of CIE)

Tool	No. of Assessments	Marks
Internals	3	40
QUIZ	1	10
Total		50

SEE Exam Question paper format -100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Semester	III		
Course Title:	Data Structures		
Course Code:	23DC3PCDSC	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hours
1	Introduction To Data Structure: Data Management concepts, Data types – primitive and non-primitive, Types of Data Structures- Linear & Non-Linear Data Structures. Structures and pointers Dynamic memory allocation: allocating a block of memory: Malloc, allocating multiple blocks of memory: Calloc, Releasing the used space: Free Altering the size of memory: Realloc.	8
2	Linear list: Singly linked list implementation, insertion, deletion and searching operations on linear list, circularly linked lists- insertion, deletion and searching operations for circularly linked lists, doubly linked list implementation, insertion, deletion and searching operations, maintaining directory of names, Manipulation of polynomials (addition), representing sparse matrices.	8
3	Stacks: Operations, array representations of stacks, stack applications - infix to postfix conversion, postfix expression evaluation, and function call tracing, recursion. Queues: Introduction, Basic concept, linear queue operations, circular queue, priority queues, double ended queues. Applications of Queues. Stack and queue implementation using linked lists	8
4	Trees: Definitions, tree representation, properties of trees, Binary tree, Binary tree representation, binary tree properties, binary tree traversals, binary tree implementation, Binary Search Tree operations and its implementation, applications of trees.	8
5	Balanced Trees: AVL Trees, Splay trees, Red- Black Trees – Definitions, Rotation and other basic operations.	8

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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Data Structures in C	Horowitz, Sahni, Anderson Freed	Second	Universities Press	2008
2.	Data Structures using C	Reema Thareja	Second	Oxford University press	2014
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Structures using C	Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein	Fifth	Pearson Education	2007
2	Data Structures - A Pseudocode Approach with C	Richard F. Gilberg Behrouz A. Forouzan	First	Cengage Learning	2005

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Structures using C	E. Balaguruswamy		McGraw Hill	2013	https://dokumen.pub/data-structures-using-c-9781259029547-1259029549.html
2.	Data structures and program design in C	Robert L. Kruse, Clovis L. Tondo, Bruce P. Leung	Second	Prentice Hal	1997	https://cdn.preterhuman.net/texts/math/Data_Structure_And_Algorithms/Data%20Structure%20and%20Program%20Design%20in%20C++%20-%20Robert%20L.%20Kruse.pdf

MOOC Courses				
Sl. No.	Course name	Course Offered By	Year	URL
1	Data Structures	Coursera	2023	https://www.coursera.org/learn/data-structures
2	Data Structures and Algorithms	NPTEL	2023	https://nptel.ac.in/courses/106102064/



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Course Outcomes

At the end of the course the student will be able to

CO1	Apply the concept of linear and nonlinear data structures for computing problems.
CO2	Analyse the appropriate data structure operations for a given problem
CO3	Design and develop solutions using the linear and nonlinear data structure for a given specification.
CO4	Conduct experiments for demonstrating the operations of different data structures.
CO5	Investigate the given problem and provide solution using competitive platform.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												1	
CO2		3										1		
CO3			3											
CO4			3		3						1			
CO5				2					1		1			1

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	20
QUIZ/AAT	1	5
Lab Component	CIE+ Two Lab Tests	25
Total		50

Laboratory Plan

Instructions to Students to be followed in each lab:

1. Each Student should write down the program in the observation book and get it evaluated by the respective lab faculty in-charge and then execute the program.
2. Each Student should bring the lab record with the programs and output written for the programs completed in their respective previous week and get it evaluated by the lab faculty in-charge. In the record book students should - Handwrite the Program - Pasting of the printout of the Output or Handwriting of the Output (Output should be written for all the cases).
3. Students have to practice following list of programs and additional programming exercises will also be given in lab. Students will be made to solve coding challenges on programming platforms like LeetCode and HackerRank.



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Lab Program	Unit#	Program Details
1	2	Write a program to implement Singly Linked List with following operations a) Create a linked list. b) Insertion of a node at first position, at any position and at end of list. c) Display the contents of the linked list.
2	2	Write a program to Implement Singly Linked List with following operations a) Create a linked list. b) Deletion of first element, specified element and last element in the list. c) Display the contents of the linked list.
3	2	Write a program to Implement Singly Linked List with following operations a) Sort the linked list. b) Reverse the linked list. c) Concatenation of two linked lists
4	2	Write a program to Implement doubly linked list with primitive operations a) Create a doubly linked list. b) Insert a new node to the left of the node. c) Delete the node based on a specific value d) Display the contents of the list
5	3	Write a program to simulate the working of stack using an array with the following: a) Push b) Pop c) Display The program should print appropriate messages for stack overflow, stack underflow
6	3	Write a program to convert a given valid parenthesized infix arithmetic expression to postfix expression. The expression consists of single character operands and the binary operators + (plus), - (minus), * (multiply) and / (divide)
7	3	Write a program to simulate the working of a queue of integers using an array. Provide the following operations a) Insert b) Delete c) Display The program should print appropriate messages for queue empty and queue overflow conditions
8	3	Write a program to simulate the working of a circular queue of integers using an array. Provide the following operations. a) Insert b) Delete c) Display The program should print appropriate messages for queue empty and queue overflow conditions
9	3	Write a program to implement Stack & Queues using Linked Representation
10	4	Write a program a) To construct a binary Search tree. b) To traverse the tree using all the methods i.e., in-order, preorder and post order c) To display the elements in the tree.
11	4	Write a program a) To construct a binary search tree b) To implement iterative inorder traversal c) To delete a given element



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12	5	Write a program to construct an AVL tree of integers
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SEE Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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DEPARTMENT OF ARTIFICIAL INTELLIGENCE & DATA SCIENCE

Sem	III		
Course Title:	Database Management Systems		
Course Code:	23DC3PCDBM	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hours
1	Introduction to Database Systems: Introduction, An Example, Characteristics of Database approach, Advantages of using DBMS approach, when not to use a DBMS. Database System Concepts and Architecture: Data models, Schemas and instances, Three schema architecture. SQL: SQL Data Definition and Data Types specifying basic constraints in SQL, Basic retrieval queries in SQL, Insert, Delete and Update statements in SQL, Additional features of SQL, more complex SQL Queries, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL, Schema Change Statement in SQL.	8
2	Entity Relation Model: Using High-Level Conceptual Data Models for Database Design, a sample Database Application, Entity types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity types, Refining the ER Design, ER Diagrams, Relationship Types of Degree Higher than two, Relational Database Design using ER to Relational Mapping. Relational Databases: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations, Functional Dependencies	8
3	Relation Algebra: Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra. Normalization: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multi-valued Dependencies and a Fourth Normal Form, Join Dependencies, Fifth Normal Form.	8
4	Transaction Processing Concepts: Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Transaction Support in SQL, Two-Phase Locking Techniques for Concurrency Control.	8
5	Storage Systems: Overview of Physical Storage Media, Storage Interfaces, Magnetic Disks, Flash Memory, RAID, Disk-Block Access, Database Backup and Recovery from Catastrophic Failures Indexing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B+-Tree Extensions, Hash Indices, Multiple-Key Access, Creation of Indices, Write-Optimized Index Structures, Bitmap Indices, Indexing of Spatial and Temporal Data Query processing & operations	8

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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Database Systems	Elmasri and Navathe	7th Edition	Pearson	2016
2.	Database System Concepts	Silberschatz, H Korth and S Sudarshan	7th Edition	McGrawHill	2019
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Database Management Systems	Ramakrishnan and Gehrke	3 rd Edition	McGrawHill	2014
2.	Database Systems: Design, Implementation, and Management	Peter Rob and Carlos Coronel	8 th Edition	CENGAGE Learning	2009

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	An Introduction to Relational Database Theory	Hugh Darwen	3 rd Edition	Ventus Publishing ApS	2012	https://www.e-booksdirectory.com/details.php?ebook=3093
2.	Database System The Complete Book	Hector GarciaMolina, Jeffrey D. Ullman, Jennifer Widom	Second Edition	Pearson Education	2009	https://people.inf.elte.hu/miiqaai/elektroModulatorDva.pdf

MOOC Course				
Sl. No.	Course name	Course offered by	Year	URL
1.	Database Management Systems	SWAYAM	2023	https://onlinecourses.swayam2.ac.in/c23_cs10/preview
2.	Database Management Essentials	Coursera	2023	https://www.coursera.org/learn/databases-e-management

Course Outcomes*At the end of the course the student will be able to*

CO1	Apply the concepts of database management systems for various applications.
CO2	Analyze the given database concepts to its correctness.
CO3	Design and demonstrate conceptual models, query and optimization.
CO4	Ability to conduct experiments to demonstrate the various SQL query processing



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CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												2	
CO2		3												
CO3			3									2		
CO4			3		3									

Proposed Assessment Plan (for 50 marks of CIE)

Tool	No. of Assessments	Marks
Internals	2	25
QUIZ	1	5
Lab Component	CIE + Lab Test	25
Total		50

Laboratory Plan

- Each Student should write down the work carried out and the outputs in the observation book and get it evaluated by the respective lab faculty in-charge.
- Students have to practice following SQL queries and additional exercises will also be given in the lab.

Lab Program	Program Details
1	Sailor Database
2	Supplier Database
3	Salesman Database
4	Movie Database
5	Employee Database

PROGRAM 1: SAILOR DATABASE

Create tables for the following schema:

SAILOR (sid: integer, sname: string, rating: integer, age: real)

BOAT (bid: integer, bname:string, color:string)

RESERVES (sid: integer, bid: integer, day: date)

Queries:

- Add the required constraints on the created tables.
- Populate the relations with at least 5 tuples each.
- Select names and ages of all sailors. Rename same as 'Sailor Name'
- Find all sailors with a rating above 7
- Find the sid of sailors who have reserved a red boat
- Find the colors of boats reserved by 'Shyam'
- Delete all boats which have never been reserved.



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PROGRAM 2: SUPPLIER DATABASE

Create tables for the following schema:

SUPPLIER (sid: integer, name: string, address: string)

PART (pid: integer, name: string, color: string)

CATALOG (sid: integer, pid: integer, cost: real)

Queries:

- 1) Add the required constraints on the created tables.
- 2) Populate the relations with at least 5 tuples each.
- 3) Select the ID and names of all the suppliers.
- 4) Select the most costly part available in the catalog.
- 5) Find the name's of parts for which there is some supplier.
- 6) Find the sids of suppliers who supply a red part and a green part.
- 7) Delete all parts of a given ID.

PROGRAM 3: SALESMAN DATABASE

Create tables for the following schema:

SALESMAN (Salesman_id:integer, Name:string, City:string, Commission:integer)

CUSTOMER (Customer_id:integer, Cust_Name:string, City:string)

ORDERS (Ord_No:integer, Purchase_Amt:real, Ord_Date:date, Customer_id:integer, Salesman_id:integer)

Queries:

- 1) Add the required constraints on the created tables.
- 2) Populate the relations with at least 5 tuples each.
- 3) Select the ID and names of all the customers.
- 4) Select the salesman with the highest commission.
- 5) List all the orders placed in descending order of their purchase amount.
- 6) Select customers who have salesmen in their cities.
- 7) Delete all orders placed before Jan 2018.

PROGRAM 4: MOVIE DATABASE

Consider the schema for Movie Database:

ACTOR(Act_id, Act_Name, Act_Gender)

DIRECTOR(Dir_id, Dir_Name, Dir_Phone)

MOVIES(Mov_id, Mov_Title, Mov_Year, Mov_Lang, Dir_id)

MOVIE_CAST(Act_id, Mov_id, Role)

RATING(Mov_id, Rev_Stars)



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Queries:

- i. List the titles of all movies directed by 'Hitchcock'.
- ii. Find the movie names where one or more actors acted in two or more movies.
- iii. List all actors who acted in a movie before 2000 and also in a movie after 2015 (use JOIN operation).
- iv. Find the title of movies and number of stars for each movie that has at least one rating and find the highest number of stars that movie received. Sort the result by movie title.
- vi. Update rating of all movies directed by 'Steven Spielberg' to 5.

PROGRAM 5: EMPLOYEE DATABASE

Create the following Tables:

LOCATION	
Location_ID	Regional_Group
122	NEW YORK
123	DALLAS
124	CHICAGO
167	BOSTON

DEPARTMENT		
Department_ID	Name	Location_ID
10	ACCOUNTING	122
20	RESEARCH	124
30	SALES	123
40	OPERATIONS	167

JOB	
Job_ID	Function
667	CLERK
668	STAFF
669	ANALYST
670	SALESPERSON
671	MANAGER
672	PRESIDENT

EMPLOYEE									
EMPLOYEE_ID	LAST_NAME	FIRST_NAME	MIDDLE_NAME	JOB_ID	MANAGER_ID	HIREDATE	SALARY	COMMIT	DEPARTMENT_ID
7839	MEGAN	JOHN	S	672	NULL	12-DEC-14	5500	NULL	30
7369	SMITH	JOHN	Q	667	7521	17-DEC-18	800	NULL	20
7499	ALLEN	KEVIN	J	670	7507	20-FEB-17	1600	300	30
7505	DOYLE	JEAN	K	671	7839	04-APR-15	2850	NULL	30
7506	DENNIS	LYNN	S	671	7839	15-MAY-15	2750	NULL	30
7507	BAKER	LESLIE	D	671	7839	10-JUN-15	2200	NULL	40
7521	WARK	CYNTHIA	D	670	7505	22-FEB-15	1250	500	30



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Queries based on the above tables:

Order By Clause:

1. List out the employee id, last name in ascending order based on the employee id.
2. List out the employee id, name in descending order based on salary column

Group By & Having Clause:

3. How many employees who are working in different departments wise in the organization
4. List out the department wise maximum salary, minimum salary, average salary of the employees
5. List out the job wise maximum salary, minimum salary, average salaries of the employees.
6. List out the no.of employees joined in every month in ascending order.
7. How many employees joined in 1985?
8. How many employees joined in March 1985.
9. Which is the department id, having greater than or equal to 3 employees joined in April1985.

Sub-Queries

10. Display the employee who got the maximum salary.
11. Display the employees who are working in Sales department
12. Display the employees who are working as "Clerk".
13. Display the employees who are working in "New York"
14. Find out the number of employees working in the "Sales" department.
15. Delete the employees who are working in the accounting department.
16. Display the second highest salary drawing employee details.

Subquery operators: (ALL, ANY, SOME, EXISTS)

17. List out the employees who earn more than every employee in department 30.
18. List out the employees who earn more than the lowest salary in department 30.
19. Find out which department does not have any employees.

Simple join

20. List our employees with their department names
21. Display employees with their designations (jobs)
22. How many employees are working in the sales department?

Non – Equi Join:

23. Display employee details with salary grades.
24. List out the no. of employees on grade wise.

Self-Join:

25. Display the employee details with their manager names.
26. Display the employee details who earn more than their manager's salaries.

Outer Join:

27. Display employee details with all departments.
28. Display all employees in sales or operation departments.

Set Operators:

29. List out the distinct jobs in Sales and Accounting Departments.
30. List out the ALL jobs in Sales and Accounting Departments.
31. List out the common jobs in Research and Accounting Departments in ascending order.

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Semester	III		
Course Title:	Introduction to Artificial Intelligence		
Course Code:	23AI3PCIAI	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hours
1	Introduction to AI: Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art. Intelligent Agents – Agents and Environments, Concept of rationality, The nature of environments, The structure of agents Problem solving based on searching: Problems solving Agents, Example problems, Searching for solutions, Uniformed Search strategies – Uniform cost search, Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening Depth First	8
2	Heuristic Search Strategies: Best-first Search, A* algorithm, Heuristic Functions Local Search & Optimization: Hill Climbing, Genetic Algorithms	8
3	Constraint Satisfaction Problem – Defining constraint satisfaction problems, Constraint propagation, Back tracking search for CSPs, Local search for CSPs Game theory – Optimal decisions in games, Alpha-Beta Search, Stochastic games, Partially observable games.	8
4	Logical Agents - Knowledge-based agents, The Wumpus world, Logic, Propositional logic, Reasoning patterns in Propositional Logic. First Order Logic - Representation Revisited, Syntax and Semantics of First Order logic, Using First Order logic. Inference in First Order Logic - Propositional Versus First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution.	8
5	Quantifying Uncertainty - Acting under Uncertainty, Basic Probability Notation, Inference using Full Joint Distributions, Independence, Baye's Rule and its use, Wumpus World Revisited.	8



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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Artificial Intelligence	Stuart J. Russell and Peter Norvig	3 rd Edition	Pearson	2015
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Artificial Intelligence	Elaine Rich, Kevin Knight	3 rd Edition	Tata Mc GrawHill	2013
2	Artificial Intelligence Structure and strategies for complex problem solving	George F Luger	5 th Edition	Pearson	2011

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Artificial Intelligence	Stuart J. Russell and Peter Norvig	3 rd Edition	Pearson	2015	https://people.engr.tamu.edu/guni/csce421/files/AI_Russell_Norvig.pdf
2.						10 Free Must-read Books on AI - KDnuggets

MOOC Courses				
Sl. No.	Course name	Course Offered By	Year	URL
1	Knowledge-Based AI: Cognitive Systems	Udacity		https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409
2	Artificial Intelligence	NPTEL		https://nptel.ac.in/courses/106105077

Course Outcomes

At the end of the course the student will be able to



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CO1	Apply basic principles of AI in solutions that require problem solving, inference, knowledge representation and learning.
CO2	Analyze search and inference algorithms in problem solving.
CO3	Demonstrate knowledge of reasoning, uncertainty and knowledge representation for solving real-world problems.
CO4	Conduct experiments to solve problems using AI techniques.
CO5	Design and implement intelligent agents for real-world applications using AI methods.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3			2							3		
CO3			2	2										3
CO4				3	3									
CO5				2	2			1	1					3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	2	20
QUIZ/AAT	1	5
Lab Component	CIE+ Two Lab Tests	25
Total		50

Laboratory Plan

Instructions to Students to be followed in each lab:

1. Each Student should write down the program in the observation book and get it evaluated by the respective lab faculty in-charge and then execute the program.
2. Each Student should bring the lab record with the programs and output written for the programs completed in their respective previous week and get it evaluated by the lab faculty in-charge. In the record book students should - Handwrite the Program - Pasting of the printout of the Output or Handwriting of the Output (Output should be written for all the cases).
3. Students have to practice following list of programs and additional programming exercises will also be given in lab. Students will be made to solve coding challenges on programming platforms like

Lab Program	Unit#	Program Details
1	1	Write a program to implement Vacuum Cleaner agent for two rooms
2	1	Implement Iterative deepening search algorithm.
3	1	Solve 8 puzzle problem using BFS algorithm



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4	2	Implement A* search algorithm.
5	2	Implement Tic –Tac –Toe Game using Alpha-beta pruning
6	3	Write a program to create a knowledge base using prepositional logic and show that the given query entails the knowledge base or not
7	3	Write a program to create a knowledge base using prepositional logic and prove the given query using resolution
8	3	Convert given first order logic statement into Conjunctive Normal Form (CNF).
9	3	Implement unification in first order logic
10	4	Create a knowledgebase consisting of first order logic statements and prove the given query using forward reasoning.

SEE Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

Case Studies on AI

1. Develop an Intelligent agent to administer delivery of medicines to appropriate patients
2. Implement AI agent to develop pac game
3. Use genetic algorithms to optimize cash flow for a business

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Sem	III		
Course Title:	Foundations of Data Science		
Course Code:	23DS3PCFDS	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction to Data Science: Describing Data science , The data science Venn diagram, Python for Data Science , Data science case studies Types of Data: structured versus unstructured data, quantitative versus qualitative data, the four levels of data: nominal, ordinal, interval and ratio Total information awareness, Bonferroni's Principle, Rhine's paradox. The Data Science Process: Overview, Defining research goals, Retrieving data, Cleansing, integrating and transforming data, exploratory data analysis, Build the models, Presenting findings. Data Analytics Lifecycle.	8
2	Statistics & Probability: Statistics, Obtaining data, Sampling Data, Statistical measures, empirical rule. Points estimates, Sampling distributions, Confidence intervals, Hypothesis Tests: Conducting a hypothesis test, One sample t-tests, Type I and type II errors, Hypothesis testing for categorical variables Information Gain & Entropy, Probability Theory, Probability Types, Probability Distribution Functions, Bayes' Theorem, Inferential Statistics	8
3	Correlation Analysis: Types of correlation, correlation coefficient. Regression Analysis: Linear Regression: Simple Linear Regression, Multilinear Regression, p-values, Logistic Regression, Multinomial logistic regression, Time-Series Model, Receiver Operating Characteristic	8
4	Dealing with missing data: single and multiple data imputation, Entropy based techniques, Monte Carlo and MCMC simulations; Correcting inconsistent data: Deduplication, Entity resolution, Pairwise Matching; Fellegi-Sunter Model Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices: Definitions, Computing Eigenvalues and Eigenvectors, Finding Eigenpairs by Power Iteration, Eigenvector matrix Principal-Component Analysis: Example, Using Eigenvectors for Dimensionality Reduction, The matrix of distances Singular-Value Decomposition: Definition, interpretation, Dimensionality Reduction Using SVD, Why Zeroing Low Singular Values Works, Querying Using Concepts, Computing the SVD of a Matrix	8
5	Data Analytics on Text: Major Text Mining Areas – Information Retrieval – Data Mining – Natural Language Processing (NLP) – Text analytics tasks: Cleaning and Parsing, Searching, Retrieval, Text Mining, Part-of-Speech Tagging, Stemming, Text Analytics Pipeline. NLP: Major components of NLP, stages of NLP, and NLP applications.	8

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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Principles of Data Science	Sinan Qzdemir, Sunil Kakade & Macro Tibaldeschi	Second Edition	Packt	2018
2.	Fundamentals of Data Science	Sanjeev Wagh, Manisha Bhende, Anuradha Thakare,	1st Edition	CRC Press	2022
3.	Introducing Data Science: Big Data, Machine Learning, and More	Davy Cielen, Arno D.B. Meysman, Mohamed Ali		Manning	2016
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Doing Data Science	Rachel Schutt, Cathy O'Neil		O'Reilly	2014
2.	Mining Massive Datasets	Jure Leskovec, Anand Rajaraman, Jeffrey D Ullman	2 nd	Dreamtech Press	2016

E-Book						
Sl. No	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Science & Machine Learning	DirkP.Kroese, ZdravkoI.Botev, ThomasTaimre, RadislavVaism an	-	Universit y of Queensla nd	2023	https://people.smp.uq.edu.au/DirkKroese/DSML/DSML.pdf
2.	Becoming a Data Head	ALEX J. GUTMAN JORDAN GOLDMEIER	-	Wiley	2021	https://32net.id/bukaheula/share/QP2cf2JLdeOPn00y3Nyu8aXHp1Slq1bc6P4YcuI4.pdf

MOOC Course				
Sl. No	Course name	Course Offered By	Year	URL
1.	IBM Data Science	Coursera	2023	https://www.coursera.org/professional-certificates/ibm-data-science
2.	Foundations of Data Science	SWAYAM	2023	https://onlinecourses.swayam2.ac.in/imb23_mg64/preview



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Course Outcomes

At the end of the course the student will be able to

CO1	Apply fundamental knowledge of data science for a given dataset
CO2	Analyze and visualize data for knowledge representation.
CO3	Demonstrate proficiency in data analysis.
CO4	Ability to conduct experiments to demonstrate the use of various data science tools

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3												
CO3			3											3
CO4			3		3						1			

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	2	40
QUIZ/AAT	2	10
Alternate Assessment Tool	-	-
Total		50

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem :	3 rd		
Course Title:	Full Stack Web development		
Course Code:	22CS3AEFWD		
L-T-P:	0-0-1	Total Credits:	1

Introduction:

This course focuses on developing comprehensive skills in Full Stack Web Application Development. Students will learn to develop both front-end and back-end components of web applications, integrate with databases and external services, and apply best practices in web development. Under this project work, student should develop Advanced Web based Application using technologies such as PHP, Python, Node JS, React, Angular. Students can form a group with minimum of two and maximum of four. Teacher allotted for project work to students should teach full stack technologies like Node JS, React, etc., during Class/Lab hours as per the allotment. Teacher allotted for project work should guide the students in choosing the topic and towards carrying out project work and complete the evaluation of assigned students.

Course Outcomes

At the end of the course the student will be able to

CO1	Apply full-stack web development technologies to solve real-world problems.
CO2	Design and develop user-centric web applications focused on social and environmental issues.
CO3	Integrate front-end and back-end components effectively with databases and external services.
CO4	Demonstrate teamwork and problem-solving skills in project development.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3				3							2	3	2
CO2			3		3	3	3					3	2	2
CO3			3		3									3
CO4								3	3	3		2	2	3

Assessment Plan (for 50 marks of CIE)

Tool	No. of Assessments	Marks
Internals	---	---
QUIZ	---	---
Lab Component	1	50
Alternate Assessment Tool	----	--
Total		50



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Rubrics for Project Evaluation:

Criteria	Excellent	Good (3 Marks)	Satisfactory (2 Marks)	Needs Improvement (0-1 Marks)
Problem Identification & Relevance (10)	(10 Marks) Clearly articulates a significant social/environmental issue with insightful, innovative solutions.	(7 Marks) Recognizes a pertinent issue and offers practical solutions.	(5 Marks) Identifies a basic issue with standard solutions.	(0-2 Marks) Fails to identify a relevant issue or solution.
Technical Implementation (10)	(10 Marks) Exemplary implementation of full-stack technologies, showcasing efficiency, scalability, and technical excellence.	(7 Marks) Reliable and proficient technical performance, meeting key objectives.	(5 Marks) Basic implementation incorporating essential features and functionalities.	(0-4 Marks) Inadequate or incomplete technical implementation.
User Experience & Interface (10)	(10 Marks) Exceptional UI/UX design, prioritizing intuitiveness and user-friendliness, with a professional standard of execution.	(7 Marks) Competent UI design focused on usability and functionality.	(5 Marks) Basic UI design encompassing essential functions and user needs.	(0-4 Marks) Poor or non-functional user interface, lacking in user-centricity.
Group Participation (5)	(5 marks) Exhibits active engagement, exceptional collaboration, and effective teamwork throughout the project lifecycle.	(4 marks) Consistent participation and constructive collaboration within the group.	(2 marks) Minimal but noticeable participation and occasional contributions.	(0 marks) Lack of active participation and collaboration in the group.
Presentation (5)	(5 marks) Professional, engaging presentation with outstanding visuals and comprehensive	(4 marks) Well-structured presentation with clear content and effective	(2 marks) Basic presentation with some structure and varying delivery	(1 marks) Disorganized presentation lacking in coherence and adequate content.



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	content, demonstrating exceptional delivery skills.	delivery.	quality.	
Report & Documentation (10)	(10 marks) Comprehensive report covering all project aspects with meticulous documentation, including methodology, design, and future scope.	(7 marks) Well-structured report with detailed coverage of project implementation.	(5 marks) Basic report with limited content, covering essential project details.	(2-4 marks) Poorly structured and incomplete report, lacking essential details.

Sl. No	Week	Activity	Content deliverables by the assigned teacher	Technologies/Skills to be Covered
1	1st	Formation of groups. Note: Student groups of size 2 or 3 or 4	Introduction to Full Stack Technologies & Issue Identification	- Overview of full stack development tools and frameworks. - Overview of web development (HTML, CSS, JavaScript), - Introduction to full stack frameworks (MEAN, MERN), Identifying social/environmental issues for web solutions.
2	2nd	Project topic selection by each Group. Presentation: Student and Project topic introduction by each group	Conceptualizing a Web Application	- Identifying problem and understanding social and environmental issues. - Brainstorming and planning a web application focused on a chosen social/environmental issue. - Tools for wireframing and prototyping (Figma, Sketch),
3	3rd	Design Layout of the Web Pages	Basic Front-end and Back-end Development	- Define layouts based on project scope and objectives. - Learning the basics of front-end (HTML, CSS, JavaScript) and back-end (Node.js, Python) development. - Front-end: HTML5, CSS3, JavaScript basics.



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				Back-end: Introduction to Node.js, Express.js, RESTful API development
4	4th ,5th , and 6th	Front end and back-end implementation	Data Management and Integration	- Techniques for managing and integrating data in web applications. - Database technologies (MongoDB, SQL), Integrating databases with back-end (Mongoose for MongoDB), Basic CRUD operations.
5	7th 8th and 9th	Design and Development of connecting among different web pages	Advanced Front-end & Back-end Technologies Project Development and Mid-term Review	- Delving into advanced front-end technologies (React, Angular) and back-end technologies (databases, server management). - Front-end: React.js/Angular for dynamic UI development. - Back-end: Advanced Node.js, Authentication (JWT, OAuth), Server-side rendering.
6				Development of the project with guidance and a mid-term review to assess progress.
7	10th	Presentation by each group	Integrating Feedback & Refining Applications	- Applying feedback from the mid-term review and refining the application for better performance and impact. - Implementing feedback, Optimization for performance, Security best practices (HTTPS, data validation), User testing and UX improvements.
8	11th	Complete Project Work Demonstration by each group	Final Project Presentations and Submissions	Students present their completed projects and submit their final work for assessment.
	12th	Project Report Preparation		

Text Book :

Supplementary texts and resources

1. **Modern Full-Stack Development: Using Type Script, React, Node.js** , Frank Zammetti ,2020 (1st Edition) ,Apress



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2. Beginning MERN Stack , Build and Deploy a Full Stack MongoDB, Express, React, Node.js App, Greg Lim ,2021

Tutorial Link:

1. <https://www.springboard.com/resources/learning-paths/web-development-python-django/>
2. <https://www.coursera.org/learn/introduction-to-web-development-with-html-css-javascript>
3. <https://www.boardinfinity.com/micro-learning/full-stack-development-course-with-certification>
4. <https://www.udemy.com/course/nextjs-the-complete-developers-guide/>
5. <https://www.udemy.com/course/nextjs-build-full-stack-apps-with-nextjs-using-redux/>
6. <https://www.udemy.com/course/beginning-javascript/>

SEE Exam (50 Marks)

Evaluation of Projects carried out by students from External examiner along with internal faculty.



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IV Semester

No.	Course Type	Code	Course Title	Credits			Total Credits	Total Hours
				L	T	P		
1	BS	23MA4BSLAO	Linear Algebra and Optimization	2	1	0	3	4
2	ES	23DC4ESTOC	Theory of Computation	3	0	0	3	3
3	PC	23DC4PCOPS	Operating Systems	3	0	0	3	3
4	PC	23DS4PCCON	Computer Networks	3	0	0	3	3
5	PC	23DS4PCMLG	Machine Learning	3	0	1	4	5
6	PC	23DC4PCDAA	Design and Analysis of Algorithms	3	0	1	4	5
7	AE	23DS4AEDVZ	Data Visualization using Tools	0	0	1	1	2
		23DS4AEJUL	JULIA for Data Science					
		23DS4AEGIT	Version Controller with GIT					
8	UHV	22MA4HSUHV	Universal Human Values	0	1	0	1	2
9	NCMC	23NCMC4NS2	NSS	0	0	0	0	1
		23NCMC4YG2	YOGA					
		23NCMC4PE2	Physical Edu. (Sports and Athletics)					
	TOTAL						22	28

PC-14, ES-3, BS-3, UHV-1, AE-1



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Course Title	Linear Algebra and Optimization	Course Code	23MA4BSLAO
Credits	03	L – T – P	2-1-0
Contact hours	39		

Course Objectives:

The objectives of the course are to facilitate the learners to

- Appreciate the importance of linear algebra in computer and allied engineering science.
- Gain the knowledge of linear algebra tools and concepts to implement them in their core domain.
- Improve their mathematical thinking and acquire skills required for sustained lifelong learning.

Teaching-Learning Process (General Instructions)

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

- Lecture method(L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Encourage collaborative (Group Learning) Learning in the class.
- Ask HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
- Adopt Problem-Based Learning (PBL), which fosters students' Analytical skills, and develops thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Discuss how every concept can be applied to the real world and when that's possible, it helps to improve the students' understanding.

UNIT-1

CONTINUOUS OPTIMIZATION – 1

[8 hours]

Function of several variables, partial differentiation, local and global optima, convex sets and functions separating hyperplanes, application of Hessian matrix in optimization, gradients of vector-valued functions, gradients of matrices, useful identities for computing gradients.

Teaching-Learning Process:	Chalk and Board, Problem-based learning
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UNIT-2

CONTINUOUS OPTIMIZATION-2

[7 hours]

Optimization using gradient descent/ascent and NR method.

Sequential search 3-point search and Fibonacci search.

Constrained Optimization, Method of Lagrange multipliers, KKT optimality conditions.

Teaching-Learning Process:	Chalk and Board, Problem-based learning
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UNIT-3

INNER PRODUCT SPACES

[8 hours]

Inner products, inner product spaces, length and orthogonality, orthogonal sets and Bases, projections, Gram-Schmidt orthogonalization process, QR-factorization, least squares problem and least square error. Curve fitting – Principle of least squares, fitting a straight line and fitting a parabola.

Teaching-Learning Process:	Chalk and Board, Problem-based learning
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UNIT-4

EIGENVALUES AND EIGENVECTORS

[8 hours]

Introduction, Polynomials of Matrices, Cayley-Hamilton Theorem, eigen spaces of a linear transformation, Characteristic and Minimal Polynomials of Block Matrices, Jordan Canonical form.

Teaching-Learning Process:	Chalk and Board, Problem-based learning
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UNIT-5

MATRIX DECOMPOSITION AND THEIR APPLICATIONS

[8 hours]

Diagonalization, Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, rank and signature of real quadratic forms, Singular value decomposition. Dimensional reduction – PCA.

Teaching-Learning Process:	Chalk and Board, Problem based learning
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Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
23MA4BSLIA	CO 1	Apply the concepts of linear algebra in Computer and Allied Engineering Sciences.	1	3
	CO 2	Demonstrate the applications of computer science and Allied Engineering Science using modern ICT tools.	1 & 5	3

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
SEE	End Exam	100		50	

CIE methods/question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 1, 2 and 5 and two questions each from Units 3 and 4.

SUGGESTED LEARNING RESOURCES:

Text Books:

1. Linear Algebra and its applications, David C. Lay, Steven R. Lay, Judi J Mc. Donald, 6th Edition, 2021, Pearson Education.
2. Linear Algebra and its Applications, Gilbert Strang, 4th edition, 2005, Brooks Cole.



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3. Linear Algebra: An Introduction, Richard Bronson & Gabriel B. Costa, 2nd edition, Academic press.

Reference Books:

1. Schaum's outline series -Theory and problems of linear algebra, Seymour Lipschutz, Marc Lipson, 6th edition, 2017, McGraw-Hill Education.
2. Linear Algebra and Optimization for Machine Learning, Charu C. Aggarwal, Springer, 2020
3. Linear Algebra, Stephen H. Friedberg, Arnold J. Insel and Lawrence E. Spence, Pearson, 2019, Fifth Edition.
4. Mathematics for Machine learning, Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, 2020, Cambridge University Press.
5. Linear Algebra, Kenneth Hoffman, Ray Kunze, 2nd edition, Pearson.

E-books and online course materials:

1. <https://ocw.mit.edu/courses/mathematics/18-06sc-linear-algebra-fall-2011/index.htm>
2. <https://www.math.ucdavis.edu/~linear/linear.pdf>

Online Courses and Video Lectures:

1. <https://www.coursera.org/learn/linear-algebra-machine-learning>
2. <https://nptel.ac.in/syllabus/111106051/>

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Sem	IV		
Course Title:	Theory of Computation		
Course Code:	23DC4ESTOC	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction to Finite Automata: Central Concepts of Automata Theory, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), Finite Automata with Epsilon Transition, An Application Text Search. NP Problems solvable in Polynomial Time, Satisfiability Problem	8
2	Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Equivalence and Minimization of Automata	8
3	Context Free Grammars and Languages Parse Trees: Context Free Grammars, Parse trees, Applications of Context Free Grammars, Ambiguity in Grammars and Languages, Eliminating Useless Symbols, Computing the Generating and Reachable Symbols, Eliminating Epsilon Productions, Eliminating Unit Productions, Chomsky Normal Form, Greibach Normal form	8
4	Pushdown Automata: Definition of the Pushdown Automaton, The Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata, The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages	8
5	Introduction to Turing Machine: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers, Definition of Post Correspondence Problem, A Language That Is Not Recursively Enumerable, An Undecidable Problem That is RE, Other Undecidable Problems	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Automata Theory, Languages and Computation	John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman: education	3 rd Edition	Pearson	2007



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Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Languages and Automata Theory	John C Martin	3 rd Edition	Tata McGraw-Hill	2007
2.	An Introduction to formal Languages and Automata	Peter Linz	5 th Edition	Narosa Publishing House	2012

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Introduction to Theory of Computation	Anil Maheshwari, Michiel Smid	-	Carleton University	2019	https://cglab.ca/~michieli/TheoryOfComputation/TheoryOfComputation.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Automata Theory	edX	2022	https://www.edx.org/course/automata-theory
2.	Introduction to Automata, Languages and Computation	IITB	2022	https://onlinecourses.nptel.ac.in/noc21_cs19/preview
3.	Automata Theory	Stanford University	2022	https://online.stanford.edu/courses/soe-yicsautomata-automata-theory

Course Outcomes

At the end of the course the student will be able to

CO1	Apply the knowledge of Automata Theory, Grammars & Regular Expressions for the given requirement of the formal language.
CO2	Analyze the given Automata to identify the formal language it represents.
CO3	Design Automata and Grammar for pattern recognition and syntax checking of the given formal language.



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CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												2	
CO2		2												
CO3			2									3		

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Semester	IV		
Course Title:	Operating Systems		
Course Code:	23DC4PCOPS	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction to Operating Systems: What operating systems do, Operating System operations, Process management, Memory management, Storage management, Protection and security System Structures: Operating System Services, System calls, Operating System design and implementation, Operating System structure, System Boot.	8
2	Processes: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication. Threads: Overview, Multi-core Programming, Multithreading Models, Implicit Threading, Threading Issues. Process Synchronization- Background, The Critical section problem, Synchronization hardware, Mutex Locks, Semaphores, Classical problems of synchronization.	8
3	CPU Scheduling- Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple-Processor scheduling. Deadlocks: System Model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and recovery from deadlock.	8
4	Memory Management Strategies: Background, Swapping, Contiguous memory allocation, Paging, Structure of page table, Segmentation. Virtual Memory Management- Background, Demand paging, Page replacement, Thrashing.	8
5	Virtual Machines: Overview, Benefits and features, Building Blocks, Types of Virtual Machines and their implementations, Virtualization and Operating System Components, Protection Rings Case Study: VMWare	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Operating System Concepts	Abraham Silberschatz, Peter Baer	9th Edition	John Wiley & Sons	2018

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		Galvin , Greg Gagne			
2.	Modern operating systems	Andrew Tanenbaum	4th Edition	Pearson Education	2009
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Operating System: Internals and Design Principles	William Stallings	8th Edition	Prentice Hall	2014
2.	Schaum's Outline of Operating Systems	J. Archer Harris	Kindle Edition	McGraw-Hill	2001

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Operating Systems Course Notes	Dr. John T.Bell	-	University of Illinois Chicago	2006 & 2013	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/index.html
2.	Operating System Concepts	Abraham Silberschatz , Peter Baer Galvin , Greg Gagne	9th Edition	John Wiley & Sons	2018	https://drive.uqu.edu.sa/_/mskhayat/files/MySubjects/2017SS%20Operating%20Systems/Abraham%20Silberschatz-Operating%20System%20Concepts%20(9th,2012_12).pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Operating Systems	SWAYAM	2023	https://onlinecourses.nptel.ac.in/noc20_cs04/p/review
2.	Introduction to Operating Systems	Coursera	2023	https://www.coursera.org/specializations/coding-introduction-operating-systems

Course Outcomes*At the end of the course the student will be able to*

CO1	Apply the different concepts and functionalities of Operating System
CO2	Analyse various Operating system strategies and techniques
CO3	Demonstrate the different functionalities of Operating Systems.



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CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3												
CO3			2											3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	2	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Semester	IV		
Course Title:	Computer Networks		
Course Code:	23DS4PCCON	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction: Data Communications, Networks, Network Types, Network Models, Protocol Layering, Reference Models: The OSI Reference Model, The TCP/IP Reference Model, Physical Layer: Data and signals Digital Transmission, (D-D Conversion) Bandwidth Utilization, Multiplexing, Switching, Circuit Switched Networks, Packet Switching.	8
2	Data Link Layer: Link Layer Addressing, Error Detection and Correction, Block Coding, Cyclic Codes, Checksum. Data Link Control: DLC Services, Data-Link Layer Protocols, Media Access Control	8
3	Network Layer: Network Layer Services, Packet Switching, Network Layer Performance, IPV4 Addresses. Network Layer Protocols: Internet Protocol, ICMPV4, Unicast Routing, Routing algorithms, Unicast routing protocols, Internet Structure, Routing Information Protocol (RIP), Next Generation IP: IPV6 Addressing, IPV6 Protocol, ICMPv6 Protocol, Transition from IPV4 to IPV6	8
4	Transport Layer: Transport Layer Protocols, User Datagram Protocol, Transmission Control Protocol.	8
5	Application Layer: Introduction, Standard Client Server Protocols, DNS—The Internet's Directory Service, SMTP, SNMP, FTP	8

Prescribed Text Book					
Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Data Communications and Networking	Behrouz A Forouzan	5 th Edition	McGraw Hill	2013
2.	Computer Networks	Andrew S. Tanenbaum, David J. Wetherall	5 th Edition	Pearson	2011
Reference Text Book					
Sl. No	Book Title	Authors	Edition	Publisher	Year
1.	Data and Computer Communication	William Stallings	8 th Edition	Pearson Education	2008
2.	Computer Networks – A Systems Approach	Larry L. Peterson and Bruce S. Davie	4 th Edition	Elsevier	2007

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	An Introduction to Computer	Peter L Dordal	1 st Edition	-	2020	https://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf

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	Networks					
2.	A Top-Down Approach: Computer Networking	James F Kurose & Keith W Ross	8 th Edition	Pearson	2021	https://gaia.cs.umass.edu/kurose_ross/online_lectures.htm

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Computer Networking	Coursera	2023	https://www.coursera.org/learn/illinois-tech-computer-networking
2.	NOC: Computer Networks and Internet Protocol	NPTEL		https://nptel.ac.in/courses/106105183

Course Outcomes*At the end of the course, the student will be able to*

CO1	Apply the fundamental concepts of communication in networking.
CO2	Analyze the various protocols, and techniques in TCP/IP network architecture.
CO3	Develop applications that demonstrate the functionalities of physical, Data Link, Network, Transport or Application layer.
CO4	Design network topologies to evaluate network performance metrics and troubleshoot connectivity issues using network simulation tools.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3													
CO2		3												
CO3			3		1							2		
CO4				2	3									2

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format - 100M**All Units have internal choice** - Two Questions to be asked for 20 Marks each

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Sem	IV		
Course Title:	Machine Learning		
Course Code:	23DS4PCMLG	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hours
1	Machine Learning Landscape: Introduction, Types of Machine Learning, Challenges of Machine Learning, Testing and Validating. Supervised Learning Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Issues in Decision tree learning, CART Training algorithm	8
2	Support Vector Machines: Linear SVM, Non Linear SVM, SVM Regression, Under the Hood. Instance Based Learning: Introduction, k-Nearest Neighbor learning	8
3	Probabilistic Learning Bayesian Learning: Bayes Theorem and Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Bayesian Belief Network, EM Algorithm.	8
4	Ensemble Learning and Random Forests: Voting Classifiers, Bagging and Pasting, Random Patches and Random Subspaces, Random Forests, Boosting, Stacking	8
5	Unsupervised Learning Techniques Clustering – Kmeans, DBSCAN, Other Clustering Algorithms, Gaussian Mixtures – Anomaly Detection, Selecting Clustering, Bayesian Gaussian Mixture Models, Other algorithms for anomaly and novelty detection Reinforcement Learning: Markov Decision Process, Introduction, Learning Task, Q Learning	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Machine Learning	Tom M. Mitchell	First	McGraw Hill Education	2013
2	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	Aurelien Geron	Second	O'Reilly	2020

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Machine Learning with Python	Andreas C Muller & Sarah Guido	First	Shroff Publishers	2019
2.	Thoughtful Machine learning	Mathew Kirk	First	Shroff Publishers	2019



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E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	The Elements of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome H. Friedman	Second	-	2009	https://web.stanford.edu/~hastie/Papers/ESLII.pdf
2.	Machine Learning in Action	Peter Harrington	First	Manning	2017	http://www2.ift.ulaval.ca/~chaib/IFT-4102-7025/public_html/Fichiers/Machine Learning in Action.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Machine Learning	Coursera	--	https://www.coursera.org/learn/machine-learning
2.	Introduction to Machine learning	NPTEL	2016	https://swayam.gov.in/nd_noc20_cs29/preview

Course Outcomes

At the end of the course the student will be able to

CO1	Apply different learning algorithms for various complex problems
CO2	Analyze the learning techniques for given dataset
CO3	Design a model using machine learning to solve a problem.
CO4	Ability to conduct practical experiments to solve problems using appropriate machine learning techniques.
CO5	Develop and demonstrate a solution for a specified ML Problem.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		2										3		
CO3			3									3		
CO4				3	3									3
CO5				3	3	2		2	2					3

Proposed Assessment Plan (for 50 marks of CIE)

Tool	No. of Assessments	Marks
Internals	2	25
QUIZ/AAT	1	5
Lab Component	CIE + 2 Lab Tests	25
Total		50



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Lab Program	Unit#	Program Details
1	1	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.
2	2	Develop a program to construct Support Vector Machine considering a Sample Dataset
3	2	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions
4	3	Write a program to implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets
5	3	Write a program to construct a Bayesian network considering training data. Use this model to make predictions.
6	3	Apply EM algorithm to cluster a set of data stored in a .CSV file. Compare the results of k-Means algorithm and EM algorithm.
7	4	Implement Boosting ensemble method on a given dataset.
8	4	Write a program to construct random forest for a sample training data. Display model accuracy using various metrics
9	5	Implement tic tac toe using reinforcement learning
10	5	Consider a sample application. Deploy machine learning model as a web service and make them available for the users to predict a given instance.

SEE Exam Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Semester	IV		
Course Title:	Design and Analysis of Algorithms		
Course Code:	23DC4PCDAA	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hours
1	Introduction to Algorithm, Fundamentals of Algorithmic Problem Solving. Analysis of Algorithm Efficiency: The Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non Recursive Algorithm, Mathematical Analysis of Recursive Algorithms.	8
2	Brute-Force: String Matching, Exhaustive Search: TSP, Knapsack Problem, Assignment Problem, Depth-First Search and Breadth-FirstSearch. Decrease-and-Conquer: Topological Sorting, Algorithms for Generating Combinatorial Objects: Generating Permutations, Decrease by-a-Constant-Factor Algorithms: Binary Search, Russian Peasant Multiplication, Variable Size-Decrease Algorithms: Computing Median and the Selection Problem	8
3	Divide-and-Conquer: Merge sort, Quicksort, Multiplication of Large Integers and Strassen's Matrix Multiplication. Transform-and-Conquer: Presorting, Heaps and Heap sort, Horner's Rule. Space and Time Tradeoffs: Horspool Algorithm, Boyer-Moore Algorithm.	8
4	Dynamic Programming: Coin Problem, The Knapsack Problem, Warshall's and Floyd's Algorithms. Greedy Technique: Prim's Algorithm, Kruskal's Algorithm-Without disjoint subsets and Union Find algorithms, Dijkstra's Algorithm, Huffman Trees.	8
5	Backtracking: n -Queens Problem, Subset-Sum Problem. Branch-and-Bound: Knapsack Problem, Traveling Salesman Problem. NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility. NP-Complete Problems: The Clique problem, The Vertex Cover problem, Approximation Algorithms: The Vertex-Cover problem.	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to the Design and Analysis of Algorithms	Anany Levitin	Third Edition	Pearson	2014
2.	Introduction to Algorithms	Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein	Third Edition	The MIT Press	2009

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Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Computer Algorithms	Ellis Horowitz, Satraj Sahni and Rajasekhara m	2nd Edition	University Press Pvt. Ltd,	2009
2.	Analysis and design of Algorithms	Padma Reddy		Sri Nandi Publications	2009

E-Books						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Introduction to Design & Analysis of Algorithms	K. Raghava Rao	-	Smash words	2013	https://www.smashwords.com/books/view/365630
2.	Data structures and Algorithm Analysis in C++	Allen Weiss	Fourth edition	Pearson education	2014	http://www.uoitc.edu.iq/images/documents/informatics-institute/Competitive_exam/DataStructures.pdf

MOOC Courses				
Sl. No.	Course name	Course Offered By	Year	URL
1	Algorithms	Coursera	2023	https://www.coursera.org/course/algs4partI
2	Design and Analysis of Algorithms	NPTEL	2023	https://onlinecourses.nptel.ac.in/noc19_cs47/preview

Course Outcomes*At the end of the course the student will be able to*

CO1	Apply algorithmic design paradigms to basic computing problems.
CO2	Analyze the time complexity of different algorithms.
CO3	Design efficient algorithms using appropriate algorithm design techniques.
CO4	Conduct experiments to implement algorithms and provide valid conclusions.

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												2	
CO2		3												
CO3			3									2		
CO4				3	2									3



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	2	20
QUIZ/AAT	1	5
Lab Component	CIE+ Two Lab Tests	25
Total		50

Laboratory Plan

Instructions to Students to be followed in each lab:

1. Each Student should write down the program in the observation book and get it evaluated by the respective lab faculty in-charge and then execute the program.
2. Each Student should bring the lab record with the programs and output written for the programs completed in their respective previous week and get it evaluated by the lab faculty in-charge. In the record book students should - Handwrite the Program - Pasting of the printout of the Output or Handwriting of the Output (Output should be written for all the cases).
3. Students have to practice following list of programs and additional programming exercises will also be given in lab. Students will be made to solve coding challenges on platforms like LeetCode and HackerRank.

Lab Program	Unit#	Program Details
1	2	Write program to do the following: a. Print all the nodes reachable from a given starting node in a digraph using BFS method. b. Check whether a given graph is connected or not using DFS method.
2	2	Write program to obtain the Topological ordering of vertices in a given digraph.
3	2	Implement Johnson Trotter algorithm to generate permutations
4	3	Sort a given set of N integer elements using Merge Sort technique and compute its time taken. Run the program for different values of N and analyze its time complexity.
5	3	Sort a given set of N integer elements using Quick Sort technique and compute its time complexity.
6	3	Sort a given set of N integer elements using Heap Sort technique and analyze its time complexity.
7	4	Implement 0/1 Knapsack problem using dynamic programming.
8	4	Implement All Pair Shortest paths problem using Floyd's algorithm.
9	4	Find Minimum Cost Spanning Tree of a given undirected graph using Prim/Kruskal's algorithm.



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10	4	From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra's algorithm.
11	5	Implement "N-Queens Problem" using Backtracking.

SEE Question paper format - 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each

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Sem	IV		
Course Title:	Data Visualization using Tools		
Course Code:	23DS4AEDVZ	Total Contact Hours: 20 hours	
L-T-P:	0-0-1	Total Credits:	1

About the course: The course is designed to enhance programming and computation skills of students by exploring various features and extensive libraries of python programming language that are necessary for data science applications.

The students should work with a given dataset and create effective visualizations. The course will be executed in two cycles.

During Cycle 1, the students would be able to implement the key visualization techniques using Python tools like Matplotlib, Seaborn etc.

In Cycle 2, students will be exposed to industry-standard software tools like Tableau, Google Data Studio etc. to create compelling and interactive visualization of various types of data.

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Python Data Science Handbook	Jake Vander Plas	Second Edition	O'Reilly	2017
2.	Pro Tableau: A Step by Step Guide	Seema Acharya , Subhashini Chellappan	Second Edition	Apress	2016
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems,	Sossama Embarak		Apress	2018
2.	Python Data Visualization Cookbook	Igor Milovanović , Dimitry Foures , Giuseppe Vettigl	Second Edition	O'Reilly	2015

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Visualization with Python and JavaScript	Kyrann Dale	-	O'Reilly	2016	https://github.com/jllovet/dataviz-with-py-and-js
2.	Jumpstart Tableau: A Step-by-Step Guide to Better Data	Arshad Kha	-	Apress	2016	https://link.springer.com/book/10.1007/978-1-4842-1934-8



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	Visualization	n				
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MOOC Course				
Sl. No	Course name	Course Offered By	Year	URL
1.	IBM Data Science	Coursera	2023	https://www.coursera.org/professional-certificates/ibm-data-science
2.	Data Visualization with Tableau	Coursera	2023	https://www.coursera.org/specializations/data-visualization

Laboratory Plan (if applicable)

Lab-cycle-1

- Using the sales_data.csv, create the visualization report for the following using Matplotlib:
 - Get total profit of all months and show line plot with the following Style properties
Generated line plot must include following Style properties: –
 - Line Style dotted and Line-color should be green
 - Show annotation
 - Add a square marker.
 - Add ticks for both X and Y axis
 - Read Bathing soap facewash of all months and display it using the Subplot
- Using the sales_data.csv, create the visualization report for the following using Matplotlib:
 - Get total profit of all months and show line plot with the following Style properties
Generated line plot must include following Style properties: –
 - Line Style dashed and Line-color should be green
 - Show legend at the lower right location
 - Add ticks for both X and Y axis
 - Line width should be 2
 - Read toothpaste sales data of each month and show it using a bar plot
- Using the sales_data.csv, create the visualization report for the following using Matplotlib:
 - Calculate total sale data for last year for each product and show it using a Pie chart
 - Print the total sale inside each part
 - Explode the highest sale
 - Set the start angle=60



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- b. Read face cream and facewash product sales data and show it using the horizontal bar chart

4. Write a Python programming for the following:

- a. to display a horizontal bar chart of the sale of book. Use different color for each bar.

Sample data:

Programming languages: Fict, Tech, Moti, Business, Nutri, Dev

Sale: 5.2, 19.6, 8.7, 8, 7.7, 3.7

- Add ticks for both axis
- Show legend at the upper right corner

- b. Write a Python program to create a stacked bar plot.

Note: Use bottom to stack the women bars on top of the men bars.

Sample Data:

Means (men) = (22, 30, 35, 35, 26)

Means (women) = (25, 32, 30, 35, 29)

- Add labels and ticks
- Use annotation

5. Write a Python programming for the following:

- a. To create a pie chart with a title of the pass percentage of subjects.

Sample data:

Subjects: DSC, OOP, OPS, COA, MAT, Java

Pass percentage (%): 40, 25.6, 8.8, 30, 7.7, 60.7

- Print percentage inside the chart
- Use explode property

- b. Using the sales_data.csv, read the total profit of each month and show it using the histogram to see the most common profit ranges

6. Using the dataset planets.csv, create the visualization report for the following using Seaborn:

- a. Get the distance covered year-wise and show scatter plot with the following properties

- Add “mass” as additional features



- Use different markers
 - Control the range of marker areas with sizes
- b. Read the orbital_period of each year and show it using the histogram.
7. Using the dataset planets.csv, create the visualization report for the following using Seaborn:
- a. Get the distance covered year-wise and show scatter plot with the following properties
 - Add “mass” and “method” as additional features
 - Change the default color palette
 - Display the complete legend
 - b. Read the distance for each method and show it using the bar chart.
8. Using the dataset titanic.csv, create the visualization report for the following using Seaborn:
- a. Demonstrate the use of “displot”
 - b. Plot the distribution using Kernel density estimation.
 - c. Use lineplot for any two suitable features
 - d. Generate scatter plot with different color palette
9. Using the dataset titanic.csv, create the visualization report for the following using Seaborn:
- a. Demonstrate the subplots (2x1) on scatter plots
 - b. Demonstrate the use of violin plot
 - c. Get different line plots for survival of passengers class wise.
 - d. Create visualization for strip plot without jitter
10. Using the dataset titanic.csv, create the visualization report for the following using Seaborn:
- a. Create a visualization using categorical plot and re-order the axis contents
 - b. Demonstrate the use of violin plot
 - c. Demonstrate the subplots (1x3) on line plots
 - d. Generate scatter plot with different color palette

Lab-cycle-2

- I. Create the visualization using Tableau for the “Corriander_seed_2021.csv” dataset.
- a. Demonstrate the use of filters (General, wildcard, condition and limits)
 - b. Demonstrate the group creation, removing and renaming a group.
 - c. Demonstrate the creation of constant set



- d. Create the visualization by using quick table calculation
 - e. Customize the data using any three number functions
- II. Create the visualization using Tableau for the “Corriander_seed_2021.csv” dataset.
- a. Demonstrate the use of cascading filter, calculation filter and data source filter.
 - b. Demonstrate creating Hierarchies
 - c. Demonstrate the creation of computed sets
 - d. Create a visualization using a calculated field
 - e. Customize the data using any three string functions
- III. Create the visualization using Tableau for the “Corriander_seed_2021.csv” dataset.
- a. Demonstrate the use of cascading filter, calculation filter and data source filter.
 - b. Demonstrate the group creation, removing and renaming a group.
 - c. Create a visualization using a calculated field
 - d. Customize the data using any three number functions
 - e. Demonstrate the creation of constant set
- IV. Create the visualization using Tableau for the “supermarket_sales.csv” dataset.
- a. Demonstrate the use of filters (General, wildcard, condition and limits)
 - b. Demonstrate the group creation, removing and renaming a group.
 - c. Demonstrate the creation of constant set
 - d. Create a visualization using a calculated field
 - e. Customize the data using any three string functions
- V. Create the visualization using Tableau for the “supermarket_sales.csv” dataset.
- a. Demonstrate the use of cascading filter, calculation filter and data source filter.
 - b. Demonstrate creating Hierarchies
 - c. Demonstrate the creation of computed sets
 - d. Create the visualization by using quick table calculation
 - e. Customize the data using any three number function
- VI. Create the visualization using Tableau for the “supermarket_sales.csv” dataset.
- a. Demonstrate the use of filters (General, wildcard, condition and limits)
 - b. Demonstrate creating Hierarchies
 - c. Create the visualization by using quick table calculation



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- d. Demonstrate the creation of constant set
- e. Customize the data using any three string functions
- VII. Create the visualization using Tableau for the “supermarket_sales.csv” dataset.
 - a. Demonstrate the use of cascading filter, calculation filter and data source filter.
 - b. Demonstrate the group creation, removing and renaming a group.
 - c. Demonstrate the creation of constant set
 - d. Create a visualization using a calculated field
 - e. Customize the data using any three number functions

Course Outcomes

At the end of the course the student will be able to

CO1	Apply data transformations such as Joins, filtering, sorting, aggregation etc., for visualization using industry-standard software tools.
CO2	Analyze Data Visualization models for various domains.
CO3	Design and create effective data visualizations using Python for given problem

CO-PO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2				3	1		1	1		1		3	
CO2		2			3	1		1	1		1	3		
CO3			2		3	1		1	1		1			3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	-	-
QUIZ/AAT	-	-
Lab Component	-	50
Total		50

SEE Exam (50 Marks)

Students execute programs on Data Visualization using Python and Tableau in the presence of External and Internal examiners.



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Course Code	23MA4AEUHV	Course Name	Universal Human Values
Credits	01	L-T-P	0-1-0
Total Number of hours		15	

Course Objectives:

To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.

UNIT – 1

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration—what is it? - Its content and process; ‘Natural Acceptance’ and Experiential Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

UNIT – 2

Understanding Harmony in the Human Being - Harmony in Myself!

1. Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’
2. Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility
3. Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer)
4. Understanding the characteristics and activities of ‘I’ and harmony in ‘I’
5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail
6. Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one’s own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease



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UNIT – 3

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship

1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship
2. Understanding the meaning of Trust; Difference between intention and competence
3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship
4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals
5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives

UNIT – 4

Understanding Harmony in the Nature and Existence - Whole existence as Coexistence

1. Understanding the harmony in the Nature
2. Holistic perception of harmony at all levels of existence.

UNIT – 5

Implications of the above Holistic Understanding of Harmony on Professional Ethics

1. Natural acceptance of human values
2. Definitiveness of Ethical Human Conduct

Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

At the end of the course, the student will have the able to

CO1	Conduct self-exploration and distinguish between values and skills, happiness and accumulation of physical facilities, the self and the body, Intension and Competence of an individual
CO2	Analyze the value of harmonious relationship based on trust and respect in personal and professional life
CO3	Examine the role of a human being in ensuring harmony in society and nature
CO4	Apply the understanding of ethics in life and profession

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE MATERIAL:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	-	-
QUIZ/AAT	-	-
Lab Component	-	50
Total		50



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V Semester

No.	Course Type	Code	Course Title	Credits			Total Credits	Total Hours
				L	T	P		
1	PC	23DS5PCTSA	Time Series Analysis	2	1	0	3	4
2	PC	23DS5PCBDA	Big Data Analytics	3	0	1	4	5
3	PC	23DS5PCDLG	Deep Learning	4	0	1	5	5
4	PC	23DS5PCPWR	Programming with R	0	0	1	1	2
5	AE	23DC5AERMI	Research Methodologies & IPR	3	0	0	3	3
6	PE	23AI5PEOTM	Optimization Techniques for Machine Learning	3	0	0	3	3
		23DS5PEIOT	Internet of Things					
		23DS5PECNS	Cryptography & Network Security					
		23DS5PERAI	Responsible AI					
7	PW	23AI5PWSNA	Mini Project – Social Network Analytics	0	0	2	2	4
8	HS	23DC5HSEVS	Environmental Studies	1	0	0	1	1
9	NCMC	23NCMC3NS1	NSS	0	0	0	0	1
		23NCMC3YG1	YOGA					
		23NCMC3PE1	Physical Edu. (Sports and Athletics)					
	TOTAL						22	29

PC-13, PE-3, PW-2, AE-3, HS-1



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Sem	V		
Course Title:	Time Series Analysis		
Course Code:	23DS5PCTSA	Total Contact Hours: 40 hours	
L-T-P:	2-1-0	Total Credits:	3

Unit No.	Topics	Hours
1	Time Series Data: Purpose, Time series: Plots , Trends, and seasonal variation, Decomposition of series, Characteristics of Time Series: Introduction, Examples, Objectives and its nature, Introduction to time series databases and applications, Measures of dependence, Stationary Time Series, Estimation of Correlation, VectorValued and Multi Dimensional Series Components of Time Series: Trends, Seasonality, Cycles, Noise, Mathematical Models: Additive and Multiplicative models. Resolving components of a Time Series - Measuring Trend: Graphic, Semi-Averages, Moving Average and Least Squares Methods.	8
2	Correlation: Expectation and the ensemble, correlogram, covariance of sum of random variables, Measuring Seasonal Variation: Method of Simple Averages, Ratio-to- Trend Method, Ratio-to-Moving Average Method and Link Relative Method, Cyclical and Random Fluctuations, Variate Difference Method.	8
3	Index Numbers and their Definitions: Construction and Uses of Fixed and Chain based Index Numbers, Simple and Weighted Index Numbers, Laspeyres, Paasche's, Fisher's, and Marshall - Edgeworth Index Numbers, Optimum Tests for Index Numbers, Cost of Living Index Numbers. Forecasting Strategies: Leading variables and associated variables, Bass Model, Exponential Smoothing and Holt-Winters method	8
4	Basic Stochastic Models: White Noise, Random Walks, Fitted models & diagnostic plots, Autoregressive models: stationary and non-stationary Autoregressive process Time series Regression and Exploratory Data Analysis: Classical Regression, Exploratory Data Analysis, generalized least square method, linear models with seasonal variables, Harmonic seasonal models, logarithmic transforms.	8



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5	Linear Models: Moving Average models, Fitted MA Models, ARIMA Models: Autoregressive Moving Average Models, Differential Equations, Autocorrelation and Partial Correlation, Forecasting & Estimation, Non-stationary Models: Building non-seasonal ARIMA Models, ARCH Models, GARCH Models.	8
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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introductory Time series with R	Paul S.P. Cowpertwait, Andrew V. Metcalfe	1st Edition	Springer	2010
2.	Time Series Analysis and its Applications with R Examples	Robert H Shumway, David S Stoffer	4th Edition	O'Reilly	2020

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Time Series and Forecasting	Peter J Brokewell, Richard A Davis	Third	Springer	2016
2.	The Analysis of Time Series – An Introduction	Chris Chatfield	First	Chapman & Hall / CRC	1996

E-book						
SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Time Series Analysis: Univariate and Multivariate methods	William W. S Wei	2nd Edition	Pearson	2007	https://civil.colorado.edu/~balajir/CVEN6833/lectures/wwts-book.pdf
2	Time Series Analysis: Forecasting and	George P. Box, Gwilym Jenkins	5th Edition	Wiley	2017	http://repo.darmajaya.ac.id/4781/1/Time%20Series%20Analysis_%20Forecasting%20and%20



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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Intro to Time Series Analysis in R	Coursera	2024	https://www.coursera.org/projects/intro-time-series-analysis-in-r
2.	Applied Time-Series Analysis	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc21_ch28/preview
3	Time Series Analysis in R	DataCamp	2024	https://www.datacamp.com/courses/time-series-analysis-in-r

Course Outcomes

At the end of the course the student will be able to

CO1	Analyze and interpret time series data by identifying key components such as trends, seasonal variations, and stationarity.
CO2	Apply advanced statistical techniques to decompose time series data and implement effective forecasting methods.
CO3	Develop and evaluate time series models, including ARIMA and GARCH, to make accurate predictions and informed decisions.
CO4	Implement time series models using programming tools like R / Python, conducting experiments to preprocess, visualize and forecast data.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		2	2								3	
CO2	3	2		2	2							3		
CO3		3		3	2									3
CO4			3		2					2	1			3

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Big Data Analytics		
Course Code:	23DS5PCBDA	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hou rs
1	Introduction to Big Data Analytics: Introduction - Need of Big Data, Types of Digital Data, Definition of Big Data Analytics, Data intensive scientific discovery and the role of Big Data, Phases in Analytics, Characteristics of Big Data. Designing Data Architecture: Managing Data for Analysis, Architecture reference model, Big Data Stack, Case Study on Business Analytics for Emerging Trends and Future Impacts , Big Data Analytics standards - Process management framework for big data analytics- ISO/IEC 24668:2022	8
2	NoSQL: Data Store and Characteristic features, CAP theorem, NoSQL Data Architecture Patterns, Shared- Nothing Architecture for Big Data Tasks, MongoDB Databases - Features, Querying commands Apache Cassandra : Features and Components of Cassandra, Data types, Cassandra Data Model, CQL commands, Keyspaces, CRUD Operations, Time to Live (TTL), Alter Commands, Import and Export	8
3	Introduction to Hadoop: Introduction, Hadoop and its Ecosystem – Zookeeper, Ozie, Sqoop and Flume MapReduce Framework and Programming Model: Anatomy of MapReduce Job Run, Shuffle and Sort Map Tasks, MapReduce Execution Apache Yarn - How Yarn runs an application, Scheduling in Yarn, Scheduler options.	8
4	The Hadoop Distributed File System : The design of HDFS, HDFS Concepts , Hadoop File Systems and Interface, Dataflow - Anatomy of a File read and write Essential Hadoop Tools, Using Sqoop, Flume, Oozie, HBase.	8
5	Spark and Big Data Analytics : Spark basic architecture , Overview of structured spark types, Structured API Execution Components, Data Frame Transformation Spark works with different types of data : Boolean , numbers , JSON , Dates and Timestamp. Spark SQL - Tables, Views, Databases	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Science & Analytics – A Hands-on Approach	Arshdeep Bahga, Vijay Madiseti	First	ISBN: 978-1-949978-00-1	2019



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2	Hadoop - The definitive Guide	Tom White	Fourth	O'Reilly	2015
3	Spark: The Definitive Guide - Big Data Processing made Simple	Bill Chambers and Matei Zaharia	First	O'Reilly	2018

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Analytics	Rajkamal, Preeti Saxena	First	McGraw Hill Education	2019
2.	Business Intelligence, A managerial Perspective on Analytics	Sharda, R, Delen D, Turban E	Tenth	Pearson	2015

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Hadoop Starter Kit	Udemy	--	Free Hadoop Tutorial - Hadoop Starter Kit Udemy, 2023
2.	NPTEL IIT Patna 2023 https://nptel.ac.in/courses/10610418	NPTEL	2023	https://nptel.ac.in/courses/10610418 9, 2023

Course Outcomes

At the end of the course the student will be able to

CO1	Apply the concepts of NoSQL, Hadoop, Spark to big data patterns
CO2	Analyze data analytic techniques for big data enabling technologies
CO3	Design solutions using Hadoop and spark for big data case studies
CO4	Conduct experiments using big data problems using NoSQL, Hadoop, Spark frameworks
CO5	Investigate complex queries using big data frameworks

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2		3											3		
CO3			3		3										3
CO4				3	3										3
CO5				3	3				3	2		3			3



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SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Deep Learning		
Course Code:	23DS5PCDLG	Total Contact Hours: 50 hours	
L-T-P:	4-0-1	Total Credits:	5

Unit No.	Topics	Hrs
1	Introduction to Artificial Neural Networks: From Biological to Artificial Neurons: Biological Neurons, Logical Computations with Neurons, The Perceptron, The Multilayer Perceptron and Backpropagation, Regression and Classification MLPs, Implementing MLPs with Keras, Fine-tuning Neural Network Parameters Introduction to Deep Learning: Challenges motivating Deep Learning, Historical Trends in Deep Learning, Deep Feedforward Networks, Gradient-based Learning, and Efficient Computation.	10
2	Convolution Neural Networks(CNN): The Architecture of the Visual Cortex, Convolutional Layer, Pooling Layer, CNN Architectures- LeNet-5, AlexNet, GoogLeNet, VGGNet, ResNet, Xception, Pre-trained Models for Transfer Learning, Classification and Localization, Object Detection- Fully Convolutional Networks (FCNs), You Only Look Once (YOLO), Semantic Segmentation, Convolution Networks and the History of Deep Learning.	10
3	Training Deep Neural Networks: Vanishing/Exploding Gradients, Reusing Pretrained Layers, Faster Optimizers, Avoiding Overfitting Through Regularization. Recurrent Neural Networks(RNN): Recurrent Neurons and Layers, Training RNNs, Forecasting a Time Series, Handling Long Sequences- LSTM, GRU, Bidirectional RNNs, Recursive Neural Networks, Attention Mechanisms.	10
4	Representation Learning using Autoencoders: Stacked Autoencoders, Convolutional Autoencoders, Recurrent Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Applications of Autoencoders, Transfer Learning, and Domain Adaptation. Generative Adversarial Networks(GANs): Difficulties of training GANs, Deep Convolutional GANs, Progressive Growing of GANs, StyleGANs	10
5	Deep Generative Models: Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Boltzmann Machines for Real-Valued Data	10



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	Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications.	
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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville		MIT Press	2016
2.	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	Aurelien Geron	Second	O'Reilly	2020
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Deep Learning with Tensor Flow and Keras 3rd Edition	Amita Kapoor, Antonio Gulli, Sujit Pal	Third	Packt	2022
2.	Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers using TensorFlow	Magnus Ekman	First	Addison-Wesley Professional	2021

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Dive into Deep Learning	Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola	First	Cambridge University Press	2023	https://d2l.ai/d2l-en.pdf
2.	The Little Book of	François Fleuret	-	University of Geneva,	2024	https://fleuret.org/public/lbdl.pdf



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	Deep Learning			Switzerland		
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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Deep learning – IIT Ropar	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc24_cs114/prview
2.	Neural Networks and Deep Learning	Coursera	2024	https://www.coursera.org/learn/neural-networks-deep-learning?specialization=deep-learning

Laboratory Plan

Sl. No.	Lab Program
1	Write a program to implement XOR gates using Perceptron.
2	Design a deep NN, optimize the network with Gradient Descent, and optimize the same with Stochastic gradient descent(SGD).
3	Classification of MNIST Dataset using CNN.
4	Implement Region-Based CNN for object detection.
5	Implement RNN for handwriting digit recognition.
6	Implement Bidirectional RNNs for music generation.
7	Implement Bidirectional LSTM for sentiment analysis.
8	Implement Variational Autoencoders for image-denoising.
9	Implementation of a Restricted Boltzmann Machine (RBM) that demonstrates stacking.
10	Implement Generative Adversarial Networks to generate realistic photographs.

Course Outcomes

At the end of the course, the student will be able to

CO1	Apply the fundamentals of deep learning algorithms for various complex problems
CO2	Analyze deep learning models to optimize its performance for prediction.
CO3	Design models using deep learning to solve real-world problems and present solutions in a team.
CO4	Conduct practical experiments and implement Deep Learning Models for Applications
CO5	Propose solutions using Deep Learning models for real-world text and image datasets.

CO-PO-PSO mapping



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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		2										3		
CO3			3			2			2	2				3
CO4				2	2									3
CO5				3	3	2	2				3			3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	Best of 2	20
Lab Test + Project	1	25
QUIZ/AAT	1	5
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Programming With R		
Course Code:	23DS5PCPWR	Total Contact Hours: 24 hours	
L-T-P:	0-0-1	Total Credits:	1

Module 1

SI no	Lab Program	No. of Hours
1	Introduction to R and RStudio: Install R and RStudio. Write and execute your first R script that includes basic arithmetic operations, variable assignments, and printing results. Document the steps to install R and RStudio and describe the purpose of each line of your script.	1
2	Basic Data Types and Operations: Design an R program to create and manipulate vectors, matrices, lists, and data frames. Include operations such as indexing, subsetting, and applying functions like sum(), mean(), and length(). Create a data frame from scratch, perform basic operations, and describe the structure and type of each element in the data frame.	1
3	Basic Statistical Operations: Design an R program to calculate mean, median, mode, standard deviation, and variance of a dataset. Use a sample dataset, calculate each statistical measure, and provide a detailed explanation of what each measure represents and how it can be interpreted in the context of the data.	1
4	Data Import and Export: Design an R program to import data from a CSV file, perform some basic cleaning (such as removing NA values), and export the cleaned data to a new CSV file. Include steps to check the structure of the imported data, summarize its contents, and verify the successful export of the cleaned data.	1
5	Basic Data Visualization: Design an R program to create simple plots including a histogram, bar plot, line plot, and scatter plot. Use a given dataset, generate each plot, customize the plots with titles, axis labels, and colors, and save the plots as image files. Provide a brief interpretation of each plot in the context of the data.	1

Module 2

SI no	Lab Program	No. of Hours
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1	Data Cleaning and Preparation: Design an R program to handle missing data, filter rows based on certain conditions, and select specific columns from a dataset. Use a sample dataset with missing values, filter the data to include only relevant rows, and create a new dataset with selected columns. Document the cleaning process and the rationale behind each step.	1
2	Advanced Data Manipulation using dplyr: Design an R program to use dplyr functions to manipulate data frames. Include tasks such as selecting columns, filtering rows, creating new columns with mutate, summarizing data with summarize, and arranging rows. Apply these operations to a complex dataset and provide a detailed explanation of each operation and its outcome.	1
3	Data Visualization using ggplot2: Design an R program to create advanced plots using ggplot2. Include examples of faceting, customizing plot aesthetics, and adding annotations. Use a dataset with multiple variables, generate plots that show different aspects of the data, and explain the insights gained from each plot.	1
4	Descriptive Statistics and Data Summary: Design an R program to generate descriptive statistics and create a data summary report. Use a comprehensive dataset, calculate measures such as mean, median, range, quartiles, and create summary tables. Write a report that includes the calculated statistics and an interpretation of the data distribution.	1
5	Basic Data Analysis: Design an R program to perform simple linear regression analysis. Use a dataset with a clear dependent and independent variable, fit a linear model, plot the regression line, and interpret the results. Include diagnostic plots to check the assumptions of the linear model and provide a detailed analysis of the findings.	2

Module 3

SI no	Lab Program	No. of Hours
1	Advanced Data Analysis: Design an R program to perform multiple linear regression analysis. Use a dataset with multiple predictor variables, fit a multiple regression model, interpret the coefficients, and evaluate the model's performance.	2



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	Include steps to check for multicollinearity, perform model selection, and validate the model using cross-validation techniques.	
2	Introduction to Machine Learning with R: Design an R program to implement a basic k-means clustering algorithm. Use a dataset with multiple features, normalize the data, perform k-means clustering, visualize the clusters, and interpret the results. Provide an analysis of the optimal number of clusters and discuss the practical applications of clustering in data analysis.	3
3	Time Series Analysis: Design an R program to analyze and forecast time series data using ARIMA models. Use a time series dataset, perform exploratory data analysis, fit an ARIMA model, and make future forecasts. Include steps to check for stationarity, select model parameters, and evaluate the model's forecasting accuracy. Provide a detailed interpretation of the time series components and the forecast results.	4
4	Creating Interactive Visualizations: Design an R program to create interactive plots using the plotly package. Use a complex dataset, generate interactive visualizations such as scatter plots, line charts, and bar charts, and customize the interactivity features. Include examples of how to incorporate tooltips, hover effects, and interactive legends. Discuss the advantages of using interactive visualizations for data exploration.	2
5	Data Reporting with RMarkdown: Design an R program to generate a comprehensive report using RMarkdown. Include sections that combine code, text, and visualizations to create a dynamic and reproducible report. Use a case study to demonstrate the end-to-end data analysis process, from data cleaning and manipulation to analysis and visualization. Provide the final RMarkdown document and the rendered report, highlighting the key findings and insights.	2

Prescribed Textbook					
SI No	Book Title	Authors	Edition	Publisher	Year
1.	R for Data Science	Hadley Wickham &	First	O'Reilly Media, Inc	2017



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		Garrett Grolmund			
2.	An Introduction to R	W. N. Venables, D. M. Smith and the R Core Team	First	R Core Team	2023

Reference Textbook					
SI No	Book Title	Authors	Edition	Publisher	Year
1	R in Action	Robert Kabacoff	2nd Edition	Manning	2015
2	The Art of R Programming	Norman Matloff	1st Edition	No Starch Press	2011

E-book						
SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Hands-On Programming with R	Garrett Grolmund	1st Edition	O'Reilly	2014	https://rstudio-education.github.io/hopr/index.html
2	R Graphics Cookbook	Winston Chang	2nd Edition	O'Reilly	2018	https://r-graphics.org/

MOOC Course				
SI No	Course Name	Offered By	Year	URL
1	Data Science: Foundations using R	Coursera (Johns Hopkins University)	2023	https://www.coursera.org/specializations/jhu-data-science
2	R Programming	Coursera (Johns Hopkins University)	2023	https://www.coursera.org/learn/r-programming
3	Foundations of R	IIT Kanpur	2024	https://onlinecourses.nptel.ac.in/noc22_ma69/preview



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Course Outcomes

At the end of the course the student will be able to

CO1	Apply complex data analysis techniques, including machine learning, time series analysis, and generate dynamic interactive reports.
CO2	Formulate advanced data manipulation, cleaning techniques, and comprehensive data visualizations using R.
CO3	Develop proficiency in R programming to perform data manipulation and basic statistical analysis.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3								2	2			3	
CO2		3		3								3		
CO3				3	3									3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Lab Internal	2	40
Project	1	10
Total		50

SEE Exam (50 Marks)

Evaluation of Projects carried out by students, as assessed by an external examiner along with internal faculty.



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Sem	V		
Course Title:	Research Methodologies and IPR		
Course Code:	23DC5AERMI	Total Hours : 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs.
1	Research Methodology: An Introduction - Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research methods vs Methodology, Research and scientific method, Research Process, Criteria of Good Research. Define the Research Problem - What is research problem, Selecting the problem, Necessity of Defining the problem, Technique involved in Defining a Problem Research Design - Meaning of Research Design, Need for Research Design, Features of Good Design, Important concepts Relating to Research Design, Different Research Design	8
2	Design of Sample Surveys - Introduction, Sample Design, Sampling and Non-Sampling Errors, Sample Survey vs Census Survey, Types of Sampling Designs Chi-Square Tests - Test of Difference of more than Two proportions, Test of Independence of Attributes, Test of Goodness of Fit Analysis of Variance - The ANOVA technique, The Basic principle of ANOVA, One way ANOVA, Two way ANOVA, Latin-square Design.	8
3	Nature of Intellectual property, IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation- international cooperation on IP.	8
4	A brief summary of Patents-Copyrights-Trademarks, patent rights-licensing and transfer of technology-patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights.	8
5	Interpretation and Report Writing - Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing Report, Layout of the Research Report, Types of Reports, Oral presentation, Mechanics of writing a research Report, Precautions of Writing Research Report. Case study - Research paper related to computer science	8



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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Research Methodology: Methods and Techniques	C R Kothari, Gaurav Garg	Multicolor (Fourth)	New Age International Publishers	2019
2	An introduction to Research Methodology	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K	Fourth	RBSA Publishers	2002
3	Handbook of Intellectual property law and practise	Subbaram NR	First	S Viswanathan Printers and Publishing Private Limited	1998

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Understanding Research Methods	Coursera	2024	https://www.coursera.org/learn/research-methods
2.	Fundamentals of Research Methodology	Udemy	2024	https://www.udemy.com/course/fundamentals-of-research-methodology/

Course Outcomes

CO1	Analyze qualitative and quantitative data using appropriate statistical tools to derive meaningful and valid conclusions.
CO2	Apply ethical principles and adhere to intellectual property rights to ensure integrity and credibility in scientific research.
CO3	Identify research gaps through critical literature review and formulate relevant research questions and hypotheses
CO4	Utilize modern research tools and software for data analysis and visualization to improve the accuracy and efficiency of research findings.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3		3									3	
CO2	3						1	3	1			3		
CO3		3		2						1				3
CO4	2	1		2	3									3



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Optimization Techniques for Machine Learning		
Course Code:	23AI5PEOTM	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction to Optimization: Definition, Need for optimization algorithms, Optimization Process, Basic Optimization Problem, Constraints, Handling huge matrices in Python, Mathematical Formulation, Example: A Transportation Problem One-Dimensional Search Methods: Golden Section Search, Fibonacci Search	8
2	Approaches of optimization: Continuous versus Discrete Optimization, Constrained and Unconstrained Optimization, Global and Local Optimization, Stochastic and Deterministic Optimization Convexity Convex optimization: Convex Functions, Convex Optimization Problems	8
3	Gradient Descent: Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Cauchy's steepest descent method, Newton's Method – Optimization in practice, conjugate gradient method Function optimization: interpolation, extrapolation	8
4	Optimizing Model Performance Using Optimization Algorithms: Batch Normalization, Grid Search, RMSProp optimizer Random Search, derivative-free optimization algorithms, Automated Hyperparameter Tuning: Evolution algorithms, Bayesian optimization	8
5	Particle Swarm Optimization: Particle Swarm Optimization (PSO) Algorithm, PSO System Parameters, Particle Swarm Optimization versus Evolutionary Computing. Ant colony Optimization: The Invisible Manager, The Pheromone, Ant Colonies and Optimization, Ant Colonies and Clustering, Applications	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Algorithms for Optimization	Mykel J. Kochenderfer Tim A. Wheeler	-	MIT Press Cambridge	2019
2	Numerical Optimization	Jorge Nocedal Stephen J. Wright	Second	Springer	2006

Reference Text Book					
Sl.	Book Title	Authors	Edition	Publisher	Year



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No.					
1.	Computational Intelligence An Introduction	Andries P. Engelbrecht	-	John Wiley & Sons, Ltd	2002
2.	An Introduction to Optimization	Edwin K. P. Chong, Stanislaw H. Zak	Second	John Wiley & Sons, Ltd	2004

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Optimization Algorithms for Machine Learning Models	Lovekush Chaurasia, Amol Borse	-	Global Logic	2020	https://www.globallogic.com/wp-content/uploads/2020/02/Optimization-Algorithms-for-Machine-Learning-1.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Optimization for Machine Learning	NPTEL	2024	https://nptel.ac.in/courses/106106245

Course Outcomes

At the end of the course the student will be able to

CO1	Apply computation techniques for single variable functions and multiple variable functions
CO2	Analyse concept of search space and optimality through tuning approaches
CO3	Analyse population-based metaheuristic for social behavior and other engineering problems

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3										3		
CO3			3		3							3		



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Internet of Things		
Course Code:	23DS5PEIOT	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	Introduction to Internet of Things: Introduction: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, Logical Design of IoT: IoT Functional Blocks, IoT Communication Models, IoT Communication APIs. IOT Enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Embedded Systems, IoT Levels and Deployment Templates.	8 Hrs
2	Introduction to Embedded Systems for IoT: Embedded Computing Basics - Microcontrollers, System-on-Chips, Choosing Your IoT Development Platform, Working with Arduino: Introduction to Arduino, Setting Up and Developing on the Arduino, Working with Raspberry Pi, Introduction to Raspberry Pi. Sensors and Actuators in IoT: Working Principles and Types of Sensors, Working Principles and Types of Actuators. Smart Objects - Overview and Trends.	8 Hrs
3	IoT and M2M Communications: Introduction, M2M, Differences between M2M and IoT, SDN and NFV for IoT. Connecting smart things: Communication Criteria, IoT access Technologies (IEEE 802.15.4, IEEE 802.15.4g and IEEE 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, NB-IoT)	8 Hrs
4	IP as the IoT Network Layer: The business case for IP, The need for Optimization, Optimizing IP for IoT -From 6LoWPAN to 6Lo, 6TiSCH, RPL. Application Protocols for IoT: Transport Layer, IoT Application Layer Protocols: CoAP, MQTT.	8 Hrs
5	IoT Applications: Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, and Healthcare. Case Studies – Home Intrusion Detection, Smart Parking, Weather Monitoring System, Air Pollution Monitoring, Forest Fire Detection, and Smart Irrigation.	8 Hrs



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Prescribed Text Books				
Book Title	Authors	Edition	Publisher	Year
Internet Of Things - A Hands-On Approach	Arsheep Bahga, Vijay Madiseti	First Edition	Universities Press	2023
Designing the Internet of Things	Adrian McEwen and Hakim Cassimally	First Edition	John, Wiley & Sons	2014
IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro	First Edition	CISCO Press	2022

Reference Text Books				
Book Title	Authors	Edition	Publisher	Year
Internet of Things	Surya S. Durba	First Edition	Oxford University Press	2021
Internet of Things: Principles and Paradigms	Rajkumar buyya	First Edition	Todd Green	2016

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro	First	CISCO Press	2022	https://nibmehub.com/opac-service/pdf/read/IoT%20Fundamentals.pdf
2.	Using the Web to build IOT	Dominique Guinard and Vlad Trifa ,	First	Manning	2016	https://www.manning.com/books/using-the-web-to-build-the-iot



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Course Outcomes

At the end of the course the student will be able to

CO1	Understand characteristics such as design, communication model, prototyping and enabling technologies required to develop application of IOT
CO2	Apply knowledge of Internet of Things in identifying the appropriate sensors and actuators with microcontrollers
CO3	Design and develop IOT applications for solving real world problems.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2	3	2											2	
CO3			3											2

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Cryptography And Network Security		
Course Code:	23DS5PECNS	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs.
1	Introduction: Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. Classical Encryption Techniques: Symmetric Cipher Model, Substitution Techniques – Caesar Cipher, Monoalphabetic Ciphers, Play fair Cipher, Hill Cipher, Polyalphabetic Ciphers, One-Time Pad, Transposition Techniques.	8
2	Block Ciphers: Traditional Block Cipher Structure – Stream Ciphers and Block Ciphers, Motivation for the Feistel Cipher Structure, The Feistel Cipher, Block Cipher Design Principles, The Simplified Data Encryption Standard (S-DES) – S-DES Encryption, S-DES Decryption, SDES Key Generation. Stream Ciphers: StreamCiphers, RC4 – Initialization of S, StreamGeneration, Strength of RC4	8
3	Public-Key Cryptosystems: Principles of Public-Key Cryptosystems – Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptosystems, Public-Key Cryptanalysis, The RSA Algorithm – Description of the Algorithm, Computational Aspects, The Security of RSA, Diffie-Hellman Key Exchange – The Algorithm, Key Exchange Protocols, Man-in-the-Middle Attack. Cryptographic Hash Functions: Secure Hash Algorithm (SHA) – SHA-512 Logic, SHA-512 Round Function, Examples.	8
4	Key Management and Distribution: Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using Asymmetric Encryption, Distribution of Public Keys. Transport-Level Security: Transport Layer Security – Architecture, Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol, Cryptographic Computations, Heartbeat Protocol, SSL/TLS Attacks, HTTPS – Connection Initiation, Connection Closure	8
5	Digital Signatures: Digital Signatures – Properties, Attacks and Forgeries, Digital Signature Requirements, Direct Digital Signature, SCHNORR Digital Signature Scheme, NIST Digital Signature Algorithm. IP Security: IP Security Overview – Applications, Benefits, Routing	8



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	Applications, IPsec Documents, IPsec Services, IP Security Policy – Security Associations and its Database, Security Policy Database, IP Traffic Processing, Encapsulating Security Payload – ESP Format, Encryption and Authentication Algorithms.	
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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Cryptography and Network Security – Principles and Practice	William Stallings	7th Edition	Pearson	2017

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Network Security Essentials Applications and Standards	William Stallings	4th Edition	Pearson	2012
2.	Network Security Private Communication in a Public world	Charlie Kaufman, Radia Perlman and Mike Speciner	Second	PHI	2013

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Cryptography I	Coursera	2024	https://www.coursera.org/learn/cryptography
2.	Cryptography and System Security	Udemy	2024	https://www.coursera.org/specializations/agile-development

Course Outcomes

At the end of the course the student will be able to

CO1	Understand the fundamental concepts of computer security, including security architecture, attacks, services, and mechanisms.
CO2	Apply classical encryption techniques and block cipher structures to ensure data confidentiality and integrity.



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CO3	Analyze the principles and algorithms of public-key cryptosystems and cryptographic hash functions for secure communication.
CO4	Make an effective communication and presentation in a team on different algorithms or tools used in cryptography and network security.

CO-PO-PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1														
CO2	3												2	
CO3		3										2		
CO4									1	1			2	

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	V		
Course Title:	Responsible AI		
Course Code:	23DS5PERAI	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	An Ethical Framework for a Good AI Society: opportunities, Risks, principles and Recommendations. Establishing the rules for building trustworthy AI. Translating principles into practices of digital ethics: five risks of being Unethical The Ethics of Algorithms: Key problems and Solution How to Design AI for Social Good: Seven Essential Factors.	8
2	How to design AI for social good: seven essential factors From What to How: An Initial Review of publicly available AI Ethics tools, Methods and Research to Translate principles into Practices Innovating with Confidence: Embedding AI Governance and fairness in financial Services Risk management framework, What the near future of AI could be. Human-AI Relationship: AI and Workforce, Autonomous Machines and Moral Decisions, AI in HealthCare: balancing Progress and Ethics	8
3	Responsible AI :Need for ethics in AI. AI for Society and Humanity, ISO/IEC 42001: A New Standard for Ethical and Responsible AI Management Fairness and Bias : Sources of Biases, Exploratory data analysis, limitation of a dataset, Preprocessing, inprocessing and postprocessing to remove bias, Group fairness and Individual fairness, Counterfactual fairness	8
4	Interpretability and explainability: Interpretability through simplification and visualization, Intrinsic interpretable methods, Post Hoc interpretability, Explainability through causality, Model agnostic Interpretation	8
5	Privacy preservation: Attack models, Privacy-preserving Learning, Differential privacy, Federated learning, HIPAA Compliance Standards with AI Relevance: Case study: Recommendation systems, Medical diagnosis, Hiring/ Education	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year



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1.	Ethics, governance and Policies in Artificial Intelligence	Luciano Floridi	1st Edition	Springer	2021
2.	Ethics and AI	Aaron Aboagye	1st Edition	kindle	2023
3.	Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way	Virginia Dignum	ISBN-10 : 3030303705, ISBN-13 : 978-3030303709	Springer Nature	2019
4	Interpretable Machine Learning	Christoph Molnar	1st edition	Lulu	2019
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Responsible AI in the Enterprise	Adnan Masood, Heather Dawe	1st	Packt	2023

E-Book						
Sl. No.	Book Title	Authors	Editi on	Publisher	Year	URL
1.	Responsi ble AI - Interdisci plinary perspecti ves	Silja Voenekey, Philipp Kellmeyer, Oliver Mueller, Wolfram Burgard,	1st	Cambridg e University Press	2022	https://doi.org/10.1017/9781009207898

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Responsibl e AI in Generative AI era	Coursera	2024	https://www.coursera.org/learn/responsible-ai-in-generative-ai?action=enroll
2.	Responsibl e & Safe AI systems	NPTEL	2024	https://onlinecourses.nptel.ac.in/noc24_cs132/prview



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Course Outcomes

At the end of the course, the student will be able to

CO1	Apply ethical frameworks and principles to the development and use of AI systems, ensuring they align with societal values and address potential risks.
CO2	Design AI systems for social good by understanding the seven essential factors and translating ethical principles into practical tools and methodologies.
CO3	Develop skills to address issues of fairness and bias in AI systems, including techniques for bias detection, data preprocessing, and ensuring both group and individual fairness.
CO4	Implement AI models that cater to standards, including methods for simplification, visualization, and post hoc interpretation to make AI decisions transparent and understandable

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3					2	2	3					3	
CO2		2				2	2	3				3		
CO3			3											2
CO4	2							2						2

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Semester	V		
Course Title:	Mini Project – Social Network Analytics		
Course Code:	23AI5PWSNA	Total Contact Hours:30 hours	
L-T-P:	0-0-2	Total Credits:	2

Sl.No	Lab Programs
1	Create basic graph structures using NetworkX and Demonstrate how to add and access node and edge attributes Customer Segmentation: Use a simple graph to represent customer interactions, where nodes are customers and edges represent interactions like referrals or shared reviews. Add attributes to nodes (e.g., customer purchase history) and edges (e.g., frequency of interaction).
2	Create and visualize directed graphs Marketing Campaign Spread: Model user interactions on social media as directed graphs, where nodes are users and directed edges represent actions like shares or mentions. Calculate the degree of nodes in a graph Employee Collaboration: Identify the most connected employees in a collaboration network using degree analysis to find key influencers.
3	Find and visualize the shortest path between nodes. Supply Chain Optimization: Identify the shortest path from suppliers to retailers to optimize the supply chain network.
4	Compute various centrality measures (degree, betweenness, closeness). Customer Segmentation: Identify influential customers using centrality measures to target marketing campaigns effectively.
5	Calculate the clustering coefficient of nodes in a graph. Employee Collaboration: Analyze collaboration density to improve team communication. Use community detection algorithms to find clusters within the network. Marketing Campaign Spread: Identify clusters of users who are more likely to share marketing messages.
6	Visualize a network using node and edge attributes to influence the appearance. Customer Segmentation: Visualize customer network using attributes like customer lifetime value or interaction frequency.
7	Work with bipartite graphs, visualize, and analyze them Product-User Relationships: Model the relationship between products and customers



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	as a bipartite graph.
8	Explore connectivity within graphs and identify connected components. Supply Chain Optimization: Analyze the robustness of the supply chain by identifying connected components and potential weak points.
9	Check if two graphs are isomorphic (structurally identical). Product Line Similarity: Determine if two product lines have the same structure by comparing their relationship graphs.
10	Analyze the resilience of a network by removing nodes or edges. Employee Collaboration: Understand the impact of losing key employees on the overall collaboration network.

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Social Network Analysis: Methods and Applications.	Stanley Wasserman, Katherine Faust		Cambridge University Press	2012
2.	Networks, Crowds, and Markets: Reasoning about a Highly Connected World	David Easley, Jon Kleinberg.		Cambridge University Press	2010
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Social Network Analysis	John Scott	3rd Edition	SAGE publications Ltd.,	2012
2.	Understanding-Social-Networks-Theories-Concepts-and findings	Charles Kadushin		Oxford university press	2012

E-Book					
Sl. No.	Book Title	Authors	Publisher	Year	URL



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1	Networks, Crowds, and Markets: Reasoning about a Highly Connected World	David Easley, Jon Kleinberg.	Cambridge University Press	2010	https://www.cs.cornell.edu/home/kleinber/networks-book/networks-book.pdf
2.	Social Network Analysis theory and applications.	Dr. John T.Bell	University of Illinois Chicago	2006 & 2013	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/index.html

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Social Network Analysis	Coursera	2024	https://www.coursera.org/learn/social-network-analysis
2.	Applied Social Network Analysis in Python	Coursera	2024	https://www.coursera.org/learn/python-social-network-analysis

Course Outcomes

At the end of the course the student will be able to

CO1	Understand the Fundamentals of Graph Theory and Network Structures
CO2	Construct and Visualize Network Graphs Using NetworkX
CO3	Apply Community Detection and Analyze Network Components
CO4	Evaluate Network Resilience and Robustness

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2												
CO2	2	2	2	3	3					2				3
CO3		3		3	2	2					2		3	
CO4		3		2	2	2	3					3		

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	-	-
QUIZ/AAT	-	-
Lab Component	-	50
Total		50



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SEE Exam Question paper format – 100M

Students execute programs on Data Visualization using Python and Tableau in the presence of External and Internal examiners.



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Sem	V		
Course Title:	Environmental Studies		
Course Code:	23DC5HSEVS	Total Contact Hours: 13 hours	
L-T-P:	1-0-0	Total Credits:	1

Unit No.	Topics	Hrs.
1	Introduction to Environment: Definition, About Earth i.e Atmosphere, Hydrosphere, Lithosphere and Biosphere, Structure of Atmosphere, Internal structure of Earth, Ecology & Ecosystem, balanced ecosystem, types of ecosystem.	2
2	Effect of Human activities on Environment: i) Agriculture ii) Housing iii) Industries iv) Mining and v) Transportation activities. Sustainability Standards: ISO 14001, LEED, REACH, ISO 50001, UN's Sustainable Development Goals (SDGs).	2
3	Natural Resources: Definition, Water resources – its availability, quality, water borne & water induced diseases. Mineral resources, Forest resources, Energy resources – conventional & non - conventional energy resources, Hydroelectric, wind power, solar, Biogas. Fossil fuel-based energy resources- Coal, Oil & Gas, Nuclear power. Hydrogen as an alternate future source of energy.	3
4	Environmental pollution: Introduction and its types, Water pollution – definition, effects, control methods. Land pollution - definition, effects, Solid waste management. Noise pollution - definition, effects, control methods. Current environmental issues & importance: Population growth, effects & control, climatic changes, Global warming, Acid rain, ozone layer depletion & effects, Environmental protection, Role of government, legal aspects.	3



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5	Green Computing- Sustainable IT Practices and Metrics: Introduction to Sustainable Information Systems, Environmental Impacts of IT- E-waste, Carbon footprint, Energy footprint, Water footprint. Green IT- Green Data Centers, Green Data Storage, Applying IT for Enhancing Environmental Sustainability, Green IT Standards and Eco-Labeling of IT.	3
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TEXT BOOKS:

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Environmental studies	Dr. Geetha Balakrishnan	Seventh	SUNSTAR	2016
2	Harnessing Green IT Principles and Practices	San Murugesan, G.R. Gangadharan	First	John Wiley & Sons	2016
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Environmental studies	Benny Joseph	Second	Tata McGraw-Hill	2019

E-Books				
Sl. No.	Book Title	Publisher	Year	URL
1.	Environmental studies	University Grants Commission (UGC)	2019	https://www.ugc.gov.in/oldpdf/modelcurriculum/env.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Environmental studies	Swayam	2019	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview



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2	Sustainable Software Development	Microsoft	2022	https://learn.microsoft.com/en-us/training/modules/sustainable-software-engineering-overview
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Course Outcomes

At the end of the course the student will be able to

CO1	Apply the environmental concepts for conservation and protection of natural resources
CO2	Identify and establish relationships between social, economic, and ethical values from environmental perspectives, with reference to sustainability standards and the UN Sustainable Development Goals (SDGs).
CO3	Analyze the impact of Computing solutions in the environmental context and realize the need for sustainable development

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2										
CO2		2					2	1			
CO3		2					2				2

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	1	25
QUIZ/AAT	2	25
Total		50



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	Course Type	Code	Course Title	Credits			Total Credits	Total Hours
				L	T	P		
1	PC	23DS6PCCCT	Cloud Computing	2	1	0	3	4
2	PC	23DS6PCNGD	Next Gen Databases	3	0	1	4	5
3	PC	23DS6PCNLP	Natural Language Processing & Generative AI	3	0	1	4	5
4	PC	23DC6PCSEA	Software Engineering & Agile Methodologies	2	0	0	2	2
5	PE	23AI6PEDWD	Data Ware House and Data Mining	3	0	0	3	3
		23AI6PEVAL	Video Analytics					
		23AI6PEAVR	Augmented Reality / Virtual Reality					
		23AI6PEDIP	Digital Image Processing					
6	OE	23AI6OEIAI	Introduction to AI	3	0	0	3	3
7	PW	23AI6PWPP1	Project work – Phase I	0	0	2	2	4
8	AE	23DS6AECGP	Competitive Programming	0	0	1	1	2
		23AI6AEOOJ	OOPs with JAVA					
		23DSAEDOP	DevOps					
9	NCMC	23NCMC3NS1	NSS	0	0	0	0	1
		23NCMC3YG1	YOGA					
		23NCMC3PE1	Physical Edu. (Sports and Athletics)					
	TOTAL						22	29

PC-13, PE-3, OE-3, PW-2, AE-1



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Semester	VI		
Course Title:	Cloud Computing		
Course Code:	23DS6PCCCT	Total Contact Hours: 40 hours	
L-T-P:	2-1-0	Total Credits:	3

Unit No.	Topics	Hou rs
1	Introduction, Cloud Infrastructure: Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.	8
2	Cloud Computing: Application Paradigms: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre The Web application, Cloud for science and engineering, High performance computing on a cloud, Cloud computing for Biology research, Social computing, digital content and cloud computing.	8
3	Cloud Resource Virtualization: Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades, Performance comparison of virtual machines, The dark side of virtualization, Exercises and problems	8
4	Cloud Resource Management and Scheduling: Policies and mechanisms for resource management, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems	8
5	Cloud Security: Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks	8



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	posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, Cloud Application Development: Amazon web services: EC2 instances, Connecting clients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis .Exercises and problems.	
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Prescribed Text Book				
Sl. No.	Book Title	Authors	Publisher	Year
1.	Cloud Computing : Theory and Practice	Dan C Marinescu Elsevier	Morgan Kaufmann	2013
2.	Computing Principles and Paradigms	RajkumarBuyya , James Broberg, Andrzej Goscinsk,	John Wiley & Sons	2014
Reference Text Book				
Sl. No.	Book Title	Authors	Publisher	Year
1.	Cloud Computing Implementation, Management and Security	John W Rittinghouse, James F Ransome	CRC Press	2013

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Cloud Computing : Theory and Practice	Dan C Marinescu Elsevier	-	Morgan Kaufmann	2013	https://eclass.uoa.gr/modules/document/file.php/D416/CloudComputingTheoryAndPractice.pdf
2.	Computing Principles and Paradigms	RajkumarBuyya , James Broberg, Andrzej Goscinsk,	-	John Wiley & Sons	2014	https://dphoto.lecturer.pens.ac.id/lecture_notes/internet_of_things/CLOUD%20COMPUTING%20Principles%20and%20Paradigms.pdf



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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Introduction to Cloud Computing	Coursera	2024	https://www.coursera.org/learn/introduction-to-cloud
2.	Cloud Computing Foundations	Coursera	2024	https://www.coursera.org/learn/cloud-computing-foundations-duke

Course Outcomes

At the end of the course the student will be able to

CO1	Apply cloud computing models and services to solve practical problems.
CO2	Analyze cloud resource management and virtualization techniques to evaluate their impact on performance and security.
CO3	Demonstrate the working of VM and VMM on any cloud platforms(public/private), and run a software service on that.
CO4	Develop cloud-based solutions for different applications using appropriate cloud technologies.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2			1				2				3	
CO2	2	1	2	2	2				3			3		
CO3		2	1	2	1				2					3
CO4		2	3	2	2				2					3

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	VI		
Course Title:	Next Gen Databases		
Course Code:	23DS6PCNGD	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	4

Unit No.	Topics	Hrs.
1	Early Database Management Systems - Database revolutions: First, second and Third generation - Big Data Revolution - Google: Pioneer of Big Data, Hadoop: Open-Source Google Stack. Introduction to Sharding - CAP Theorem	8
2	Object Oriented Database: Introduction, properties and applications. PostgreSQL , Relations, CRUD and Joins, starting with SQL, Working with tables, Join Reads, The outer limits, Fast Lookups with Indexing, Advanced queries, Code and Rules, Aggregate functions, Grouping, Window Functions, Transactions, Stored procedures, Pull the triggers, View, Full Text and Multidimensions, Fuzzy searching, PostgreSQL's Strengths and Weaknesses	8
3	Document Database : Introduction and its types. Couch DB , CRUD, Futon and cURL Redux, Getting Comfortable with Futon, Performing RESTful CRUD Operations with cURL, Creating a Document with POST, Updating a Document with PUT, Removing a Document with DELETE, Creating and Querying Views, Accessing Documents Through Views, Importing Data Into CouchDB Using Ruby, Creating Advanced Views with Reducers, CouchDB's Strengths and Weaknesses	8
4	Graph Database : Introduction and its architecture Neo4J: Graphs, Groovy, and CRUD, Neo4j's Web Interface, Neo4j via Gremlin, The Power of Pipes, Pipeline vs. Vertex, Schemaless Social, Domain-Specific Steps, Update, Delete, Done, REST, Indexes, Creating Nodes and Relationships Using REST, Indexing, Distributed High Availability, Transactions, Neo4J's Strengths and Weaknesses, NEO4J on CAP	8
5	Key Value Database : Introduction, features and advantages Redis: Data Structure Server Store, CRUD and Datatypes, Transactions, Complex Data Types, Expiry, Database Namespaces, Advanced Usage, Distribution, publish-subscribe , Redis Configuration, Master-Slave Replication, Data Dump, Redis Cluster, Bloom Filters , Redis's Strengths and Weaknesses SSD & In-Memory Databases —SAP HANA, Berkeley Analytics Data Stack and Spark.	8



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Prescribed Text Book					
Sl. No.	Book Title	Auth ors	Edition	Publisher	Year
1	Next Generation Databases	Guy Harrison	First	Apress	2015
2	Seven Databases in Seven Weeks - A Guide to Modern Databases and the NoSQL Movement	Erick Redmond, Jim R Wilson	Second	Pragmatic Bookshelf	2018

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	NoSQL for Dummies	Adam Fowler	First Edition	John Wiley & Sons	2015
2	Fundamentals of Database Systems	Ramez Elmasri and Shamkant Navathe	Sixth Edition	Pearson	2011

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Seven Databases in Seven Weeks	Eric Redmond, Jim R. Wilson	First	O'Reilly	2012	https://lib.fbtuit.uz/assets/files/8.-EricRedmondJimRWilson-SevenDatabasesinSevenWeeks-EN.pdf
2.	NoSQL for Mere Mortals	Dan Sullivan	Second	Addison-Wesley Professional	2015	https://databaze.wordpress.com/wp-content/uploads/2021/03/nosql-for-mere-mortals.pdf

MOOC Courses				
Sl. No.	Course name	Course Offered By	Year	URL
1	Introduction to NoSQL Databases	Course era	2024	https://www.coursera.org/learn/introduction-to-nosql-databases
2	Introduction to Graph Databases using Neo4J	Udemy	2024	https://www.udemy.com/course/introduction-to-graph-databases-using-neo4j



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Laboratory Plan

Lab Program	Program Details
1	PostgreSQL Query Questions - Hospital Management System Create a database for a hospital management system with tables: Patients (PatientID, Name, Age, Gender, AdmissionDate) and Doctors (DoctorID, Name, Specialization, Experience). a) Fetch Patient Details: b) List Patients Admitted on a Specific Date ('2024-06-15'): c) List Patients by Age Group: d) Update Patient Details (Change Name for PatientID = 1): e) List Doctors by Specialization ('Cardiology'): f) Count Patients per Doctor: g) Calculate Average Experience of Doctors:
2	CRUD operations in CouchDB Student Database Create a student database with the fields: (SRN, Sname, Degree, Sem, CGPA) a) Display all the documents b) Display all the students in BCA c) Display all the students in ascending order d) Display first 5 students e) Display students 5,6,7 f) List the degree of student "Rahul" g) Display students details of 5,6,7 in descending order of percentage h) Display all the BCA students with CGPA greater than 6, but less than 7.5
3	CRUD operations in CouchDB Library Database Create a library database with the fields: (ISBN, Title, Author, Genre, PublicationYear, CopiesAvailable, Rating). a) Display all the documents in the library database. b) Display all the books in the genre "Fiction". c) Display all books sorted by their Title in alphabetical order. d) Display the first 3 books. e) Display books 4, 5, and 6. f) List the Author of the book titled "The Great Gatsby".
4	CRUD Operations in Neo4j - Social Network Database



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	Create a social network database with nodes: User (UserID, Username) and relationships: (FOLLOWS). a) Write a query to display all users. b) Write a query to display users followed by a specific user with Username "Jane". c) Write a query to display all users in ascending order by Username. d) Write a query to find users who follow both "Alice" and "Bob". e) Write a query to find users with the most number of followers. f) Display first 5 users:
5	CRUD Operations in Neo4j - Movie Recommendation Database: where we have nodes: Movie (MovieID, Title) and User (UserID, Username), and relationships: (LIKES) indicating a user likes a specific movie. a) Write a query to display all movies liked by a specific user with Username "John". b) Write a query to find all users who like the movie titled "Inception". c) Write a query to display all movies in ascending order by Title. d) Write a query to find users who like both "The Matrix" and "Inception". e) Write a query to find the most liked movie. f) Write a query to display the top 5 users who like the most movies.
6	Redis Query Questions - Product Catalog Scenario Create a product catalog database with products having attributes: (ProductID, Name, Category, Price) a) Insert products into Redis with keys like product:{ProductID} and values as JSON objects containing Name, Category, and Price. b) Retrieve details of a specific product by ProductID. c) Fetch all products belonging to a specific category.(Electronics) d) List Products in a Price Range (500 - 1000): e) Update Product Price: f) Delete a Product:



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7	Consider an employee management system where each employee has attributes: (EmployeeID, Name, Department, Position, Salary). Questions: - Insert Employee Details into Redis: Insert employee records into Redis with keys like employee:{EmployeeID} and values as JSON objects containing Name, Department, Position, and Salary. - Retrieve All Employees in a Specific Department (e.g., "HR"): Write a Redis query to fetch all employees belonging to a specific department, such as "HR." - List Employees with a Salary Above a Certain Amount (e.g., \$50,000): Write a Redis query to list all employees whose salaries are above a certain threshold (e.g., \$50,000). - Update an Employee's Position: Write a Redis query to update the position of a specific employee identified by their Employee ID.
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Course Outcomes

At the end of the course the student will be able to

CO1	Apply appropriate database operations and queries for SQL and NoSQL databases.
CO2	Analyze different database architectures and operations for next generation databases.
CO3	Design and execute complex queries and transactions using next-gen databases leveraging advanced features.
CO4	Conduct experiments for demonstrating operations on different next generation databases.
CO5	Investigate NoSQL database architectures through case study presentations or research paper study to understand their effectiveness in solving complex database challenges.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3										3		
CO3			2											3
CO4				3	3									3
CO5	1	1							1	1	1			3



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	Number of Assessments	Marks
Internals	3	20
QUIZ/AAT	1	5
Lab Component	CIE + Lab Test	25
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	VI		
Course Title:	Natural Language Processing and Generative AI		
Course Code:	23DS6PCNLP	Total Contact Hours: 40 hours	
L-T-P:	3-0-1	Total Credits:	3

Unit No.	Topics	Hrs
1	Introduction: What is Natural Language Processing (NLP), Origins of NLP, Phases of NLP, Ambiguities in NLP. Why is NLP hard? Text Processing: Regular Expressions, Word normalisation - Lemmatization, Stemming, Tokenizations - Word Tokenization, Character Tokenization, Byte Pair Encoding, Word piece	8
2	Sequence Labeling for Parts of Speech and Named Entities: English Word Classes, Part-of-Speech Tagging, Named Entities and Named Entity Tagging, HMM Part-of-Speech Tagging Vector Semantics and Embeddings: Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF-IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI), Word embeddings. Parsing: Constituency Parsing, Dependency Parsing: Transition-Based Dependency Parsing	8
3	Language Modeling: Types of language models, Statistical Language Models The Transformer: A Self-Attention Network, Multihead Attention, Transformer Blocks, The Residual Stream view of the Transformer Block, The input: embeddings for token and position, The Language Modeling Head, Large Language Models with Transformers, Large Language Models: Generation by Sampling, Large Language Models: Training Transformers Introduction to Pre-trained Language Models, Masked Language Model - BERT. Fine-tuning LLMs for specific tasks	8
4	Generative Modeling: What is Generative Modeling? Probabilistic Generative Models Variational Autoencoders: Building a VAE, Using VAE to generate faces.	8



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	Transformer based Generative Models (GPT and T5), Potential Harms from Language Models.	
5	Teaching Machines to Paint, Write and Compose: Creating CycleGAN to paint, LSTM Network to generate text, Music generating RNN	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition	James H Martin	Third	Pearson Education India	2024
2.	Generative Deep Learning	David Foster	Second	O'Reilly	2023

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Natural Language Processing and Information Retrieval	Tanveer Siddiqui, U.S. Tiwary	First	Oxford University Press	2008
2.	Natural Language Understanding	James Allen	Second	Benjamin /Cummings publishing company	1995
3.	Generative AI with Python and Tensorflow2	Raghav Bali	First	Packt	2021

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Natural Language Processing Recipes	Akshay Kulkarni Adarsha Shivananda	First	APRESS	2019	https://www.aitskadapa.ac.in/e-books/CSE/DEEP%20LEARNING/Natural%20Language



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						age%20Processing%20Recipes_%20Unlocking%20Text%20Data%20with%20Machine%20Learning%20and%20Deep%20Learning%20using%20Python%20(%20PDFDrive%20).pdf
2.	HANDBOOK OF NATURAL LANGUAGE PROCESSING	NITIN INDURKHY A FRED J. DAMERA U	Second	CRC Press	2010	https://karczmarczuk.users.greyc.fr/TEACH/TAL/Doc/Handbook%20Of%20Natural%20Language%20Processing,%20Second%20Edition%20Chapman%20&%20Hall%20Crc%20Machine%20Learning%20&%20Pattern%20Recognition%202010.pdf
3	Natural Language Processing with Python	Steven Bird, Ewan Klein, and Edward Loper	First	O'Reilly	2011	https://www.nltk.org/book/

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Natural Language Processing	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc19_cs56/preview
2.	Natural Language Processing	Coursera	2024	https://www.coursera.org/specializations/natural-language-processing
3	Generative AI Fundamentals Specialization	Coursera	2024	https://www.coursera.org/specializations/generative-ai-for-everyone

Laboratory Plan

Sl. No.	Lab Program
1	Write a Python program using nltk to perform tokenization, eliminate stopwords, perform stemming and lemmatization



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2	Implement traditional machine learning algorithms to perform Parts of Speech tagging and Named entity recognition.
3	Write a python program to find Term Frequency and Inverse Document Frequency (TF-IDF).
4	Write a python program to find all unigrams, bigrams and trigrams present in the given corpus.
5	Build traditional machine learning models for sentiment analysis. Compare the performance with a transformer model fine tuned on a dataset like IMDB or Twitter
6	Implement a VAE on the MNIST dataset and generate new images by sampling from the latent space.
7	Fine-tune a pre-trained language model (e.g., GPT, BERT) using transfer learning techniques on a domain-specific dataset and evaluate its performance for text generation tasks.
8	Implement a Long Short-Term Memory (LSTM) model on a dataset of text sequences and generate new text samples.

Course Outcomes

At the end of the course the student will be able to

CO1	Apply existing mathematical models and machine learning algorithms to build NLP applications.
CO2	Analyze NLP tasks like text pre-processing, part-of-speech tagging, syntax parsing using existing algorithms and frameworks.
CO3	Design and develop applications using Natural Language Processing and Generative AI.
CO4	Conduct experiments to implement applications based on statistical NLP and Deep learning based NLP

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2		3										3		
CO3			2		2									3
CO4				3	2									3



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	Number of Assessments	Marks
Internals	3	20
QUIZ/AAT	1	5
Lab Component	CIE + Lab Test	25
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	VI		
Course Title:	Software Engineering & Agile Methodologies		
Course Code:	23DC6PCSEA	Total Contact Hours: 26 hours	
L-T-P:	2-0-0	Total Credits:	2

Unit No.	Topics	Hrs.
1	Introduction - Software metrics, Overview of Software Development Projects, Emergence of Software Engineering Software Life Cycle Models - Basic Concepts, Waterfall Model and its Extensions, Rapid Application Development, Agile Development Models: Essential Ideas Behind Agile Models, Agile vs. Other Models, Spiral Model, Comparison of Different Life Cycle Models	5
2	Requirements Analysis and Specification - Requirements Gathering and Analysis, Software Requirements Specification (SRS) Case Study - IEEE SRS Software Design - Overview of the Design Process, Characteristics of Good Software Design: Cohesion and Coupling, Approaches to Software Design Function-Oriented Software Design - Overview of SA/SD Methodology, Structured Analysis: Developing the DFD Model of a System, Structured Design and Detailed Design	5
3	Software Project Management - Project Planning, Metrics for Project Size Estimation, Project Estimation Techniques: Empirical Estimation Techniques, COCOMO (A Heuristic Estimation Technique), Scheduling and Team Structures	5
4	Understanding Agile - What is Agile?, The Agile Manifesto and Principles, Why Agile Works Better than Traditional Models Kanban and Lean - Introduction to Kanban Method, Lean Principles in Agile Jira Fundamentals - Overview of Jira: Project Boards, Enrich Issues, Kanban Boards, Scrum Projects, Quick Search and Basic Search, JQL (Jira Query Language), Filters, Epics, Dashboards	6
5	Understanding XP - The XP Life cycle, The XP Team, XP Concepts, Software Configuration Management - Configuration Management Process, Version Control Systems, Change Management and Control	5

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year



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1.	Fundamentals of Software Engineering	Rajib Mall	5th Edition	PHI Learning	2018
2	Agile Foundations: Principles, Practices, and Frameworks	Peter Measey	Fourth	BCS Learning & Development Limited	2015
3	Atlassian Jira Service Desk A Complete Guide	Gerardus Blokdyk	First	S Viswanathan Printers and Publishing Private Limited	2020

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Essential Scrum: A Practical Guide to the Most Popular Agile Process	Kenneth Rubin	First	Pearson	2017
2.	The Art of Agile Development	James Shore & Shane Warden	Second	O'Reily	2007

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Agile Scrum Tutorial: A Step-by-Step Guide for Beginners	Simpli learn	2024	https://www.simplilearn.com/tutorials/agile-scrum-tutorial
2.	Agile Development Specialization	Coursera	2024	https://www.coursera.org/specializations/agile-development

Course Outcomes

At the end of the course the student will be able to

CO1	Apply the principles of software engineering frameworks and processes.
CO2	Analyze agile practices and software engineering techniques to manage and develop software projects using agile tools.
CO3	Design different software development models and agile practices to select the most effective approach for specific project requirements.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3												3	
CO2	3				1						3	3		
CO3		3												3



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	Number of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format – 100M

All Units have internal choice - Two Questions to be asked for 20 Marks each



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Sem	VI		
Course Title:	Data Warehousing and Data Mining		
Course Code:	23AI6PEDWD	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	Introduction and Data Preprocessing: Why data mining, what is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining, Data Preprocessing: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization. Data warehousing and online analytical processing: Data warehousing: Basic concepts- What Is a Data Warehouse, Differences between Operational Database Systems and Data Warehouses, Why Have a Separate Data Warehouse? Data Warehousing: A Multitiered Architecture	8
2	Data Warehouse Models: Enterprise Warehouse, Data Mart, and Virtual Warehouse Extraction, Transformation, and Loading. Data warehouse modeling: Data Cube: A Multidimensional Data Model Stars, Snowflakes, and Fact Constellations: Schemas for Multidimensional Data Models, Dimensions: The Role of Concept Hierarchies, Measures: Their Categorization and Computation, Typical OLAP Operations. A Business Analysis Framework for Data Warehouse Design, Data Warehouse Design Process. Data Lakes : Introduction to Data Lakes, Data Lake Maturity, Data Puddles, Data Ponds, Creating a Successful Data Lake, The Right Platform, Getting to the data, The Data Swamp, Roadmap to Data Lake Success, Standing Up a Data Lake, Organizing the Data Lake, Setting Up the Data Lake for Self-Service, Data Lake Architectures, Virtualization versus a catalog-based logical data lake	8
3	Mining Frequent Patterns, Associations, and Correlations: Market Basket Analysis: A Motivating Example, Frequent Itemsets, Closed Itemsets, and Association Rules, Apriori Algorithm: Finding Frequent Itemsets by Confined Candidate Generation, Generating Association Rules from Frequent Itemsets, Improving the Efficiency of Apriori, A Pattern Growth Approach for Mining Frequent Itemsets, Mining Frequent Itemsets Using Vertical Data Format, Mining Closed and Max Patterns, Which Patterns Are Interesting?—Pattern Evaluation Methods.	8
4	Cluster Analysis: What Is Cluster Analysis? Requirements for Cluster Analysis, Partitioning methods: k-Means: A Centroid-Based Technique, k-	8



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	Medoids, Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering, BIRCH, Chameleon, Probabilistic Hierarchical Clustering, Density-based methods: DBSCAN, OPTICS, DENCLUE Evaluation of clustering.	
5	Grid-Based Methods: STING: Statistical Information Grid, CLIQUE: An Apriori-like Subspace Clustering Method Evaluation of Clustering: Assessing Clustering Tendency, Determining the Number of Clusters, Measuring Clustering Quality. Data mining trends and research frontiers: Mining complex data types, other methodologies of data mining, Data mining applications, Data Mining and society.	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Mining Concepts and Techniques	Jiawei Han	3rd	Elsevier	2012
2.	The Enterprise Big Data Lake: Delivering the Promise of Big Data and Data Science	Alex Gorelik	1 st	O'reilly	2019
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Data Mining	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar		Pearson	2016

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Warehousing and Data	Sartaj Singh	1st	LPU		https://www.lpude.in/SLMs/Master%20of%20Computer%20Applications/Sem_1/DECAP446_DATA_WAREHOUSING_AND_DAT



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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Data Mining	NPTEL	2021	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2.	https://www.coursera.org/learn/data-warehousing-business-intelligence	Coursera	2024	https://onlinecourses.nptel.ac.in/noc24_cs132/preview



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Semester	VI		
Course Title:	Video Analytics		
Course Code:	23AI6PEVAL	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hou rs
1	Getting Started with OpenCV : Introduction to computer vision, Introduction to images, Basic image operations, Mathematical operations on images, Sunglass filter : A simple application, Bitwise operations, Image Annotation. Video IO and GUI: Video IO using HighGUI, Callback functions, Keyboard as input device.	8
2	Binary Image Processing: Thresholding, Erosion / Dilation, Opening and Closing, Connected Component Analysis, Contour Analysis, Blob Detection. Image Enhancement and Filtering: Color Spaces, Color Transforms, Image Filtering, Image Smoothing, Image Gradients.	8
3	Advanced Image Processing and Computational Photography: Hough Transforms, High Dynamic Range Imaging, Seamless Cloning, Image Inpainting. Geometric Transforms and Image Features: Geometric Transforms, Image Features, Feature Matching, Application: Image Alignment, Application: Creating Panorama, Application: Finding Known Objects using OpenCV.	8
4	Image Segmentation and Recognition: Image segmentation using GrabCut, Image Classification, Object Detection. Video Analysis: Motion Estimation using Optical Flow, Application: Video Stabilization, Object Tracking, Object Trackers in OpenCV, Multiple Object Tracking using OpenCV, Kalman Filter, MeanShift and CamShift.	8
5	Deep Learning with OpenCV: Image Classification- Image Classification using Caffe and Tensorflow ,Object Detection - Single Shot Multibox Detector(SSD) , You Only Look Once Detector(YOLO), Face Detection- SSD based Face Detector , Human Pose Estimation- OpenPose.	8

Prescribed Text Book					
Sl.	Book Title	Authors	Edition	Publisher	Year



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No.					
1.	Computer Vision: Algorithms and Applications	Richard Szeliski	2nd Edition	Springer	2021
2.	Multiple View Geometry in Computer Vision	Richard hartley and Andrew Zisserman	2nd Edition	Cambridge University Press	2003
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Computer Vision: A Modern Approach	David Forsyth and Jean Ponce	2nd Edition	Pearson	

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Computer Vision: Algorithms and Applications	Richard Szeliski	2nd Edition	Springer	2021	http://cv2.csie.ntu.edu.tw/CV2/2023/textbook.pdf
2.	Multiple View Geometry in Computer Vision	Richard hartley and Andrew Zisserman	2nd Edition	Cambridge University Press	2003	https://www.r5.org/files/books/computer-salgo-list/image-processing/vision/Richard_Hartley_Andrew_Zisserman-Multiple_View_Geometry_in_Computer_Vision-EN.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Introduction to Computer Vision and Image Processing	Coursera	2024	https://www.coursera.org/learn/introduction-computer-vision-watson-opency
2.	Deep Learning Application for Computer Vision	Coursera	2024	https://www.coursera.org/learn/deep-learning-computer-vision



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Sem	VI		
Course Title:	Augmented Reality and Virtual Reality		
Course Code:	23AI6PEAVR	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	Introduction to Augmented Reality - Part 1: History of AR, AR Scenarios, the future of AR, Applications of AR. Calibration and Registration: Transformations, Coordinate Systems.	8
2	Introduction to Augmented Reality - Part 2: Projections, Image formation in a pinhole camera, camera calibration, camera calibration techniques, camera calibration tools.	8
3	Pose Estimation and Tracking: Pose Estimation; Pose Tracking in AR, Classification of Tracking, Stationary Tracking Systems, Mobile Sensor-Based Tracking, Optical Tracking, Hybrid Tracking, Marker-Based Tracking and AR, Diminished Reality, Markerless Tracking and AR.	8
4	Display Data with Core UI components in Unity, Responding to user Events for Interactive UIs, Inventory and Advanced UIs	8
5	Playing and Manipulating sounds, Creating 3D Objects, Terrains, Textures and Materials	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Unity 2021 Cookbook	Matt Smith, Shaun Ferns,	4th	Packt	2021
2.	Augmented Reality: Theory, Design and Development	Chetankumar G Shetty		McGrawHill	2020
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Teach Yourself Unity 2018 Game Development in 24 Hours	Mike Gieg, Sams		Pearson	2018
2.	Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit and Vuforia	Jonathan Linowes, Krystian Babilinski		Packt	2017



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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Augmented Reality Development and its Applications	VTU, TCSiON	2024	https://online.vtu.ac.in/course-details/Certificate-in-Augmented-Reality-Development-and-its-Applications-TCS-iON-July-2024
2.	Mastering VR : Fundamentals to Practice	NPTEL	2024	https://elearn.nptel.ac.in/shop/iit-workshops/completed/certificate-course-on-fundamentals-of-virtual-reality/?v=c86ee0d9d7ed



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Sem	VI		
Course Title:	Digital Image Processing		
Course Code:	23AI6PEDIP	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction: Fundamental Steps in Digital Image Processing, Components of an Image Processing System, Sampling and Quantization, Representing Digital Images (Data structure), Some Basic Relationships Between Pixels – Neighbors and Connectivity of pixels in image, Applications of Image Processing: Medical imaging, Robot vision, Character recognition, Remote Sensing. Colour Image Processing: Colour Fundamentals, Colour Models, Pseudo-colour Image Processing.	8
2	Image Enhancement: Spatial Domain: Some Basic Gray Level Transformations, Histogram Processing, Enhancement using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters. Frequency Domain: Preliminary Concepts, Filtering in the Frequency Domain, Image Smoothing and Image Sharpening using Frequency Domain Filters.	8
3	Restoration: Noise models, Restoration in the Presence of Noise Only using Spatial Filtering and Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering	8
4	Morphological Analysis: Morphological Image Processing: Preliminaries, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transforms, Some Basic Morphological Algorithms. Representation and Description: Representation, Boundary descriptors.	8
5	Image Segmentation: Introduction, Detection of isolated points, Line detection, Edge detection, Edge linking, Region-based segmentation – Region growing, Split and merge technique, Local processing, regional processing, Hough transform, Segmentation using Threshold.	8

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Digital Image Processing	Rafael C G., Woods R E. and Eddins S L	7	Pearson Education	2018
2	Digital Image Processing	Jayaraman S, Veerakumar T, Esakkirajan S	1	Thomson Press India Ltd	, 2017

Reference Text Book					
Sl.	Book Title	Authors	Edition	Publisher	Year



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No.					
1.	Fundamentals of Digital Image Processing	Anil K. Jain	2	Prentice Hall	2015
2.	Digital Image Processing	S. Sridhar	2	Oxford University Press	2016

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Fundamentals of Digital Image and Video Processing	Coursera	2024	https://www.coursera.org/learn/digital
2.	Digital Image Processing	Indian Institute of Technology, Kharagpur and NPTEL	2024	https://www.classcentral.com/course/swayam-digital-image-processing-14005



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Semester	VI		
Course Title:	Competitive Programming		
Course Code:	23DS6AEC PG	Total Contact Hours: 24 hours	
L-T-P:	0-0-1	Total Credits:	1

	Programming Challenges on the topics listed below	Hou rs
1	Getting Started : Programming Fundamentals	2
2	Arithmetic & Algebra	2
3	Sorting and Searching Algorithms	2
4	Tree Queries	2
5	Range Queries	2
6	Divide and Conquer	2
7	Greedy Algorithms - I	2
8	Greedy Algorithms - II	2
9	Dynamic Programming - I	2
10	Dynamic Programming - II	2
11	Graph Algorithms	2
12	String Algorithms	2

Prescribed Text Book				
Sl. No.	Book Title	Authors	Publisher	Year
1.	Competitive Programming in Python: 128 Algorithms to Develop Your Coding Skills	Christoph Dürr and Jill-Jênn Vie	Cambridge University Press	2021
2.	Guide to Competitive Programming	Antti Laaksonen	Springer	2017
Reference Text Book				
Sl.	Book Title	Authors	Publisher	Year



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No.				
1.	Introduction to Algorithms	Thomas H . Cormen, Charles E. Leiserson	MIT Press	2022
2.	Programming Challenges	Steven S. Skiena Miguel A. Revilla	Springer	2003

E-Book					
Sl. No	Book Title	Authors	Publisher	Year	URL
1.	Competitive Programming 3	Steven Halim, Felix Halim	Lulu	2013	https://files.gitter.im/SamZhangQingChuan/sam/DA1g/Steven-Halim_-Felix-Halim-Competitive-Programming-3_-The-New-Lower-Bound-of-Programming-Contests-Lulu.com- 2013 .pdf
2.	Algorithms	Jeff Erikson	-	2019	https://jeffe.cs.illinois.edu/teaching/algorithms/

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Getting started with Competitive Programming	NPTEL	2024	https://onlinecourses.nptel.ac.in/noc24_cs103/preview
2	Competitive Programming Essentials, master Algorithms	Udemy	2024	https://www.udemy.com/course/competitive-programming-algorithms-coding-minutes/



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Semester	VI		
Course Title:	OOPs with JAVA		
Course Code:	23AI6AE00J	Total Contact Hours: 20 hours	
L-T-P:	0-0-1	Total Credits:	1

	Program Details
1	Create a class to represent a bank account with data members : Account no, Account holder name, Address and Balance amount. Create member methods to assign initial value to the account, deposit an amount, withdraw an amount after checking balance and display account holders name and balance. Write a main method for the above class that reads the initial values from the keyboard and invokes the appropriate methods.
2	Create a class named RetailItem that holds data about an item in a retail store. The class should have the following fields: • Description - The description field references a String object that holds a brief description of the item. • Units - The units field is an int variable that holds the number of units currently in inventory. • Price - The price field is a double that holds the item's retail price. Write a constructor that accepts arguments for each field, appropriate mutator methods that store values in these fields, and accessor methods that return the values in these fields. Write the main method which creates three RetailItem objects and invokes appropriate methods.
3	Write a program in java to define a class Shape which has data members and a member function showArea(). Derive two classes Circle and Rectangle from Shape class. Add appropriate data members and member functions to calculate and display the area of Circle and Rectangle.
4	Write a program that has an Interface I which is extended by I1 and I2. Interface I12 inherits from both I1 and I2. Each interface declares one constant and one method. Class DemoI implements I12. Instantiate DemoI and invoke each of its methods. Each method displays one of the constants.
5	Define Create a package named mypack, containing a class AreaTriangle in which a method Area() finds area of a triangle and returns area. Import this package in another class Triangle which is in package mypack1. The Triangle class invokes the Area() method from mypack and displays the area of triangle. Member variables can be considered as per the program requirement



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6	Create a base class called “Father” and derived class called “Son” which extends the base class. In Father class, implement a constructor which takes the age and throws the exception WrongAge() when the input age<0. In Son class, implement a constructor that checks both father and son’s age and throws an exception if son’s age is >=father’s age.
7	Consider a bank offering online access to its customers to perform transactions. Suppose there are two transactions of deposit and withdrawal for a particular account simultaneously which leads to race condition. Develop a solution to avoid unpredictable situations with a program.
8	Implement a class that checks whether a given number is a prime using both the Thread class and Runnable interface.
9	Write a program to copy the content of File1.txt to another file File2.txt. by reading the file name as command line arguments.
10	Illustrate the following string operations using String object. i) Difference of equals() method and == operator ii) Check whether the string is palindrome or not To convert the string into character array
11	Create a Class Gen which implements a stack using generics. Ensure that the stack never overflows and the main method would invoke the stack methods in class Gen by passing integer and floating-point numbers.
12	Write a program to create a new array list, add some colors (string) and perform the following operations: i. Add elements of List to ArrayList i. Copy ArrayList to Array i. Reverse ArrayList content .Get Sub list from an ArrayList. .To sort a given ArrayList

Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Java : The Complete Reference	Herbert Schildt	11 th Edition	McGraw-Hill Education	2018
2.	Programming with Java A Primer	E.BalaGuru Swamy	6 th Edition	McGraw-Hill Education	2014
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Java Programming	Y. Daniel Liang	11 th Edition	Pearson	2017



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2.	Object Oriented Programming with Java: Essentials and Applications	Rajkumar Buyya, Thamarai Selvi, Xing	1 st Edition	Tata McGraw Hill Education	2009
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E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	The Art and science of Java	Eric S. Roberts	-	Greg Tobin	2007	http://people.reed.edu/~jerry/121/materials/artsciencejava.pdf
2.	Java Programming	Wikibooks Contributors	7th Edition	wikibooks.org	2016	https://upload.wikimedia.org/wikipedia/commons/e/e7/Java_Programming.pdf

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Object Oriented Programming in Java Specialization	Coursera	2024	https://www.coursera.org/specializations/object-oriented-programming
2.	Introduction to Java	Coursera	2024	https://www.coursera.org/learn/java-introduction



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Sem	VI		
Course Title:	DevOps		
Course Code:	23DSAEDOP	Total Contact Hours: 2 hours/week	
L-T-P:	0-0-1	Total Credits:	1

A Introduction:

This course develops skills in DevOps practices, including CI/CD, infrastructure as code, configuration management, and containerization.

Students will develop a DevOps pipeline using technologies such as Jenkins, Docker, Kubernetes, Ansible, Terraform, and cloud platforms like AWS, GCP, or Azure.

Groups should consist of 2 to 4 students.

The teacher allotted for project work should teach DevOps technologies like Jenkins, Docker, Kubernetes, etc., during Class/Lab hours as per the allotment. The teacher allotted for project work should guide the students in choosing the project topic and in carrying out the project work, as well as completing the evaluation of assigned students.

C Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
Lab Test	2	20
Project Reviews	2	30
Total		50

Laboratory Plan:

Project Topics:

E-commerce Platform with CI/CD Pipeline, Social Media Analytics Dashboard, Online Learning Management System, Real-time Chat Application, Personal Finance Management App, Content Management System (CMS), Smart Home IoT Dashboard, Healthcare Appointment Booking System, Weather Forecasting Application, Online Voting System

Note: Apart from the above-mentioned project topics if student groups come up with any innovative project ideas which are useful for the Department / College academic purpose will be considered based on the approval and acceptance from class teacher.

Week	Activity	Content Delivered by Assigned Teacher	Technologies/Skills to be Covered
1	Lecture and discussion, Formation of groups, Basic setup of a lab environment	Introduction to DevOps, History and evolution of DevOps, Key concepts and principles, DevOps lifecycle, Importance and benefits of DevOps, Group Formation, Lab Setup	DevOps Fundamentals, Group Collaboration, Lab Setup



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2	Hands-on exercises with Git, Creating and managing a repository	Introduction to version control, Basic Git commands (clone, commit, push, pull), Branching and merging, Using GitHub for collaboration, Git Repository Management	Git, Version Control, GitHub
3	Installing Docker, Creating and running Docker containers	Introduction to containers, Docker architecture and components, Basic Docker commands (build, run, images), Dockerfile and containerization of applications, Docker Container Management	Containerization, Docker
4	Setting up a Kubernetes cluster, Deploying a sample application	Introduction to container orchestration, Kubernetes architecture, Basic Kubernetes objects (pods, services, deployments), Deploying applications on Kubernetes, Kubernetes Application Deployment	Container Orchestration, Kubernetes
5	Jenkins installation and setup, Configuring a simple CI pipeline	Introduction to CI/CD, Setting up Jenkins, Creating and running basic Jenkins jobs, Integrating Jenkins with GitHub, CI Pipeline Configuration	Continuous Integration, Jenkins, CI/CD Pipeline
6	Installing and configuring Ansible, Writing simple playbooks	Introduction to configuration management, Basics of Ansible, Writing and running Ansible playbooks, Managing infrastructure with Ansible, Ansible Playbook Creation	Configuration Management, Ansible
7	Installing Prometheus and Grafana, Configuring basic monitoring and alerts	Importance of monitoring and logging in DevOps, Introduction to Prometheus and Grafana, Setting up monitoring with Prometheus, Visualizing metrics with Grafana, Prometheus and Grafana Configuration	Monitoring, Prometheus, Grafana
8	Installing Terraform, Creating and applying Terraform scripts	Introduction to IaC, Basics of Terraform, Writing and applying Terraform configurations, Managing infrastructure with Terraform, Terraform Scripting	Infrastructure as Code, Terraform
9	Setting up security scanning tools, Running security scans	Introduction to DevSecOps, Security best practices in DevOps, Tools for security	DevSecOps, Security Scanning



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	on applications	scanning (e.g., OWASP ZAP, Snyk), Integrating security into CI/CD pipelines, Security Scanning Procedures	
10	Setting up an account on a chosen cloud provider, Deploying a simple application on the cloud	Overview of cloud computing, Introduction to AWS/GCP/Azure (choose one), Using cloud services in DevOps workflows, Cloud Application Deployment	Cloud Computing, AWS/GCP/Azure, Cloud Deployment
11	Groups work on their DevOps projects	Project Work	Project Management, DevOps Practices
12	Project presentations and demonstrations by each group, Submission of project reports	Presentation of Projects, Project Report Submission	Presentation Skills, Documentation, Project Showcase

Text Book

SL. No	Book Title	Authors	Edition	Year
1	The DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations	Gene Kim, Patrick Debois, John Willis, and Jez Humble	1st Edition	2016
2	DevOps for Dummies	Emily Freeman	1st Edition	2019

Reference Text Book

SL. No	Book Title	Authors	Edition	Year
1	DevOps: A Software Architect's Perspective	Len Bass, Ingo Weber, and Liming Zhu	1 st Edition	2015



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E-Book				
SL No	Authors	Author	Edition	URL
1	The DevOps Handbook	Gene Kim, Patrick Debois, John Willis, and Jez Humble	1st Edition	https://dl.faghatketab.ir/Books/Computer/Programming/WebProgramming/The.DevOps.Handbook_faghatketab.ir.pdf

MOOC Course				
SL No	Course Name	Course Offered By	Year	URL
1	DevOps for Software Development – IIT Madras	NPTEL	2021	https://nptel.ac.in/courses/128106012



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Sem	VII		
Course Title:	Entrepreneurship & Project Management		
Course Code:	23DC7PCEPM	Total Contact Hours: 2	
L-T-P:	2-0-0	Total Credits:	2

Unit No.	Topics	Hrs.
1	The Entrepreneurial mind-set: The nature of entrepreneurship, How Entrepreneurs Think, Entrepreneur background and characteristics. Reasons for interest in corporate entrepreneurship, Sustainable Entrepreneurship, Generation of new entry opportunity, Entry strategy for new entry exploitation, Risk reduction for new entry exploitation.	5
2	Creativity and the business idea: Sources of New Ideas, Methods of Generating Ideas, Creative Problem Solving. Innovation: Innovation, Opportunity recognition, Product planning and development process, Ethics: Factors that Shape Trust in Business and Innovation Ecommerce and business start-up, international v/s domestic entrepreneurship, Entrepreneurial entry strategies, Legal issues in setting up the organization.	5
3	Project Management: concept of project management attributes of a project, project management systems, project life cycle, Difference among Projects, Routine Activities and Programs, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures.	5
4	Project Planning: Work Breakdown Structure, Types of Work Breakdown Structure, Planning Framework and Its Importance. Project Formulations and Planning: Private commercial criteria for project choice, feasibility, marketing feasibility, Financing for Projects and financial feasibility, Preparation of techno-economic feasibility report.	5
5	Project Identification: Principles of project identification, Project Implementation. Brief outline of social cost benefit analysis: rationale, UNIDO and little Mirrlees approaches, UNIDO IDCAS manual. Project appraisal: time value of money, project appraisal techniques: Non discounting criteria, discounting criteria, appraisal and selection in practice, payback period, accounting rate of return, net present value, internal rate of return, benefit cost ratio, social cost benefit analysis, effective rate of protection, risk analysis: measures of risk, sensitivity analysis, simulation analysis, decision tree analysis.	5



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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Entrepreneurship	Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd	10th	McGrawHill Education	2017
2	Effective Project Management	James P Clements, Jack Gido	4 th	South Western	2009

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Entrepreneurship: The Practice and Mindset (3rd)	Heidi M. Neck, Christopher P. Neck, Emma L. Murray	3rd	SAGE Publications	2023	https://www.barnesandnoble.com/
2.	The Handbook of Project Management	Martina Huemann & Rodney Turner	6th	Routledge	2024	https://rpitst.com/img/ebook/1711029511_630733f488172765377f.pdf

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Project Management: The Managerial Process	Gray, Clifford F., Larson, Eric W., and Desai, Gautam V	8th edition	McGraw Hill Education	2020
2.	Project Management and Appraisal	Kharua, Sitangshu	7th edition	Oxford Press University	2011

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Project management	SWAYAM/NPTEL	2025	https://nptel.ac.in/courses/110107081
2.	Entrepreneurship Management	SWAYAM/NPTEL	2024	https://onlinecourses.swayam2.ac.in/cec24_mg28/preview

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.



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Semester	VII		
Course Title:	Robotic Process Automation		
Course Code:	23AI7PCRPA/ 23AI8PCRPA	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction: Introduction to Robotic Process Automation. Scope and Techniques of Automation: Process to be automated. Techniques of automation. Robotic Process Automation: Tasks RPA can perform, Benefits of RPA, Components of RPA, RPA platforms, The future of Automation. Record and Play: About RPA IDE, Downloading and Installing IDE, IDE Stack, Learning IDE, Task Recorder, Emptying trash in Gmail, Emptying Recycle Bin.	8
2	Sequence, Flowchart and Control Flow: Sequencing the Workflow, Activities, Control flow, various types of loops, and decision making, how to use a sequence, how to use a flowchart, step by step example using sequence and control flow. Data Manipulation: Variables and scope, Collections, Arguments-purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example. CSV/Excel to data table and vice versa examples.	8
3	Taking control of the controls: Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls-mouse and keyboard activities, working with RPA IDE explorer, Handling events, Revisit recorder, Screen scraping, Uses of OCR, Types of OCR available, How to use OCR?, Avoiding typical failure points. Tame that Application with Plugins: Mail plugin, PDF plugin, web integration, Excel and Word plugins, Credential management.	8
4	Handling User Events and Assistant Bots: Assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event. Exception Handling, Debugging, and Logging Exception handling: Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting.	8



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5	Managing and Maintaining the Code: Project Organization, Nesting workflows, Reusability of workflows, Commenting techniques, State Machine, Appropriate usage of Flowcharts, State Machines or sequences, Using config files and examples of a config file. Deploying and Maintaining the Bot: Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots.	8
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Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Learning Robotic Process Automation	Alok Mani Tripathi	1st	Packt	2018

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Tom Taulli	1st	A Press	2020
2.	Introduction to Robotic Process Automation: a Primer	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston			

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1	https://www.uipath.com/rpa/robotic-process-automation					
2	https://www.packtpub.com/product/learning-robotic-process-automation/9781788470940					

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1	Robotic Process Automation	UiPath Academy	2025	https://www.uipath.com/learning/video-tutorials
2	UiPath RPA	Guru99	2025	https://www.guru99.com/uipath-tutorial.html



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	1	10
Total		50

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.



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Semester	VII		
Course Title:	Bio-inspired Algorithms		
Course Code:	23DC7BSBIO	Total Contact Hours:	2
L-T-P:	0-0-1	Total Credits:	1

	Course Content
1	Introduction to Evolutionary Algorithms and Optimization Terminology, Different Types of Optimization, Hill Climbing, Intelligence, Genetic Algorithms, Mathematical Models of Genetic Algorithms
2	Recent Evolutionary Algorithms-1 Simulated Annealing, Ant Colony Optimization, Particle Swarm Optimization, Differential Evolution
3	Recent Evolutionary Algorithms-2 Biogeography-based Optimization, Cultural Algorithms, Opposition-based Learning, The Firefly Algorithm, Bacterial Foraging Optimization
4	Combinatorial Optimization Travelling Salesman Problem (TSP), TSP Initialization, TSP Representation and Crossover, TSP Mutation, Graph Coloring Problem
5	Recent Trends in the Domain of Bio-inspired Algorithms

	Lab Programs
1	Genetic Algorithm for Function Optimization Objective: Maximize or minimize a mathematical function using a genetic algorithm. Concepts Covered: Initialization, selection, crossover, mutation, fitness function.
2	Hill Climbing Algorithm for N-Queens Problem Objective: Solve the N-Queens problem using a basic Hill Climbing approach. Concepts Covered: Local search, steepest ascent, fitness evaluation.
3	Simulated Annealing for Traveling Salesman Problem (TSP) Objective: Minimize the TSP path using simulated annealing. Concepts Covered: Temperature schedule, acceptance probability, path cost evaluation.
4	Ant Colony Optimization for TSP Objective: Solve TSP using Ant Colony Optimization (ACO). Concepts Covered: Pheromone update, path selection, evaporation rate.
5	Particle Swarm Optimization for Global Minima Objective: Find the global minimum of a function using Particle Swarm Optimization (PSO). Concepts Covered: Velocity update, position update, pBest and gBest.
6	Differential Evolution for Function Optimization Objective: Use Differential Evolution (DE) to find the minimum of a benchmark function. Concepts Covered: Mutation, crossover, selection strategies.



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7	Tabu Search for Job Scheduling Problem Objective: Minimize job completion time using Tabu Search. Concepts Covered: Tabu list, aspiration criteria, neighborhood generation.
8	Biogeography-Based Optimization (BBO) for Benchmark Function Objective: Apply BBO to solve optimization problems. Concepts Covered: Habitat suitability index, migration, mutation
9	Firefly Algorithm for Unconstrained Function Optimization Objective: Use the firefly algorithm to optimize a multimodal function. Concepts Covered: Light intensity, attractiveness, randomization.
10	Graph Coloring using Genetic Algorithm Objective: Minimize colors used in coloring a graph using a GA approach. Concepts Covered: Chromosome encoding, constraint satisfaction, mutation strategies.

Prescribed Textbook					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Nature-Inspired Optimization Algorithms	A Vasuki	1 st Edition	CRC Press, Taylor & Francis Group	2020
2.	Evolutionary Optimization Algorithms by	Dan Simon	1 st Edition	John Wiley & Sons, Inc.	2013
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Evolutionary Computing	A. E. Eiben and J. E. Smith	2 nd Edition	Springer-Verlag Berlin Heidelberg	2015
2.	Ant Colony Optimization - Techniques and Applications	Helio J.C. Barbosa	1 st Edition	Intech	2013
3.	Swarm Intelligence: Principles, Advances, and Applications	Aboul Ella Hassanien and Eid Emary	1 st Edition	CRC Press, Taylor & Francis Group	2016

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Bio-inspired Algorithms	Sándor Szénási, Gábor Kertész	-	MDPI	2025	https://www.mdpi.com/books/reprint/11135-bio-inspired-algorithms



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2.	Genetic Algorithms in Search, Optimization, and Machine Learning	David E Goldberg	-	Addison -Wesley	1989	https://www2.fiit.stuba.sk/~kvasnicka/Free%20books/Goldberg_Genetic_Algorithms_in_Search.pdf
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MOOC Courses			
Sl. No.	Course name	Course Offered By	URL
1.	Biology Meets Programming: Bioinformatics for Beginners	Coursera	https://www.coursera.org/learn/bioinformatics
2.	Bio-inspired Artificial Intelligence Algorithms	Udemy	https://www.udemy.com/course/bio-inspired-artificial-intelligence-algorithms-for-optimization/?srsltid=AfmBOoojXI8gwKeva_6V2L4I_28nKrWUrppVThwTINde3ne5WCWJUehn&couponCode=NVDIN35

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	-	-
QUIZ/AAT	-	-
Lab Component	-	50
Total		50



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Sem	VIII		
Course Title:	Block Chain Technology		
Course Code:	23DS8PEBCT /23DS7PEBCT	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	Blockchain Essentials: The history of Blockchain and Bitcoin, The Growth of Blockchain Technology, Blockchain- Definition, Architecture, Generic elements of a Blockchain, Benefits, Features and Limitations, Types of Blockchain, Consensus. Decentralization: Decentralization using Blockchain, Decentralized Applications	8
2	Cryptographic Constructs in Blockchain: Cryptographic primitives- Hash function, ECC Digital Signature, Zero Knowledge proof, Different types of digital signatures. Applications of Cryptographic Hash Functions: Merkel Trees, Patricia Trees, Distributed Hash Table. Consensus Algorithms: Introducing the Consensus Problem, Analysis and Design, Classification, Algorithms(Raft,Paxos,PBFT), Choosing an Algorithm.	8
3	Bitcoin: Overview, Cryptographic Keys, Bitcoin Network, Wallets, Bitcoin Payments, Innovation in Bitcoin, Alternative coins- Introduction, Theoretical Foundations- Alternative Proof of Work. Transactions: Transaction Life Cycle, Genesis block, Mining	8
4	Ethereum : An Overview, Ethereum Network, Components of Ethereum Ecosystem, Ethereum Virtual Machines Smart Contracts: History, Definition, Deploying Smart Contracts. Decentralized Applications(DApp), A Basic DApp Example	8
5	Hyperledger: Architecture, Projects under Hyperledger, Hyperledger Fabric Tokenization: Tokenization on a blockchain, Types of tokens, Process of Tokenization, Token offerings	8

Prescribed Text Book:



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Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Mastering Blockchain	Imran Bashir	3rd	Packt	2020
2	Mastering Ethereum Building Smart Contracts and DApps	Andreas M. Antonopoulos and Dr. Gavin Wood	First Edition	O'Reilly	2018

Reference Text Book:

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Mastering Blockchain	Melanie Swan	3rd	O'Reilly	2014
2	Blockchain Applications: A Hands-On Approach	Arshdeep Bahga, Vijay Madisetti	7th	A Press	2019

MOOC Course:

Sl. No.	Course Name	Course Offered by	URL
1	Blockchain Specialization Course 1: Blockchain Basics Course 2: Smart contracts Course 3: Decentralized Applications	Coursera	https://www.coursera.org/specializations/blockchain
2.	Blockchain architecture, Design and Use cases	NPTEL	https://nptel.ac.in/courses/106/105/106105184/

Proposed Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.



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Sem	VIII		
Course Title:	Quantum Machine Learning		
Course Code:	23DS8PEQML /23DS7PEQML	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction and overview: History of quantum computation, Quantum bits (Qubit), Quantum Gates Quantum Machine Learning: Introduction to Quantum Machine Learning, Quantum Machine Learning for Quantum Data , A Taxonomy of Quantum Machine Learning, Characteristics of Quantum Machine Learning Methods, The four big families of quantum machine learning. Quantum Algorithms : Deutsch Jozsa , Grover's Algorithm <i>CASE studies : Deutsch-Jozsa Algorithm for Database Validation , Grover's Algorithm for Password Recovery</i>	8
2	Quantum Kernel Methods: The general idea behind quantum support vector machines, Quantum Feature maps. Quantum support vector machines in PennyLane : Setting the scene for training a qSVM , Penny Lane and scikit-learn, Reducing the dimensionality in qSVM , Implementing and using custom feature map Hybrid quantum neural networks (QNN): Definition of hybrid QNNs, Hybrid QNNs construction <i>CASE studies- qSVM for Iris Classification Custom Feature Map for qSVM in Credit Risk Assessment</i>	8
3	Hybrid architectures- Using PennyLane: Setting things up for a binary classification problem, Training the model. A multi-class classification problem: A general perspective on multi-class classification tasks, Implementing a QNN for a ternary classification problem	8
4	Quantum-Inspired Machine Learning: Tang's Quantum-Inspired Algorithm for Recommendation Systems, Quantum-Inspired Data Clustering, Quantum-Inspired Gravitational Search. Quantum Enhanced Machine Learning: Algorithms for Linear Algebra, Algorithms for Regression, Algorithms for Clustering, Algorithms for Nearest Neighbor Search, Quantum Principal Component Analysis (qPCA), Algorithms for Classification, Quantum Boosting	8



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5	Applications of QML: Quantum Finance, Quantum Chemistry and Drug Discovery, Pattern Recognition and NLP, Image Classification (with QML) Tools and Frameworks: Case Study on Qiskit, PennyLane, IBM Quantum Lab Quantum Generative Adversarial Networks: Case study on quantum GANs (QGANs) in Qiskit Challenges & Future Research Directions: Scalability, noise mitigation, quantum advantage	8
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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	A Practical Guide to Quantum Machine Learning and Quantum Optimization	Elías F. Combarro Samuel González-Castillo	1st	Packt Publishing Ltd.	2023
2.	Quantum Machine Learning State of the Art and Future Directions	Christian Bauckhage, Fraunhofer IAIS	1 st	Federal Office for Information Security	2022
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	An Introduction to Quantum Machine Learning for Engineers	Osvaldo Simeone		Boston — Delft	2022

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Hands-On Quantum Machine Learning With Python	Dr. Frank Zickert		PYQML	2021	https://stel.asu.cas.cz/~skoda/QML/Dr.%20Frank%20Zickert%20-%20Hands-On%20Quantum%20Machine%20Learning%20With%20Python%20Volume%201_%20Get%20Started-PYQML%20%282021%29.pdf?utm_source=chatgpt.com



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MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Quantum Computing and Quantum Machine Learning	Udemy	2021	https://www.udemy.com/course/quantum-computing-and-quantum-machine-learning-part-1/?srsltid=AfmBOoq1gXz5vGOz8I1Wi207Y3SM9HgQxgGWrAZ6njbXKO8RTBtXP6zu

Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.

Sem	VIII		
Course Title:	Machine Learning Operations MLOps		
Course Code:	23DS8PEMLO /23DS7PEMLO	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hours
1	Introduction to MLOps: MLOps Hierarchy - Maslow's hierarchy, ML engineering hierarchy, Implementation of DevOps, Steps involved in migration from DevOps to MLOps, DataOps and Data Engineering, MLOps -MLOps Feedback Loop, Machine learning model targets, Build an MLOps Pipeline from Zero, MLOps standards and best practices The MLOps Workflow : MLOps model lifecycle, Risks handled by MLOps workflow, Case Study : Real-World Example - The Story of Two Companies with (& without) MLOps Workflow,	8
2	Quantifying success of MLOps project : Steps to get started , Role of ML in your organisation, Objectives and Metrics, Actors in MLOps. MLOps Industrial Revolution The MLOps Toolchain : Model and Data Exploration, Metrics and Model Optimization, Productionalization - End to End Pipelines, Feature Stores, Testing, Deployment and Inferences.	8



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3	MLOps for Containers and Edge Devices - Overview of the needs and challenges Containers : Container Runtime , Creating and Running Container Edge Devices : Coral , Azure Percept , TFHub Containers for Managed ML Systems : Containers in Monetizing MLOps, Build Once , Run many MLOps workflow	8
4	From Development to Production in MLOps: Developing Models (Theory vs. Practice), ML algorithms and their MLOps challenges, Feature selection impact on MLOps, Adaptation from Development to Production Environments, The Purpose of Model Validation, Deploying to Production, CI/CD Pipelines, ML artifacts: what and why Testing pipelines.	8
5	Monitoring and Feedback Loop: Understanding Model Degradation, Input Drift Detection & Techniques, The Feedback Loop MLOps Tools : AI Platforms on Kubernetes - Kubeflow , MLOps Frameworks - teraflow Governance and Industrial Use Cases: Introduction to Model Governance in MLOps, Key Elements of Responsible AI, A Template for MLOps Governance. Real-World MLOps Applications: Case Study 1: Credit Risk – Bias handling and deployment. Case Study 2: Recommendation Engines – Personalization, scalability, monitoring.	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Practical MLOps - Operationalizing Machine Learning	Noah Gift and Alfredo Deza	1st	O'Reilly	2021
2	Introducing MLOps- How to scale Machine Learning in the enterprise	Mark Treveil and the dataiku Team	1st	O'Reilly	2021

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Machine Learning Engineering in Action	Ben Wilson	1st	Manning Publications	2022
2	Designing Machine Learning Systems- An Iterative Process for Production-Ready Applications	Chip Huyen	1st	O'Reilly	2022

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL



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1	Practical MLOps - How to get ready for Production Mode	By Valohai , Sigopt, Tecton		Valohai , Sigopt, Tecton		https://valohai.com/mlops-ebook/
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MOOC Course

Sl. No.	Course name	Course offered by	Year	URL
1	MLOps Machine Learning Operations Specialization	Coursera - Duke University	2024	https://www.coursera.org/specializations/mlops-machine-learning-duke#outcomes
2	Machine Learning Operations (MLOps): Getting Started	Coursera	2025	https://www.coursera.org/learn/mlops-fundamentals

READING ARTICLE

Sl. No.	Article name	Author	Year	Published at
1	Industrial Edge MLOps: Overview and Challenges	Rani, Fatima	2024	Computer Aided Chemical Engineering 53 : 3019-3024

Proposed Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.



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Sem	VIII		
Course Title:	Design Patterns		
Course Code:	23AI8PEDPT /23AI7PEDPT	Total Contact Hours: 40 hours	
L-T-P:	3-0-0	Total Credits:	3

Unit No.	Topics	Hrs
1	Introduction to UML: Importance of Modeling, Principles of Modeling, Object-Oriented Modeling, Overview of UML, A Conceptual Model of the UML, Architecture, Software Development Life Cycle, Structural Modeling, Behavioral Modeling, Architectural Modeling	8
2	Introduction to Design Patterns: What is a Design Pattern, Design Patterns in Smalltalk MVC, Describing design patterns, the catalog of design pattern, Organizing the catalog, How design patterns solve design problems, How to select a design pattern, How to use a design pattern.	8
3	A Case Study: Designing a Document Editor- Design Problems, Document Structure, Formatting, Embellishing the User Interface, and Supporting Multiple Look – and - Feel Standards, Supporting Multiple Window Systems, User Operations Spelling Checking and Hyphenation. Creational Patterns: Introduction to Creational Patterns, Abstract Factory Pattern, Builder Pattern, Factory Method Pattern, Prototype Pattern, Singleton Pattern	8
4	Structural Patterns: Introduction to Behavioral Patterns, Adapter Pattern, Bridge Pattern, Composite Pattern, Decorator Pattern, Façade Pattern, Flyweight Pattern, Proxy Pattern.	8
5	Behavioral Patterns: Introduction to Behavioral Patterns, Chain of Responsibility Pattern, Command Pattern, Interpreter Pattern, Iterator Pattern, Mediator Pattern, Memento Pattern, Observer Pattern, Strategy Pattern, Template Method Pattern, Visitor Pattern.	8



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Prescribed Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	The unified modeling language user guide	Grady Booch, James Rumbaugh and Ivar Jacobson	First	Addison Wesley	1998
2.	Design Patterns: Elements of Reusable Object-Oriented Software	Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides	–	Addison Wesley	1994
Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Object-Oriented Analysis, Design and Implementation	Brahma Dathan, Sarnath Ramnath	Second	Springer	2015
2.	Head First Design Patterns	Eric Freeman, Bert Bates, Kathy Sierra, and Elisabeth Robson	First	O'Reilly	2004

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	The unified modeling language user guide	Grady Booch, James Rumbaugh and Ivar Jacobson	First	Addison Wesley	1998	https://patologia.com.mx/informatica/uug.pdf
2.	Design Patterns: Elements of Reusable Object-Oriented Software	Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides	-	Addison Wesley	1994	https://www.javier8a.com/itc/bd1/articulo.pdf

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Object Oriented System Development using UML, Java and Patterns	SWAYAM	2020	https://onlinecourses.nptel.ac.in/noc20_cs84/preview
2.	Design Patterns	Coursera	2018	https://www.coursera.org/learn/design-patterns



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Proposed Assessment Plan (for 50 marks of CIE)

Assessment Tool	No. of Assessments	Marks
Internals	3	40
QUIZ/AAT	2	10
Total		50

SEE Exam Question paper format:

Each unit will cover two questions for 20 marks and students can choose any one full question.