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||Jai Sri Gurudev||

Sri Adichunchanagiri Shikshana Trust (R.)

SJC INSTITUTE OF TECHNOLOGY

An Autonomous Institution under VTU from 2024-25

AICTE Approved, Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF(151-300) in 2023,Gold Rated by QS I-Gauge

P.B. No.20, B.B Road, Chikkaballapur - 562 101, Karnataka

Estd : 1986

IV Semester
Scheme & Syllabus of B.E. Programme
Computer Science & Engineering (AI&ML)
(2025 Scheme)

Core Values

Spiritual, Judicious, Commitment, Integrity, Trustworthy



AICTE | NATIONAL INSTITUTIONAL RANKING FRAMEWORK 151-300 | NBA | NAAC A+ | QS I-GAUGE GOLD | INSTITUTION'S INNOVATION COUNCIL (Ministry of HRD Initiative) 4-Star Rating

||ज्ञं ज्ञं गुरुदेव||
Sri Adichunchanagiri Shikshana Trust (R.)
SJC INSTITUTE OF TECHNOLOGY
(An Autonomus Institute Under VTU Belagavi & Approved by AICTE, New Delhi)
Accredited by NAAC with A+ Grade & NBA (CSE, ISE, ECE, ME & CV), NIRF (151-300), QS-I Gauge GOLD Rated
Estd.:1986
Post Box #20, B.B. Road, Chikkaballapur - 562 101, Karnataka

B.E. in Dept of Computer Science and Engineering (Artificial Intelligence and Machine Learning)
Scheme of Teaching and Examinations
2025
Outcome-Based Education (OBE) and Choice-Based Credit System (CBCS) (Effective from the academic year 2025-26)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching and Learning Scheme					Examination				Credits
					CI		LI	TW & SL	Total Hours	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	SL						
1	ASC	1BMATS401	Probability Statistics and Linear Algebra	TD /PSB: Mathematics	42	0	0	48	90	3	50	50	100	3
2	IPCC	1BCS402	Database Management Systems	TD/PSB : CS Allied Depts	42	0	28	50	120	3	50	50	100	4
3	PCC	1BCS403	Algorithms Design Techniques	TD/PSB : CS Allied Depts	42	28	0	50	120	3	50	50	100	4
4	IPCC	1BCI404	Artificial Intelligence	TD/PSB : CS Allied Depts	42	0	28	50	120	3	50	50	100	4
5	PCCL	1BCSL405	Algorithms Laboratory	TD/PSB : CS Allied Depts	0	0	28	02	30	3	50	50	100	1
6	AEC	1BXXL406x	Ability Enhancement Course Laboratory**	TD/PSB : CS Allied Depts	0	0	28	02	30	2	50	50	100	1
7	BSC	1BBI407	Biology for Engineers (CS and EC Streams)	TD / PSB : BSH	14	0	0	16	30	2	50	50	100	1
8	SEC	1BEP408	Environmental Science Project	TD/PSB : Civil	0	0	0	30	30	2	50	50	100	1
9	HSSM	1BMP409	Metaphysical Science	TD/PSB : CS	14	0	0	16	30	2	50	50	100	1

10	NCMC	1BNS410	National Service Scheme	Campus	NSS coordinator	0	0	0	28	28	--	100	---	100	PP
		1BPE410	Physical Education		Physical Education Director										
		1BYO410	Yoga		Yoga Teacher										
		1BMU410	Music		Music Teacher										
		1BNC410	National Cadet Corps - II		NCC coordinator										
11	NCMC	1BCE411	Competency Enhancement Course-2	CDCAC		14	0	0	14	28	--	100	---	100	PP
12	NCMC	1BMATDIP412	Additional Mathematics -II	TD/PSB -Maths Dept.		14	0	0	14	28	--	100	---	100	PP
					Total							**750**	**450**	**1200**	**20**

Ability Enhancement Course (Laboratory) 1BxxL406x			
1BADL406A	MERN	1BCSL406C	JavaScript and jQuery
1BCIL406B	Data Analytics with Power BI and Tableau	1BCGL406D	User Interface and Experience

Semester: IV					
Probability, Statistics and Linear Algebra **(Common to the Branches: AD, AI, CD, CS, EC & IS)**					
Course Code	**:**	**1BMATS401**	**Credits**	**:**	3
Hours/Semester (L:T:P:SL)	**:**	20:20:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40	**SEE**	**:**	50 Marks
Course Type	**:**	PCC	**SEE Duration**	**:**	3

Prerequisites:	
Courses	Basic Probability and Statistics.
Knowledge on Fundamental Concepts	Basic Probability distributions and linear Algebra.
Knowledge on Connected Tools (If any)	Proficiency in programming using R and Python for feature selection and data visualization.

Course Learning Objectives: This course will enable the students to	
CLO1	Investigate the association between attributes and the correlation between two variables.
CLO2	Describe the concept of random variables, probability distributions, specific discrete and continuous distributions with practical application in Computer Science Engineering and real-life situations.
CLO3	Demonstrate the principles of statistical inferences and the basics of hypothesis testing with emphasis on some commonly encountered hypotheses.
CLO4	Interpret the concepts of eigenvalues, eigenvectors, and the Cayley-Hamilton theorem to solve matrix-related problems.
CLO5	Implement optimization techniques using diagonalization, SVD.

Module – 1	**08 Hrs.**
Curve fitting and Statistical Analysis: Curve fitting by method of least squares: $y = ax+b$, $y = ax^2 +bx+c$ and $y= ax^b$, Correlation–Karl Pearson's coefficient of correlation, Rank correlation and Regression analysis – lines of regression (without proof)- problems.	
Module – 2	**08 Hrs.**
Probability Distributions: Random Variables (Discrete and Continuous). Probability mass and density functions. Mathematical expectation, Mean and variance. Discrete probability distributions: Binomial, Poisson, and Normal distributions (derivations for mean and standard deviation for Binomial and Poisson distributions only)-Illustrative examples.	
Module – 3	**08 Hrs.**
Sampling Theory: Introduction, sampling distribution, standard error, Type-I and Type-II errors. Testing of hypothesis, levels of significance, confidence limits, test of significance for large samples for mean and proportions. test of significance for small samples - Students 't' distribution, Chi-square distribution as a test of goodness of fit.	

Module – 4	08 Hrs.
Eigenvalues and Eigenvectors: Introduction, Applications of Cayley-Hamilton Theorem, Eigen spaces of a linear transformation, Characteristic and Minimal Polynomials of Block Matrices, Jordan Canonical form.	
Module – 5	**08 Hrs.**
Optimization Techniques in Linear Algebra: Diagonalization and Orthogonal diagonalization of real symmetric matrices, quadratic forms and its classifications, Hessian Matrix, Method of steepest descent, Singular value decomposition. Dimensionality reduction.	

Topics for Self-learning		
Module – 1	**Applications:**	Multiple regression in performance tuning and optimization in Software engineering.
	Self-Study:	Curve fitting by method of least squares: $y= ae^{bx}$, ab^{X}.
Module – 2	**Applications:**	Analyze the performance of the algorithms.
	Self-Study:	Exponential distribution.
Module – 3	**Applications:**	Data analysis and Cryptography.
	Self-Study:	Sampling of attributes, F-distribution.
Module – 4	**Applications:**	Discrete dynamical systems
	Self-Study:	Complex Eigen values
Module – 5	**Applications:**	Applications to the linear models, PCA
	Self-Study:	Complex Eigen values

Course Outcomes: After completing the course, the students will be able to	
CO1	**Analyze** data using correlation and regression techniques by using the principles of least squares to perform curve fitting.
CO2	**Evaluate** probability distributions and random variable concepts to model and simulate uncertainties in engineering systems such as atmospheric turbulence.
CO3	**Analyze** statistical inference techniques including hypothesis testing, error analysis.
CO4	**Apply** eigenvalues, eigenvectors, and the Cayley–Hamilton theorem for solving matrix-related problems.
CO5	**Evaluate** quadratic forms and use SVD and PCA for optimization and dimensionality reduction in real-world applications.

Text Books	
1	A First Course in Probability" – Sheldon Ross (10th edition) 2019, Pearson College Div Publication, ISBN-13: 978-0134753119. Chapters: Ch 4: 4.1-7.4.1 & Ch 5: 5.1 - 5.4. Ch 24: 24.5(a), 24.5(b),24.6(1). Ch 25: 25.12-14,16.
2	Probability and Statistics for Engineers and Scientists" – Ronald E. Walpole et al. (9th edition) 2022, Pearson Publication, ISBN-13: 978-0321629111. Chapters: Ch 1: 1.1-1.2, Ch 6: 6.7,

	Ch 8: 8.1-8.6, Ch 10: 10.1-10.8. Ch 11: 11.1 - 11.3, Ch 12.
3	David C. Lay, Steven R. Lay, Judi J Mc. Donald: "Linear Algebra and its applications", Pearson Education Publication, 6th Edition, 2021, ISBN-13: 978-1292351216. Chapters: Ch-5: 5.1, 5.2, 5.4, 5.5. Ch-6: 6.4. Ch-7: 7.1, 7.2, 7.4.

Reference Books	
1	Srimanta Pal & Subodh C.Bhunia: "Engineering Mathematics" Oxford University Press, 3rd Ed., 2016, ISBN: 978-0198070894.
2	C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics" McGraw – Hill Book Co., New York, 6th Ed., 2017, ISBN: 978-0071135436.
3	H.K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics" S.Chand Publication, 3rd Ed.,2014, ISBN: 978-8121938907.
4	N.P Bali and Manish Goyal: "A Textbook of Engineering Mathematics" Laxmi Publications, 10thEd., 2022, ISBN-13: 978-8131808320.

Web links and Video Lectures (e – Resources)	
1	http://nptel.ac.in/courses.php?disciplineID=111
2	http://www.class-central.com/subject/math(MOOCs)

CO – PO MAPPING

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

	CSE		**ISE**		**CSD**		**AI&ML**		**AI&DS**		**EC**	
	PSO1	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**	**PSO1**	**PSO2**
CO1	**1**			**1**		**1**		**1**		**1**		**1**
CO2	**1**			**1**		**1**		**1**		**1**		**1**
CO3	**1**			**1**		**1**		**1**		**1**		**1**
CO4	**1**			**1**		**1**		**1**		**1**		**1**
CO5	**1**			**1**		**1**		**1**		**1**		**1**

Semester: IV					
Database Management Systems					
Course Code	:	1BCS402	**Credits**	:	4
Hours/Semester (L:T:P:SL)	:	42:0:28:50	**CIE**	:	50 Marks
Total Hours	:	120Hrs	**SEE**	:	50 Marks
Course Type	:	IPCC	**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	Problem Solving Through Programming, Data Structures, Discrete Mathematics, Operating Systems.
Knowledge on Fundamental Concepts	Understanding of sets, relations and functions, logic, data structures, and basics of concurrency and process management.
Knowledge on Connected Tools (If any)	Oracle AI Database 23c, MySQL, MongoDB.

Course Learning Objectives: This course will enable the students to	
CLO1	Articulate fundamental database concepts, technologies, and practices.
CLO2	Design relational models, constraints and apply relational algebra operations to formulate queries
CLO3	Implement relational database solutions using SQL commands, constraints, views, triggers and assertions.
CLO4	Analyze relational schemas using functional dependencies and normalization techniques to improve database design.
CLO5	Demonstrate database transaction, concurrency, storage, access, and NoSQL technologies for effective data management.

Module – 1	**08 Hrs**
Databases and Database Users: Introduction: An example, characteristics of the database approach, actors on the scene, workers behind the scene, advantages of using the DBMS approach, a brief history of database Applications, when Not to use a DBMS. **Database System – Concepts and Architecture**: Data models, schemas, and instances, three schema architecture and data independence, database languages and interfaces, the database system environment. **Entity-Relationship Model**: Using High-Level Conceptual Data Models for Database Design, An Example Database Application, Entity Types, Entity Sets, Attributes and Keys, Relationship types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, Refining the ER Design for the COMPANY Database, ER Diagrams, Naming Conventions and Design Issues.	
Module – 2	**08 Hrs**
Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations. **Relational Algebra**: Unary relational operations: Select, Project, Relational Algebra Operations from Set Theory, Binary relational operations: join and division, additional relational operations (aggregate, grouping, Outer Join and Union Operations), Examples of Queries in relational algebra. **Mapping Conceptual Design into a Logical Design**: Relational database design using ER to Relational Mapping.	

Module – 3	**08 Hrs**
Basic SQL: SQL Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT, DELETE and UPDATE Statements in SQL, Additional features in SQL **More SQL**: More complex SQL retrieval queries, Specifying constraints as assertions and actions as triggers, Views in SQL, Schema Change Statements.	
Module – 4	**08 Hrs**
Basics of Functional Dependencies: Informal Design Guidelines for Relation Schemas, Functional Dependencies. **Normalization for Relational Database**: Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Further Topics in Functional Dependencies: Inference Rules, Equivalence, and Minimal Cover.	
Module – 5	**08 Hrs**
Transaction Processing Concept: Introduction to transaction processing, transaction and system concepts, desirable properties of transactions. **Concurrency Control**: Two phase locking techniques, Concurrency control based on Timestamp ordering. **NOSQL Databases and Big Data Storage Systems**: Introduction to NOSQL Systems, The CAP Theorem, Document-Based NOSQL Systems and MongoDB, NOSQL Key-Value Stores, Column-Based or Wide Column NOSQL Systems, NOSQL Graph Databases and Neo4j.	

Practical component

Design, develop, and Implement the specified queries for the following problems using Oracle, MySQL, MS SQL Server, or any other DBMS under LINUX/Windows environment.

Module – 3	**1.Consider the EMPLOYEE table with the following attributes and domains:** **EMPLOYEE (EMPNO NUMBER(5), ENAME VARCHAR2(50), JOB VARCHAR2(30), MGR NUMBER(5), SAL NUMBER(10,2))** Write SQL queries to perform the following operations: a. Create a user and grant all privileges to that user. b. Create the EMPLOYEE table using the above attributes and insert at least 5 records. c. Add a new column COMMISSION NUMBER(10,2) to the EMPLOYEE table. d. Alter the EMPLOYEE table to add a PRIMARY KEY constraint to EMPNO. e. Add a NOT NULL constraint to the ENAME column and verify it by trying to insert a record with NULL to the ENAME attribute. f. Update the JOB designation of an employee whose EMPNO = 102. g. Rename the column MGR to MANAGER_NO using the ALTER command. h. Delete the employee whose EMPNO = 105. i. Insert any three records into the EMPLOYEE table, verify the inserted records using a SELECT statement, and then perform a ROLLBACK operation to undo the changes. Write an SQL statement to DROP the EMPLOYEE table from the database.
Module – 3	**2.Consider the PLAYER table with the following attributes and domains:** **PLAYER (PLAYERID INT, PLAYERNAME VARCHAR(50), TEAM_NAME VARCHAR(30), ROLE VARCHAR(20), RUNS INT, WICKETS INT, NO_MATCHES INT)** Write SQL queries to perform the following operations: a. Create the PLAYER table using the above attributes and insert at least 5 records. b. Display all player details from the PLAYER table. c. Retrieve the distinct TEAM_NAME values from the PLAYER table. d. Display the PLAYERNAME of players whose names start with 'A' using the

	LIKE operator. e. Find the total number of RUNS scored by all players using the SUM aggregate function. f. Find the average RUNS scored by players in each TEAM_NAME using GROUP BY. g. Display the maximum RUNS scored and the minimum number of WICKETS taken by players in each TEAM_NAME using the GROUP BY clause. h. Find the total RUNS scored by each TEAM_NAME and display them in descending order using ORDER BY. i. Find the average RUNS for each ROLE and display only those ROLE values whose average RUNS are greater than 3000 using HAVING. j. Find the number of players in each TEAM_NAME using COUNT and GROUP BY. k. Create a VIEW that displays players who have played more than 100 matches (NO_MATCHES > 100).
Module – 3	**3.Consider a relational database schema for a SAILORS database as given below:** **SAILORS (SID INTEGER, SNAME STRING, RATING INTEGER, AGE REAL)** **BOATS (BID INTEGER, BNAME STRING, COLOR STRING)** **RESERVES (SID INTEGER, BID INTEGER, DAY DATE)** Using the above schema, perform the following operations: a. Create the above tables with appropriate PRIMARY KEYS and FOREIGN KEYS and insert at least 5 records into each table. b. Retrieve the SNAME of sailors who have reserved a RED boat, listed in ascending order of AGE. c. Retrieve the SNAME of sailors who have reserved boat number 103. d. Calculate the average AGE of sailors for each RATING level, considering only those RATING levels that have at least two sailors. e. Retrieve the SNAME of sailors who have reserved a RED or GREEN boat.
Module – 3	**4.Create a row-level trigger for the CUSTOMERS table** that fires on INSERT, UPDATE, or DELETE operations performed on the CUSTOMERS table. The trigger should display the difference between the OLD and NEW SALARY values wherever applicable. **CUSTOMERS(ID,NAME,AGE,ADDRESS,SALARY**)
Module – 3	**5.Consider the schema for STUDENT DATABASE:** **STUDENT (USN, NAME, BRANCH, PERCENTAGE)** **FACULTY (FID, FNAME, DEPARTMENT, DESIGNATION, SALARY)** **COURSE (CID, CNAME, FID)** **ENROLL (CID, USN, GRADE)** Write SQL queries to perform the following operations: a. Create the above tables with appropriate PRIMARY KEYS and FOREIGN KEYS and insert at least 5 records into each table. b. Retrieve the NAME of all students enrolled for the course 'CS_54'. c. List all the DEPARTMENT values having an average SALARY of the faculties above 10000. d. List the NAME of the students enrolled for the course 'CS_51' and having GRADE 'B'. e. Retrieve the FNAME of faculty members who are handling more than one course.

	f. List the NAME of students who have enrolled in more than two courses.
Module 5	6.Install an Open Source NoSQL Data base MangoDB & perform basic CRUD(Create, Read, Update & Delete) operations. Execute MangoDB basic Queries using CRUD operations.
Module 1-5	7.Open Ended Mini Project should be implemented and shall be carried out in a batch of three students. The students will finalize a topic in consultation with the faculty.

Topics for Self learning	
Module – 1	1. Evolution of Databases (Hierarchical, Network, Relational, Cloud Databases)
	2. Cloud Databases and Database as a Service
Module – 2	1. Introduction to Data Modeling Tools
	2. Introduction to Distributed Databases
Module – 3	1. Stored Procedures and Functions
	2. SQL Injection and Database Security
Module – 4	1. Database Denormalization Techniques
	2. Data Redundancy and Data Integrity Issues
Module – 5	1. Blockchain Databases
	2. Big Data Ecosystem (Hadoop, Spark Basics)

Course Outcomes: After completing the course, the students will be able to	
CO1	Comprehend database concepts, architecture, classifications and design relational schemas from ER diagrams.
CO2	Apply relational model concepts in the design of relational databases.
CO3	Develop database schemas and SQL queries using DDL, DML, constraints, views, triggers and assertions.
CO4	Analyze relational schemas and perform normalization using functional dependency.
CO5	Design reliable database systems using transactions, concurrency control, recovery mechanisms and NoSQL database technologies.

Textbook	
1	"Fundamentals of Database Systems", Elmasri and Navathe, 8th Edition, 2026, Pearson Education, ISBN: 9780138090807 Chapters:1,2,3,5,6,7,8,9,14.15.20,21,22,24

Reference Books	
1	"Database System Concepts", Silberschatz, A., Korth, H. F., & Sudarshan, 7th Edition, 2019 McGraw-Hill, ISBN: 9780078022159.
2	"Database Management Systems", Raghu Ramakrishnan and Johannes Gehrke 7th Edition, 2003, McGraw-Hill ISBN: 9780072465631.

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/watch?v=IoL9Ve2SRwQ&list=PLIwC9bZ0rmjSkm1VRJROX 4vP2YMIf4Ebh
2	https://www.youtube.com/watch?v=sEaYXwmsLw0&list=PLyqSpQzTE6M-xymXgqewlzcC3U4cdRoSu
3	https://www.w3schools.com/sql/default.asp
4	https://www.tutorialspoint.com/dbms/index.htm

5	https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system- set-1/

CO – PO – PSO MAPPING

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

Semester: IV					
Algorithms Design Techniques					
Course Code	**:**	1BCS403	**Credits**	**:**	04
Hours/Semester (L:T:P:SL)	**:**	42:28:0:50	**CIE**	**:**	50 Marks
Total Hours	**:**	120	**SEE**	**:**	50 Marks
Course Type	**:**	PCC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Problem Solving through Programming, Data Structures and Algorithms, Discrete Mathematical Structures and Graph Theory
Knowledge on Fundamental Concepts	Basic programming constructs, Time and space complexity analysis, Recursion and mathematical induction, Linear and non-linear data structures
Knowledge on Connected Tools (If any)	GCC, Turbo C, Code::Blocks, Dev C++, Visual Studio Code

Course Learning Objectives: This course will enable the students to	
CLO1	Explain brute-force and decrease-and-conquer techniques for solving computational problems.
CLO2	Apply divide-and-conquer and dynamic programming methods to sorting, optimization, and string-matching problems.
CLO3	Describe greedy algorithms and network flow techniques used in graph problems and data compression.
CLO4	Implement transform-and-conquer and space-time trade-off techniques to improve algorithm efficiency.
CLO5	Apply backtracking, branch-and-bound, and approximation techniques to solve NP-hard problems.

Module – 1	**08 Hrs**
Brute Force: Selection Sort and Bubble Sort, Sequential Search and Brute Force String Matching, Exhaustive Search. **Decrease and Conquer:** Algorithms for Generating Combinatorial Objects, Decrease-by-a-Constant-Factor Algorithms: Binary Search.	
Module – 2	**08 Hrs**
Divide And Conquer: Merge Sort, Quick Sort, Multiplication of large integers. **Dynamic Programming:** Three basic examples, The Knapsack Problem and Memory Functions, Optimal Binary Search Trees, Bellman-ford algorithm, Knuth-Morris-Pratt algorithm	
Module – 3	**08 Hrs**
Greedy Technique: Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Johnson's algorithm for sparse graphs, Max-Flow: Flow networks, Ford-Fulkerson method, Maximum bipartite matching, Huffman Trees and Codes.	
Module – 4	**08 Hrs**
Transfer and Conquer: Balanced Searched Trees, Heaps and Heap Sort. **Space-Time Trade-offs:** Sorting by Counting: Comparison counting sort, Input Enhancement in string matching: Horspool's algorithm, Boyer-Moore algorithms.	
Module – 5	**08 Hrs**

Limitations of Algorithmic Power: Decision Trees, P, NP, and NP-Complete Problems. **Coping with Limitations of Algorithmic Power:** Backtracking, Branch-and-Bound, Approximation algorithms for NP-Hard problems.

Topics for Self learning	
Module – 1	Analysis and Comparison of Basic Sorting Algorithms
	Applications of Permutations and Combinations in Computing
Module – 2	Longest Common Subsequence (LCS) using Dynamic Programming
	Rabin-Karp String Matching Algorithm
Module – 3	Applications of Minimum Spanning Trees in Network Design
	Huffman Coding for Data Compression
Module – 4	Applications of Maximum Flow in Real-World Networks
	Shortest Path Algorithms in Navigation Systems
Module – 5	Traveling Salesman Problem (TSP)
	Heuristic and Metaheuristic Approaches for NP-Hard Problems

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the fundamental principles of algorithm design techniques and illustrate their applications.
CO2	Analyze a given algorithm and express its time and space complexities in asymptotic notations
CO3	Analyze and apply algorithm design paradigms to solve computational / combinatorial / graph-based / optimization problems.
CO4	Employ graphs to model engineering problems and illustrate graph algorithms and their analysis.
CO5	Analyze algorithmic limitations and apply backtracking, branch-and-bound, or approximation techniques to solve NP-hard problems.

Text Books	
1	Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian), 2022, Pearson, ISBN-13: 978-9332585485 Chapters:3,4,5,7,8,9,11,12
2	Introduction to Algorithms, Thomas H. Cormen ,Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 4th Edition, The MIT Press,2022, ISBN: 978-0262046305. Chapters:24,25,26,32

Reference Books	
1	Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press, ISBN: 978-8173716119

2	Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education), 2nd Edition,2023, Oxford University Press, ISBN: 978-9354977886

Web links and Video Lectures (e – Resources)	
1	Design and Analysis of Algorithms: https://nptel.ac.in/courses/106106131/

CO – PO MAPPING

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

Semester: IV					
Artificial Intelligence					
Course Code	:	1BCI404	**Credits**	:	04
Hours/Semester (L:T:P:SL)	:	42:0:28:50	**CIE**	:	50 Marks
Total Hours	:	120Hrs	**SEE**	:	50 Marks
Course Type	:	IPCC	**SEE Duration**	:	03 Hours

Prerequisites:	
Courses	Data structures, Python
Knowledge on Fundamental Concepts	Linear Algebra, Probability and Statistics
Knowledge on Connected Tools (If any)	Jupyter Notebook

Course Learning Objectives: This course will enable the students to	
CLO1	Understand and gain a historical perspective of AI, Intelligent Agents and its foundations.
CLO2	Finding the solution using uninformed and informed search.
CLO3	Get to know approaches of inference, perception, knowledge representation, and learning.
CLO4	Analyze the knowledge representation language.
CLO5	Develop principles of Artificial Intelligence (AI) to solve real-world problems.

Module – 1	**08 Hrs.**
Artificial Intelligence - Introduction: What Is AI? The Foundations of Artificial Intelligence, The History of Artificial Intelligence, Risks and Benefits of AI. **Artificial Intelligence - Intelligent Agents:** Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents.	
Module – 2	**08 Hrs.**
Problem-solving – Solving Problems by Searching: Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies.	
Module – 3	**08 Hrs.**
Problem-solving – Solving Problems by Searching: Informed (Heuristic) Search Strategies (Greedy best-first search, A*search), Heuristic Functions. **Knowledge, Reasoning and Planning - Logical Agents:** Knowledge–Based Agents, The Wumpus World, Logic, Propositional Logic: A Very Simple Logic.	
Module – 4	**08 Hrs.**
Knowledge, Reasoning and Planning - First Order Logic: Representation Revisited, Syntax and Semantics of First Order Logic, Using First Order logic. **Knowledge, Reasoning and Planning - Inference in First Order Logic:** Propositional vs. First Order-Inference, Unification and First Order-Inference, Forward Chaining, Backward Chaining, Resolution.	
Module – 5	**08 Hrs.**
Uncertain Knowledge and Reasoning - Quantifying Uncertainty: Acting under Uncertainty,Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes'Rule and Its Use, Wumpus World Revisited. **Expert Systems:** Representing and Using Domain Knowledge, Expert System Shells,Explanation, Knowledge Acquisition.	

Practical component	
Module – 1	Implement a vacuum cleaner agent to perform basic cleaning functions.
Module – 2	Implement the Water Jug Problem using Depth First Search Algorithm.
Module – 3	Implement the Missionaries and Cannibals Problem using the Best First Search Algorithm.
	Implement the A* search algorithm to determine the shortest distance between any two nodes in a graph.
	Implement and demonstrate the AO* Search algorithm.
	Implement a solution to the Solve 8-Queens Problem using appropriate assumptions.
	Implement a heuristic based solution to the Travelling Salesman Problem.
	Implement a two player Tic-Tac-Toe game.
Module – 4	Implement and demonstrate problem-solving strategies using Forward Chaining and Backward Chaining.
	Implement and demonstrate the resolution principle on FOPL problems.
	Implement and demonstrate the unification process in first order logic.
	Implement a knowledge base using first order logic statements and prove a given query using forward reasoning.

Topics for Self learning	
Module – 1	Evolution of Artificial Intelligence and Generative AI Applications
	Applications of Intelligent Agents in Real-World Systems
Module – 2	Search Algorithms in Robotics and Autonomous Navigation
	State Space Representation and Problem Formulation in AI
Module – 3	Adversarial Search: Minimax and Alpha-Beta Pruning
	Applications of Heuristic Search in Route Planning and Game AI
Module – 4	Introduction to Logic Programming using Prolog
	Knowledge Graphs and Semantic Web Technologies
Module – 5	Bayesian Networks and Their Applications in Decision Making
	Modern Expert Systems in Healthcare, Finance, and Industry

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the scope, history, and significance of Artificial Intelligence and intelligent agents.
CO2	Apply search strategies to solve well-defined problems in artificial intelligence.
CO3	Develop knowledge-based agents using propositional and first-order logic.
CO4	Analyze reasoning under uncertainty using probabilistic methods.
CO5	Describe the architecture and functioning of expert systems in real-world domains.

Text Books	
1	Artificial Intelligence, Stuart J. Russell and Peter Norvig, 4th Edition, Pearson,2022, ISBN: 978-9356063570. Chapters: Ch 1: 1.1 to 1.3,1.5 & Ch 2: 2.1 to 2.4 Ch 3: 3.1 to 3.4 Ch 3: 3.5(3.5.1,3.5.2),3.6 & Ch 7: 7.1 to 7.4 Ch 8: 8.1 to 8.3 & Ch 9: 9.1 to 9.5 Ch 12:12.1 to 12.5, 12.7

2	Artificial Intelligence, Elaine Rich, Kevin Knight, 3rd Edition, Tata McGraw Hill,2017, ISBN: 978-0070087705. Chapters: Ch 20: 20.1 to 20.4

Reference Books	
1	Artificial Intelligence Structure and strategies for complex problem solving, George F Lugar, 6th Edition, Pearson Education,2021, ISBN: 978-9354493782.
2	Principles of Artificial Intelligence, Nils J. Nilsson, Elsevier, 1993 ISBN: 978-0934613101.

Web links and Video Lectures (e – Resources)	
1	https://www.kdnuggets.com/2019/11/10-free-must-read-books-ai.html
2	https://www.udacity.com/course/knowledge-based-ai-cognitive-systems--ud409
3	https://nptel.ac.in/courses/106/105/106105077/

CO – PO MAPPING

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

Semester: IV					
Algorithms Laboratory					
Course Code	**:**	1BCSL405	**Credit**	**:**	01
Hours/Semester (L:T:P:SL)	**:**	0:0:28:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	30 Hrs	**SEE**	**:**	50 Marks
Course Type	**:**	PCCL	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Problem Solving through Programming, Data Structures and Algorithms
Knowledge on Fundamental Concepts	Programming Skills
Knowledge on Connected Tools (If any)	Edit plus, GCC, Code blocks, Visual Studio

Course Learning Objectives: This course will enable the students to	
CLO1	Understand and apply advanced algorithmic techniques.
CLO2	Design and implement efficient algorithms for various problems.
CLO3	Analyze the time and space complexity of algorithms and evaluate their performance for different input cases.
CLO4	Utilize appropriate data structures and optimization strategies to handle large-scale computational problems.
CLO5	Develop problem-solving skills by implementing algorithms for real-world and competitive programming scenarios.

Experiments	
Sl. No.	**List of problems for which student should Develop C program and execute in the Laboratory**
1.	Sort a given set of N integer elements using the Selection Sort algorithm, analyze its time complexity, and evaluate its performance by executing it for varying input size (N>5000). Record the time taken for each case and plot a graph of time versus input size, where the input data may be generated randomly or read from a file.
2.	Sort a given set of N integer elements using the Quick Sort algorithm, analyze its time complexity, and evaluate its performance by executing it for varying input sizes (N>5000). Record the time taken for each case and plot a graph of time versus input size, where the input data may be generated randomly or read from a file.
3.	Sort a given set of N integer elements using the Merge Sort algorithm, analyze its time complexity, and evaluate its performance by executing the algorithm for varying input sizes (N>5000). Record the time taken for each case and plot a graph of time versus input size, where the input data may be generated randomly or read from a file.
4.	Solve the 0/1 Knapsack problem using a dynamic programming approach to determine the maximum achievable value within a given capacity constraint.
5.	Compute the shortest path distances from a given source vertex to all other vertices in a weighted graph using the Bellman–Ford algorithm, and detect any negative-weight cycles reachable from the source.
6.	Perform pattern matching in a given text using the Knuth–Morris–Pratt (KMP) algorithm by preprocessing the pattern to construct the Longest Proper Prefix which is also Suffix (LPS) array, and efficiently identify all occurrences of the pattern in linear

	time.
7.	Find the Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm.
8.	Find the Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.
9.	Determine the shortest paths from a given source vertex to all other vertices in a weighted connected graph using Dijkstra's algorithm.
10.	Compute the maximum flow from a source vertex to a sink vertex in a flow network using the Ford–Fulkerson algorithm, ensuring that capacity constraints and flow conservation are satisfied.
11.	Find all subsets of a given set $S = \{s_1, s_2, \ldots, s_n\}$ of positive integers whose sum equals a specified target value D.
12.	Solve the N-Queens problem using a backtracking approach to place N queens on a $N \times N$chessboard such that no two queens attack each other, and generate all possible valid configurations.

Open Ended Experiments	
1	Comparative Performance Analysis of Selection Sort, Quick Sort, and Merge Sort for varying input sizes.
2	Performance Comparison of Bellman-Ford and Dijkstra's Algorithms on different graph structures.
3	Evaluation of String Matching Algorithms using KMP and other pattern matching techniques on large datasets.
4	Design and Optimization of Real-World Networks using Prim's and Kruskal's Minimum Spanning Tree algorithms.
5	Maximum Flow Analysis in Transportation or Communication Networks using the Ford-Fulkerson algorithm.
6	Scalability Study of Backtracking Algorithms through N-Queens and Subset Sum problems for different input sizes.

Course Outcomes: After completing the course, the students will be able to	
CO1	Design and implement algorithms to solve computational problems using appropriate techniques.
CO2	Apply suitable data structures and algorithmic strategies for efficient problem solving.
CO3	Analyze the time and space complexity of algorithms and evaluate their performance.
CO4	Develop optimized solutions by selecting appropriate approaches for various problem scenarios.
CO5	Demonstrate programming skills to solve real-world problems and validate results effectively.

Text Books	
1	Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian), 2022, Pearson, ISBN-13: 978-9332585485 Chapters:3,4,5,7,8,9,11,12
2	Introduction to Algorithms, Thomas H. Cormen ,Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, 4th Edition, The MIT Press,2022, ISBN: 978-0262046305. Chapters:24,25,26,32

Reference Books	
1	Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press, ISBN: 978-8173716119
2	Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education), 2nd Edition,2023, Oxford University Press, ISBN: 978-9354977886

Web links and Video Lectures (e – Resources)	
1	http://elearning.vtu.ac.in/econtent/courses/video/CSE/06CS35.html
2	https://nptel.ac.in/courses/106/105/106105171/
3	http://www.nptelvideos.in/2012/11/data-structures-and-algorithms.html
4	https://www.youtube.com/watch?v=3Xo6P_V-qns&t=201s
5	https://nptel.ac.in/courses/106/102/106102064/

CO – PO MAPPING

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

Semester: IV					
MERN					
Course Code	:	BADL406A	**Credit**	:	1
Hours/Week (L:T:P)	:	0:0:2	**CIE**	:	50 Marks
Total Hours	:	15 P	**SEE**	:	50 Marks
Course Type	:	AEC	**SEE Duration**	:	2 Hours

Prerequisites:	
Courses	Data Structure.
Knowledge on Fundamental Concepts	Object-Oriented Programming language.
Knowledge on Connected Tools (If any)	MongoDB Compass, Postman, Visual Studio.

Course Learning Objectives: This course will enable the students to	
CLO1	Identify the key web development languages and tools used in building dynamic web applications
CLO2	Develop server-side web applications using Node.js and Express.js to handle client request.
CLO3	Design and implement scalable front-end applications using React.js.
CLO4	Analyze the interaction between client requests, APIs, and routing in web-based systems.
CLO5	Manage data using MongoDB and integrate front-end and back-end technologies to develop full-stack web applications.

Experiments	
Sl. No.	**List of problems for which student should Develop program and execute in the Laboratory**
1.	Install the MongoDB driver for Node.js. Create a Node.js script to connect to the shop database. Implement insert, find, update, and delete operations using the Node.js MongoDB driver. Define a product schema using Mongoose. Insert data into the products collection using Mongoose.
2.	Using MongoDB, create a collection called transactions in database usermanaged (drop if it already exists) and bulk load the data from a json file, transactions. json b. Upsert the record from the new file called transactions upsert.json in MongoDB.
3.	Query MongoDB with Conditions: [Create appropriate collection with necessary documents to answer the query] a. Find any record where Name is Somu

	b. Find any record where total payment amount (Payment. Total) is 600. c. Find any record where price (Transaction.price) is between 300 to 500. d. Calculate the total transaction amount by adding up Payment. Total in all records. By using find and limit.
4.	Develop a program that extracts and validates cookie information from a request header.
5.	Write node.js program to print the car object properties, delete the second property and get length of the object.
6.	Implement all CRUD operations on a File System using Node JS
7.	Develop two routes: find_prime_100 which prints prime numbers less than 100 using Express JS routing mechanism
8.	Develop two routes: find_cube_100 which prints cubes less than 100 using Express JS routing mechanism
9.	Develop a React code to build a simple search filter functionality to display a filtered list based on the search query entered by the user.
10.	Create a REST API. Implement endpoints for a Product resource: GET: Returns a list of products. POST: Adds a new product. GET /:id: Returns details of a specific product. PUT /:id: Updates an existing product.

Open Ended Experiments	
1	Develop a Node.js application to read student details such as USN, Name, Semester, and Year of Admission, and store them in a MongoDB database. Given a partial student name as input, retrieve and display all matching student records from the MongoDB collection
2	Create a component Counter with A state variable count initialized to 0. Create Buttons to increment and decrement the count. Simulate fetching initial data for the Counter component using useEffect (functional component) or component DidMount (class component). Extend the Counter component to Double the count value when a button is clicked. Reset the count to 0 using another button.

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the fundamentals of MongoDB, including data modeling, CRUD operations, and query processing, to develop solutions for real-world problems.
CO2	Describe how Express.js routing is used to handle client requests in a web application.
CO3	Analyze the factors that contribute to the scalability and efficiency of RESTful APIs developed using Node.js
CO4	Show how React components, state, props, and JSX work together to build modern web applications
CO5	Construct front-end applications using React.js and integrate them with RESTful APIs to provide complete web solutions.

Text Books	
1	Eddy Wilson Iriarte Koroliova, MERN Quick Start Guide, Packt Publishing.

2	Vasan Subramanian Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node, Apress; 1st ed. Edition.

Reference Books	
1	"MongoDB: The Definitive Guide", Kristina chodorow, 2nd ed O'REILLY, 2013.
2	"MongoDB in Action" by KYLE BANKER et. al. 2nd ed, Manning publication, 2016

Web links and Video Lectures (e – Resources)	
1	http://geeksforgeeks.org/mern/understand-mern-stack/
2	https://blog.logrocket.com/mern-stack-tutorial/
3	https://www.w3resource.com/mongodb-exercises/

CO – PO MAPPING

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

emester: IV					
Data Analytics with Power BI and Tableau					
Course Code	**:**	1BCIL406B	**Credits**	**:**	01
Hours/Semester (L:T:P:SL)	**:**	0:0:26:04	**CIE**	**:**	50 Marks
Total Hours	**:**	30Hrs	**SEE**	**:**	50 Marks
Course Type	**:**	AEC	**SEE Duration**	**:**	2 Hours

Prerequisites:	
Courses	Probability Statistics and Linear Algebra
Knowledge on Fundamental Concepts	Basic concepts of data visualization (charts, graphs, dashboards)
Knowledge on Connected Tools	Basic knowledge of Microsoft Excel, Understanding of CSV file handling and data import/export

Course Learning Objectives: This course will enable the students to	
CLO1	Understand and apply advanced data visualization concepts using modern BI tools.
CLO2	Perform data cleaning, transformation, and preparation using real-world datasets.
CLO3	Design and develop interactive dashboards for domain-specific applications.
CLO4	Analyze data using advanced visualization techniques to derive meaningful insights.
CLO5	Communicate analytical findings effectively through visual storytelling and reports.

Sl.NO	**Part A - Experiments**
1	Analysis of Global Superstore Dataset: i) Create a Sankey Diagram (Tableau) or Decomposition Tree (Power BI) to visualize order flow using the *Global Superstore Dataset (CSV)*. ii) Create Dual Axis Maps to display shipping regions and delivery locations. iii) Analyze shipping delays using order date and ship date. iv) Create a bar chart to compare sales and profit across regions. v) Develop a calculated field to identify high-delay states. vi) Create KPI indicators for sales, profit, and delivery performance. vii) Build an interactive dashboard.
2	Analysis of Telco Customer Churn Dataset: i) Create a Cohort Analysis heat map to visualize customer retention. ii) Build a line chart to show churn trends over time. iii) Implement What-if Parameters to analyze impact of monthly charges on churn. iv) Create a pie chart to show churn distribution across contract types. v) Create a scatter plot for tenure vs monthly charges. vi) Develop calculated fields to identify “at-risk” customers. vii) Build an interactive dashboard.
3	Analysis of House Prices Dataset: i) Create a Box-and-Whisker Plot to analyze sale price distribution. ii) Identify outliers in property pricing. iii) Create a bar chart to compare prices across neighborhoods. iv) Use Z-score calculations to identify undervalued properties. v) Create a line chart to show price trends over time.

	vi) Develop a heat map for location-based pricing insights. vii) Build an interactive dashboard.
4	Analysis of Twitter Sentiment Analysis Dataset: i) Create a Word Cloud to visualize most frequent words. ii) Develop a scatter plot for sentiment vs engagement. iii) Create a bar chart to show sentiment distribution. iv) Analyze positive, negative, and neutral sentiment using calculated fields. v) Create a line chart to track sentiment trends over time. vi) Develop KPIs for engagement metrics. vii) Build an interactive dashboard.
5	Analysis of Healthcare Dataset: i) Create KPI indicators for patient count, bed occupancy, and average stay duration. ii) Develop a Bullet Graph to compare actual vs target occupancy. iii) Create Drill-through reports from hospital to department level. iv) Create a bar chart to show patient distribution across departments. v) Build a line chart for patient admission trends. vi) Analyze resource utilization using calculated fields. vii) Build an interactive dashboard.
6	Analysis of Online Retail Dataset: i) Create a Funnel Chart to visualize purchase stages. ii) Analyze drop-off rates at each stage. iii) Create a bar chart to compare product category sales. iv) Use DAX/LOD expressions to calculate purchase frequency. v) Create a heat map for customer purchase behavior. vi) Develop KPIs for revenue and conversion rate. vii) Build an interactive dashboard.
7	Analysis of Stock Market Dataset: i) Create a Candlestick Chart to visualize stock prices. ii) Add Moving Average line for trend analysis. iii) Create a line chart to compare stock performance. iv) Develop a bar chart for trading volume. v) Create calculated fields for volatility. vi) Build KPI indicators for stock performance. vii) Build an interactive dashboard.
8	Analysis of Global Renewable Energy Dataset: i) Create a Stacked Area Chart to show energy consumption trends. ii) Perform Year-over-Year (YoY) growth analysis. iii) Create a bar chart to compare energy sources. iv) Develop a line chart for renewable energy adoption. v) Create a map to visualize country-wise energy usage. vi) Develop calculated fields for growth rate. vii) Build an interactive dashboard.
9	Analysis of revenue in sales dataset: i) Create a choropleth map (fill the map) to spot the special trends to show the state which has the highest revenue. ii) Create a line chart to show the revenue based on the month of the year. iii) Create a bin of size 10 for the age measure to create a new dimension to show the revenue. iv) Create a donut chart view to show the percentage of revenue per region by creating zero access in the calculated field. v) Create a butterfly chart by reversing the bar chart to compare female & male revenue based on product category.

	vi) Create a calculated field to show the average revenue per state & display profitable & non-profitable state. vii) Build a dashboard.
10	Analysis of GDP dataset: i) Visualize the countries data given in the dataset with respect to latitude and longitude along with country name using symbol maps. ii) Create a bar graph to compare GDP of Belgium between 2006 – 2026. iii) Using pie chart, visualize the GDP of India, Nepal, Romania, South Asia, Singapore by the year 2010. iv) Visualize the countries Bhutan & Costa Rica competing in terms of GDP. v) Create a scatter plot or circle views of GDP of Mexico, Algeria, Fiji, Estonia from 2004 to 2006. vi) Build an interactive dashboard.
11	Analysis of HR Dataset: i)Create KPI to show employee count, attrition count, attrition rate, attrition count, active employees, and average age. ii) Create a Lollipop Chart to show the attrition rate based on gender category. iii) Create a pie chart to show the attrition percentage based on Department Category-Drag department into colours and change automatic to pie. Entire view, Drag attrition count to angle. Label attrition count, change to percent, add total also, edit label. iv) Create a bar chart to display the number of employees by Age group, v) Create a highlight table to show the Job Satisfaction Rating for each job role based on employee count. vi) Create a horizontal bar chart to show the attrition count for each Education field Education field wise attrition – drag education field to rows, sum attrition count to col, vii) Create multiple donut chart to show the Attrition Rate by Gender for different Age group.
12	Analysis of Amazon Prime Dataset: i) Create a Donut chart to show the percentage of movie and tv shows ii) Create a area chart to shows by release year and type iii) Create a horizontal bar chart to show Top 10 genre iv) Create a map to display total shows by country v) Create a text sheet to show the description of any movie/movies. vi) Build an interactive Dashboard.
	Part B - Mini Project
	Develop an interactive data visualization dashboard using Tableau or Power BI by selecting a real-world dataset (CSV format from Kaggle or similar sources). The project should demonstrate data preprocessing, advanced visualizations, and effective storytelling to derive meaningful insights for decision-making.

Topics for Self-learning	
Power BI	Downloading and Installation procedure
Tableau	Downloading and Installation procedure

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply advanced data visualization techniques using Tableau and Power BI.
CO2	Execute data cleaning, transformation, and preparation on real-world datasets.
CO3	Develop interactive dashboards for domain-specific applications.
CO4	Analyze datasets to derive meaningful insights using visualization techniques.

CO5	Build and present actionable insights using visual storytelling and reports.

Text Books	
1	Microsoft Power BI Data Analyst Certification Guide, Daniil Maslyuk, Greg Deckler, 2nd Edition, Packt Publishing, 2024, ISBN-13: 978-1837632053
2	Tableau Desktop Specialist Certification Guide, Mike Van Sickle, 2nd Edition, Packt Publishing, 2023, ISBN-13: 978-1803246925

Text Books	
1	Storytelling with Data: A Data Visualization Guide for Business Professionals, Cole Nussbaumer Knaflic, 2nd Edition ,Wiley, 2025, ISBN-13: 978-1394287758
2	Practical Tableau: 100 Tips, Tutorials, and Strategies, Ryan Sleeper, 2nd Edition ,O'Reilly Media, 2018, ISBN-13: 978-1491977316

Web links and Video Lectures (e – Resources)	
1	Official Documentation of Tableau https://www.tableau.com/learn
2	Official Documentation of Microsoft Power BI https://learn.microsoft.com/en-us/training/powerplatform/power-bi
3	Kaggle (Datasets & Practice) https://www.kaggle.com/datasets
4	UCI Machine Learning Repository https://archive.ics.uci.edu
5	Google Data Analytics Professional Certificate (Reference Learning) https://www.coursera.org/professional-certificates/google-data-analytics

CO – PO MAPPING

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

Semester: IV					
Environmental Science Project					
Course Code	**:**	1BEP408	**Credit**	**:**	1
Hours/Semester (L:T:P:SL)	**:**	0:0:0:30	**CIE**	**:**	50 Marks
Total Hours	**:**	30	**SEE**	**:**	50 Marks
Course Type	**:**	SDC	**SEE Duration**	**:**	2 Hours

Course Learning Objectives: This course will enable the students to	
CLO1	Understand complex, real-world environmental issues, including climate change, biodiversity loss, and pollution dynamics.
CLO2	Apply scientific, technological, and engineering principles to analyze structural environmental problems.
CLO3	Train in field-based methodologies, including site surveys, environmental auditing, and data collection protocols.
CLO4	Instill critical thinking and interdisciplinary problem-solving skills required to design sustainable, preventive, or remedial solutions.
CLO5	Develop professional competencies in teamwork, collaborative project management, and effective communication of environmental findings.

Restrictions and professional conduct:
Environmental Science Projects should be academic, socially responsible, technically focused, and politically neutral. Students and faculty must maintain professionalism, ethical conduct, and respect while working with communities and stakeholders, and avoid any political, ideological, commercial, or disruptive activities. Projects should also consider practical constraints such as cost, resources, safety, environmental impact, and stakeholder cooperation.

Methods for project identification:
Students may identify the project topic using one or more of the following methods: interaction with local rural or urban stakeholders such as local leaders, corporation/municipality personnel, NGOs, panchayat representatives, etc.; review of issues highlighted in print and electronic media, and social networks; and, after selecting a broad topic, collect data, conduct a feasibility survey, estimate timelines and resources, approximate expenditure, and define the problem statement and objectives clearly.

List of Project Topics and Engineering Outcomes:
The following structured sequence of activities is to be carried out during the semester:

Sl. No.	**Project title**	**Measurable engineering outcome**	**Mapped POs**	**SDGs**
1	Rural and urban water conservation and management systems	Prepare a site-specific water-saving plan, estimate water demand–supply gap, and propose a feasible conservation intervention with quantified savings.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 6, SDG 11, SDG 12
2	Waste management and recycling	Conduct waste audit, classify waste streams, and design a segregation/recycling workflow	PO2, PO3, PO4, PO6, PO8,	SDG 11, SDG 12, SDG 13

		with measurable reduction in mixed waste.	PO10	
3	Afforestation	Identify a degraded area, prepare plantation layout, and demonstrate survival-rate tracking and maintenance schedule for saplings.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
4	Biogas generation and power generation	Estimate organic waste availability, size a small biogas system, and document expected gas output or energy yield.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 11, SDG 12
5	DPR for solar power rural plant	Prepare a DPR with load assessment, panel sizing, cost estimate, and projected energy generation and payback.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 7, SDG 9, SDG 11
6	DPR for electrification of village/tribal community	Map unserved/underserved households, propose electrification layout, and estimate coverage, losses, and implementation cost.	PO1, PO2, PO3, PO4, PO10, PO11	SDG 7, SDG 9, SDG 10
7	DPR for rural drainage system	Survey drainage bottlenecks, develop a drainage layout, and estimate runoff handling capacity and flood-risk reduction.	PO1, PO2, PO3, PO4, PO6, PO10	SDG 6, SDG 9, SDG 11
8	Sustainability and environmental health projects	Assess local environmental health issues and propose interventions with measurable improvement in hygiene, safety, or resource use.	PO2, PO3, PO4, PO6, PO7, PO8	SDG 3, SDG 6, SDG 11, SDG 12
9	Plastic free campaigns	Measure plastic usage before and after awareness intervention and report percentage reduction or behavioural change.	PO2, PO3, PO6, PO7, PO8, PO10	SDG 11, SDG 12, SDG 13
10	Health and nutrition awareness	Conduct baseline and post-program awareness survey and document improvement in awareness score or adoption of healthier practices.	PO2, PO6, PO7, PO8, PO9, PO10	SDG 2, SDG 3, SDG 11
11	Societal projects involving health wellness	Identify a community health need and develop an awareness/service module with measurable participation and feedback outcomes.	PO2, PO3, PO6, PO8, PO9, PO10	SDG 3, SDG 11, SDG 17
12	Air quality monitoring system	Collect air-quality data, compare with reference limits, and present trends along with possible mitigation suggestions.	PO2, PO3, PO4, PO5, PO6, PO10	SDG 3, SDG 11, SDG 13
13	Plastic waste reduction campaign	Track collection, segregation, and replacement actions, and quantify reduction in plastic	PO2, PO3, PO6, PO7, PO8,	SDG 11, SDG 12, SDG 13

		waste generation or littering.	PO10	
14	Urban greening projects	Prepare greening plan, identify planting locations, and assess environmental benefits such as shade, aesthetics, or heat mitigation.	PO2, PO3, PO4, PO6, PO7, PO11	SDG 11, SDG 13, SDG 15
15	Smart agriculture solution	Design a low-cost monitoring or irrigation support solution and estimate improvement in water use efficiency or crop support.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 9
16	Smart irrigation system	Estimate crop water requirement, propose control logic, and quantify water savings compared with conventional irrigation.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 6, SDG 12
17	Food security initiatives / cold storage system	Estimate storage need, design a simple cold-chain concept, and document reduction in spoilage or wastage.	PO1, PO2, PO3, PO4, PO5, PO10	SDG 2, SDG 9, SDG 12

Suggested Learning Resources

Textbooks

1. Benny Joseph, Environmental Studies, Tata McGraw-Hill, 2nd Edition.
2. R. Rajagopalan, Environmental Studies: From Crisis to Cure, Oxford University Press, 2005.
3. Erach Bharucha, Textbook of Environmental Studies, University Press, latest edition as available in library.
4. M. P. Poonia and S. C. Sharma, Environmental Studies, Vikas Publishing House, latest edition as available Garg, N. R., *Project-Based Learning in Engineering Education*, Pearson India Education Services, Noida.

Reference books

1. R. Sivakumar, Principles of Environmental Science and Engineering, Cengage Learning, 2nd Edition.
2. G. Tyler Miller Jr., Environmental Science: Working with the Earth, Thomson Brooks/Cole, 11th Edition.
3. Pratibha Singh, Anoop Singh, and Piyush Malaviya, Text Book of Environmental and Ecology, Acme Learnin 1st Edition.
4. S. M. Prakash, Environmental Studies, Elite Publishing House, Mangalore, 3rd Edition, 2018.

Teaching Learning Process:

The suggested TLP for Community / Societal Project is as follows;

Week	**Teaching–Learning Activity**	**Faculty Role**	**Student Activity**	**Output / Evidence**
1	Course introduction, objectives, ethics, conduct, and assessment briefing	Explain course scope, rules, rubrics, and expected deliverables	Understand course requirements and form teams	Team list, course plan

2	Community problem identification and topic selection	Guide topic framing and feasibility	Identify local issues through discussion and observation	Shortlisted project topic
3	Stakeholder interaction and preliminary survey	Demonstrate survey methods and stakeholder engagement	Collect initial data from community/users	Survey notes, interview record
4	Problem statement and objective formulation	Review and refine problem statement	Prepare problem statement, scope, and objectives	Approved problem statement
5	Literature/case study review and baseline analysis	Suggest relevant references and examples	Study existing solutions and compare approaches	Baseline analysis summary
6	Project planning and role assignment	Help teams organize tasks, timeline, and responsibilities	Plan activities, divide roles, and prepare schedule	Work plan / Gantt chart
7	Feasibility analysis and solution brainstorming	Check technical feasibility and practicality	Generate possible engineering solutions	Solution alternatives sheet
8	Selection of final solution and design approach	Review final concept and design logic	Finalize concept, methods, and expected outcome	Concept note / design outline
9	Data processing / calculations / sizing / mapping	Support computations and technical review	Analyze data, perform calculations, prepare maps/charts	Technical analysis sheet
10	Prototype / model / audit / DPR / app development	Monitor progress and correct technical issues	Develop the selected output	Working model / draft DPR / map / app
11	Testing, refinement, and implementation planning	Evaluate technical correctness and improvements	Test prototype or validate proposal with users	Test results / revised output
12	Field implementation / demonstration / awareness activity	Facilitate community interaction and documentation	Conduct implementation or demonstration	Photos, attendance, implementation record
13	Documentation of outcomes, feedback, and impact	Review report structure and completeness	Compile findings, stakeholder feedback, and observations	Draft report
14	Presentation preparation and	Conduct mock presentation	Prepare slides/poster and	Presentation

	viva practice	and feedback	rehearse	deck
15	Final presentation, submission, and reflection	Evaluate performance using rubrics	Present project, submit report, reflect on learning	Final report, presentation, viva

Assessment structure:

A. Continuous Internal Evaluation (CIE) – 50 marks

- Students, in batches of 3–4, shall undertake at least one project (or a combination of two related activities) aiming, as far as possible, at a logical implemented or implementable outcome.
- CIE will be conducted by a departmental committee (HoD/nominee, guide and one senior faculty) using the following rubrics totaling 50 marks:

CIE pass requirement:

- A student shall secure a minimum of 20 marks out of 50 in CIE to become eligible to appear for SEE.
- Students who fail to earn the required CIE marks may be given additional opportunities before closure of the semester; no re-doing of CIE is permitted after the end of the semester.

B. Semester End Examination (SEE) – 100 marks (scaled to 50)

- Examination duration: 2 hours.
- Maximum examination marks: 100 (scaled to 50).
- The SEE shall be conducted batch-wise by two examiners, one faculty from the same department and one from a different department appointed by the Principal.

SEE pass requirement and overall passing rule:

- For a pass in SEE, a student shall secure minimum 35 marks out of 100.
- For declaration of a pass grade, the sum of CIE marks (out of 50) and scaled SEE marks (out of 50) shall be ≥ 40; otherwise, the student is awarded grade F (Fail).

CIE Rubric — Continuous Internal Evaluation (Total 50 marks):

Criterion	**Weight (marks)**	**Excellent (Full marks)**	**Good**	**Fair**	**Needs Improvement**
Problem identification & relevance to society/environment	8	Problem clearly identified with strong evidence of relevance and well-defined scope.	Relevant problem with clear scope and adequate evidence.	Problem defined but justification is weak.	Problem unclear or not relevant.
Formation of problem statement; engineering approach, innovation & feasibility	10	Precise statement; sound, innovative, feasible approach.	Adequate statement; feasible with minor gaps.	Partial statement; marginal feasibility.	Missing or infeasible.
Interaction with stakeholders; data collection, analysis & interpretation	8	Thorough engagement; comprehensive data and well-interpreted	Good engagement; adequate data and analysis.	Limited engagement; incomplete data and superficial analysis.	Little or no stakeholder contact; no data/analysis.

		analysis.			
Project documentation; clarity, organization & problem-solving demonstrated	10	Complete, well-organized, analytical, and strong problem-solving.	Complete and clear with some analytical content.	Basic with omissions; problem-solving limited.	Missing/ poorly organized; no clear problem-solving.
Communication & presentation skills	6	Confident, structured, and answers queries fully; visuals effective.	Clear and satisfactory; responds to most queries.	Acceptable but lacks clarity or confidence; weak responses.	Poor or absent; unable to respond.
Contribution & benefit to society (impact, sustainability)	8	Clear, demonstrable societal benefit and realistic sustainability path.	Benefit plausible; sustainability considered with minor gaps.	Limited or unclear benefit; sustainability weak.	No evident benefit or sustainability.

SEE Rubric — Semester End Examination (Will be conducted for 100 marks; later scaled to 50 marks):

Criterion	Weight (marks)	Excellent (Full marks)	Good	Fair	Needs Improvement
Problem identification & relevance to society/ Environment	16	Clearly articulated with strong evidence and context.	Clear with reasonable evidence.	Problem stated but evidence/context weak.	Poorly defined or irrelevant.
Formation of problem statement; engineering approach, innovation & feasibility	20	Precise; demonstrates engineering depth, novelty and feasibility.	Technically sound and feasible with minor limitations.	Basic; limited technical depth or feasibility concerns.	No viable engineering approach or infeasible plan.
Interaction with stakeholders; data collection, analysis & interpretation	16	Excellent engagement; rigorous data collection and insightful analysis.	Good engagement and acceptable analysis.	Superficial data collection and limited analysis.	Inadequate or no data; poor analysis.
Project documentation; clarity, technical rigor & problem-solving demonstrated	20	Comprehensive, technically rigorous, and systematic.	Complete and technically correct with minor gaps.	Lacks technical depth or has notable omissions.	Missing key elements or technically incorrect.
Communication, presentation &		Presents expertly,	Good presentation	Adequate but fails to	Poor presentation and unable to

viva-voce responses	12	defends work persuasively and answers all queries correctly.	and satisfactory answers to most queries.	answer some technical questions.	defend work.
Contribution & benefit to society; impact assessment & sustainability	16	Clear, evidence-based impact assessment with scaling recommendations.	Reasonable impact discussion and sustainability considerations.	Limited evaluation of impact or sustainability.	No coherent assessment of impact or sustainability.

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify and analyse environmental problems through field interaction and technical assessment.
CO2	Develop skills in project planning, field survey, data collection, implementation, documentation, teamwork and communication.
CO3	Formulate feasible environmental problem statements and solutions considering practical constraints and sustainability aspects.
CO4	Apply principles of environmental responsibility, ethics and societal welfare in engineering practice through community-oriented interventions.
CO5	Exhibit multidisciplinary learning and problem-solving ability based on collected data, user feedback and baseline conditions.

CO – PO MAPPING

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

Institute Vision

Preparing Competent Engineering and Management Professionals to Serve the Society

Institute Mission

- Providing Students with a Sound Knowledge in Fundamentals of their branch of Study.
- Promoting Excellence in Teaching, Training, Research and Consultancy.
- Exposing Students to Emerging Frontiers in various domains enabling Continuous Learning.
- Developing Entrepreneurial acumen to venture into Innovative areas.
- Imparting Value based Professional Education with a sense of Social Responsibility.

Department Vision

Nurturing AI&ML technocrats to become proficient in solving real – world problems.

Department Mission

- Providing fundamentals to enhance niche expertise in AI&M, cognitive computing robotics and neural networks.
- Enhancing the Analytical and problem – solving abilities to meet the challenges of the future.
- Training the students with the latest technology to become sustainable professionals.
- Fostering a culture of collaboration and propagating industry – oriented innovation and research.
- Establishing a stimulating learning environment to create value – based and pioneering.

SJC INSTITUTE OF TECHNOLOGY

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