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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)
(2024 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

SJC INSTITUTE OF TECHNOLOGY, CHIKKABALLAPURA

An Autonomous institution Under VTU from 2024 – 2025

AICTE Approved, Accredited by NBA(CSE, ISE, ECE, ME, CV, AE) and NAAC with 'A+' grade, QS – I Gauge Gold Rated

SCHEME OF TEACHING AND EXAMINATION B.E. CSE (Artificial Intelligence &Machine Learning)

(Applicable for students admitted from the Academic Year 2024-25 and onwards)

IV Semester

Sl. No.	Course Code	Course Title	Course Type	TD/ PSB	Teaching Hours / Week			Examination				
					L	T	P	SEE Duration (Hrs)	CIE Marks	SEE Marks	Total Marks	Credits
1	BCS401	Design and Analysis of Algorithms	PCC	TD : AD PSB : CI	3	0	0	**3**	**50**	**50**	**100**	**3**
2	BCI402	Artificial Intelligence	IPCC	TD : CI PSB : CI	3	0	2	**3**	**50**	**50**	**100**	**4**
3	BCS403	Database Management Systems	IPCC	TD : AD PSB : IS	3	0	2	**3**	**50**	**50**	**100**	**4**
4	BBI404	Biology for Engineers	BSC	CHE	2	0	0	**3**	**50**	**50**	**100**	**2**
5	BCSL405	Design and Analysis of Algorithms Lab	PCCL	TD : AD PSB : CI	0	0	2	**3**	**50**	**50**	**100**	**1**
6	BXX406x	ESC/ETC/PLC	ESC	TD : AD/Maths PSB : CS/Maths	If the course is a Theory			**3**	**50**	**50**	**100**	**3**
					3	0	0					
					If the course is a Laboratory							
					2	0	2					
7	BUH407	Universal Human Values	UHV	ANY DEPT	1	0	0	**1**	**50**	**50**	**100**	**1**
8	BCS408x	Ability Enhancement Course/Skill Enhancement Course - IV	AEC/ SEC	TD AND PSB : Concerned department	If the course is a Theory			**1**	**50**	**50**	**100**	**1**
					1	0	0					
					If the course is a Laboratory			**2**				

					0	0	2					
9	BMP409	Metaphysical Science	HSSMC	ANY DEPT	1	0	0	**1**	**50**	**50**	**100**	**1**
10	BNS410	National Service Scheme (NSS)	NCMC	NSS Coordinator	0	0	2	-	**100**	-	**100**	**0**
	BPE410	Physical Education (PE) (Sports and Athletics)		Physical Education Director								
	BYO410	Yoga		Yoga Teacher								
	BMU410	Music		Music Teacher								
11	BCE411	Competency Enhancement Course-2	NCMC	CDCAC		2		-	**100**	-	**100**	**0**
									650	**450**	**1100**	**20**

ASC: Applied Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, PCCL: Professional Core Course laboratory, UHV: Universal Human Value Course, NCMC: Non Credit Mandatory Course, AEC: Ability Enhancement Course, SEC: Skill Enhancement Course, ESC: Engineering Science Course, ETC: Emerging Technology Course, PLC: Programming Language Course, L: Lecture, T: Tutorial, P: Practical, CIE: Continuous Internal Evaluation, SEE: Semester End Evaluation.

Engineering Science Course (ESC/ETC/PLC) (Note- Student should opt for the course which should not be similar to the course opted in 1st Year)

Course Code	Course Name	Course Code	Course Name
BAD406A	Discrete Mathematical Structures and Linear Algebra	BCS406C	Numerical Techniques
BAD406B	Graph Theory	BAD406D	Algorithmic and Game Theory

Ability Enhancement Course/Skill Enhancement Course – IV

Course Code	Course Name	Course Code	Course Name
BCI408A	Embedded & Microcontroller Lab	BAD408C	Mongo DB
BAD408B	Julia	BIS408D	Technical Writing using LATEX

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L: T: P) can be considered as (3: 0: 2) or (2: 2: 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering (B.E.) 2024-25 may please be referred.

National Service Scheme /Physical Education/Yoga/Music: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga and Music with the concerned coordinator / teacher of the course during the first week of 3rd semester. Activities shall be carried out between 3rd semester to the 6th semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, Yoga and Music activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Semester: IV					
Analysis and Design of Algorithms					
Course Code	**:**	BCS401	**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40L	**SEE**	**:**	50 Marks
Course Type	**:**	PCC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Problem Solving through Programming and Data Structures and Application
Knowledge on Fundamental Concepts	Programming skills, Data structures
Knowledge on Connected Tools (If any)	Editor

Course Learning Objectives: This course will enable the students to	
CLO1	Learn the methods for analyzing the fundamentals of algorithmic problem solving, algorithm efficiency, and important problem.
CLO2	Apply and implement various algorithmic paradigms including brute force, divide and conquer, decrease and conquer, and transform and conquer to solve computational problems.
CLO3	Develop solutions using advanced techniques such as dynamic programming and greedy algorithms for optimization and graph-related problems
CLO4	Evaluate and compare algorithmic strategies considering time–space trade-offs, efficiency classes, and mathematical analysis of recursive and non-recursive algorithms.
CLO5	Classify and apply methods for handling limitations of algorithmic power, including P, NP, NP-complete classes, backtracking, branch-and-bound, and approximation algorithms.

Module - 1	**08 Hrs**
Introduction: What is an Algorithm? Fundamentals of Algorithmic Problem Solving, Fundamentals of the Analysis of Algorithm Efficiency: Analysis frame work, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms. **Important Problem Types:** Sorting, Searching, String processing, Graph Problems, Combinatorial Problems. **Text Book 1: Ch. 1 : 1.1 - 1.3, Ch. 2: 2.1 - 2.4**	
Module - 2	**08 Hrs**
Brute force approaches Selection Sort, Bubble sort, Brute-Force String Matching, Exhaustive Search: Travelling Salesman problem, Knapsack Problem **Divide and Conquer:** Merge sort, Quick sort, Binary Tree Traversal, Multiplication of Large Integers and Strassen's Matrix Multiplication. **Text Book 1:Ch.3:3.1,3.2,3.4 Ch.5: 5.1 - 5.4**	
Module - 3	**08 Hrs**
Decrease and Conquer: Insertion Sort, Topological Sorting. **Transform and Conquer:** Balanced Search Trees, Heaps and Heapsort. **Space-Time Tradeoffs:** Sorting by Counting: Comparison counting sort, Input Enhancement in String Matching: Horspool's Algorithm **Text Book 1: Ch.4: 4.1, 4.2, Ch. 6: 6.3, 6.4 Ch. 7- 7.1, 7.2**	

Module - 4	**08 Hrs**
Dynamic Programming: Three basic examples, The Knapsack Problem and Memory Functions, Warshall's and Floyd's Algorithms. **Greedy Technique:** Prim's Algorithm, Kruskal's Algorithm, Dijkstra's Algorithm, Huffman Trees and Codes. **Text Book 1: Ch. 8: 8.1,8.2,8.4 ,Ch.9 : 9.1-9.4**	
Module - 5	**08 Hrs**
Limitations of Algorithmic Power: Decision Trees, P, NP, and NP-Complete Problems. **Coping with Limitations of Algorithmic Power:** Backtracking (n-Queens problem, Subset-sum problem), Branch-and-Bound (Knapsack problem), Approximation algorithms for NP-Hard problems (Knapsack problem). **Text Book1:Ch.1:11.2, 11.3 ,Ch.12: 12.1 - 12.3**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze algorithm efficiency using asymptotic notations and classify algorithms into basic efficiency classes based on time and space complexity
CO2	Design and implement solutions to computational problems using Divide & Conquer and Decrease & Conquer strategies**.**
CO3	Develop solutions for real-world and complex computational problems by applying transform & conquer and dynamic programming techniques.
CO4	Construct graph and string processing algorithms using greedy approaches and input enhancement methods.
CO5	Differentiate between classes of computational problems (P, NP, NP-Complete) and apply advanced techniques such as backtracking, branch and bound, and approximation algorithms for efficient problem-solving.

Text Book	
1	Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian), 2017, Pearson, ISBN: 978-0-13-231681-1.

Reference Books	
1	Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press, ISBN: 978-8173716119.
2	Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI, ISBN: 978-8120340077.
3	Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education), ISBN: 978-0198093695.

Web links and Video Lectures (e – Resources)	
1	https://nptel.ac.in/courses/106/101/106101060/
2	https://nptel.ac.in/courses/106102064
3	https://nptel.ac.in/courses/106105164

CO – PO MAPPING

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

Semester: IV					
Artificial Intelligence					
Course Code	**:**	BCI402	**Credits**	**:**	04
Hours/Week (L:T:P)	**:**	3:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	40L+10P	**SEE**	**:**	50 Marks
Course Type	**:**	IPCC	**SEE Duration**	**:**	03 Hours

Prerequisites:	
Courses	**Datastructures, 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. **Text book 1**: **Ch1- 1.1 to 1.3,1.5 & Ch2- 2.1 to 2.4**	
Module – 2	**08 Hrs.**
Problem-solving – Solving Problems by Searching: Problem-Solving Agents, Example Problems, Search Algorithms, Uninformed Search Strategies. **Text book 1**: **Ch3- 3.1 to 3.4**	
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. **Text book 1: Ch3-3.5(3.5.1,3.5.2),3.6 & Ch7- 7.1 to 7.4**	
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. **Text book 1: Ch8- 8.1 to 8.3 & Ch9- 9.1 to 9.5**	
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. **Text Book 1: Ch12-12.1 to 12.5, 12.7 & Text Book 2: Ch20- 20.1 to 20.4**	

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.

Practical Component of IPCC

(Use Python to implement)

SL.No	Experiments
1	Implement a vacuum cleaner agent to perform basic cleaning functions.
2	Implement the Water Jug Problem using Depth First Search Algorithm.
3	Implement the Missionaries and Cannibals Problem using the Best First Search Algorithm.
4	Implement the A* search algorithm to determine the shortest distance between any two nodes in a graph.
5	Implement and demonstrate the AO* Search algorithm.
6	Implement a solution to the Solve 8-Queens Problem using appropriate assumptions.
7	Implement a heuristic based solution to the Travelling Salesman Problem.
8	Implement and demonstrate problem-solving strategies using Forward Chaining and Backward Chaining.
9	Implement and demonstrate the resolution principle on FOPL problems.
10	Implement a two player Tic-Tac-Toe game.
11	Implement and demonstrate the unification process in first order logic.
12	Implement a knowledge base using first order logic statements and prove a given query using forward reasoning.

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Group discussion on Real world examples.
2. Project based learning.
3. Simple strategies on gaming, reasoning and uncertainty etc.

Text Books	
1	Artificial Intelligence, Stuart J. Russell and Peter Norvig, 4th Edition, Pearson,2022, ISBN: 978-9356063570.
2	Artificial Intelligence, Elaine Rich, Kevin Knight, 3rd Edition, Tata McGraw Hill,2017, ISBN: 978-0070087705.

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
CO1	3	2			1					1	
CO2	3	3	2	2	2				1		
CO3	3	3	3	2	3			1	1		
CO4	3	3	2	3	3			1	1		
CO5	2	2	2	2	2	1		2	2	2	1

Semester: IV					
Database Management Systems					
Course Code	**:**	BCS403	**Credits**	**:**	4
Hours/Week (L:T:P)	**:**	3:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs + 14 Hrs	**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	Unions, Intersections, Subsets, Propositional and predicate logic, Relations and Functions, Process Management & Concurrency.
Knowledge on Connected Tools (If any)	Oracle AI Database 23c, MySQL

Course Learning Objectives: This course will enable the students to	
CLO1	Illustrate the fundamental concepts of database systems, including the database approach, system architecture, data models, and various types of database users and environments.
CLO2	Design and model a relational database using Entity-Relationship (ER) concepts and Map it to a relational schema while applying appropriate constraints and Normalization techniques.
CLO3	Demonstrate the ability to write and execute SQL statements for defining schemas, manipulating data, enforcing constraints, and creating views in a relational database.
CLO4	Apply normalization techniques and functional dependency concepts to design well-structured relational schemas.
CLO5	Analyze transaction processing, concurrency control methods, and recovery techniques to ensure consistency and reliability in database systems.

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. **Text Book 1**:**Ch. 1**: 1.1 – 1.8, **Ch. 2**: 2.1 to 2.4, **Ch. 3:** 3.1 to 3.7	
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.	

Textbook 1: Ch. 5: 5.1-5.3 **, Ch. 8:** 8.1-8.5, **Ch. 9:**9.1	
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. **Textbook 1: Ch. 6:** 6.1-6.5**, Ch. 7:** 7.1-7.4	
Module – 4	**08Hrs**
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. **Text Book 1: Ch. 14:** 14.1 to 14.7 , **Ch. 15:** 15.1	
Module – 5	**08 Hrs**
Transaction Processing Concept: Introduction to transaction processing, transaction and system concepts, desirable properties of transactions, characterizing schedules based on recoverability and serializability, transaction support in SQL. **Concurrency Control & Database Recovery Techniques:** Two phase locking techniques, Concurrency control based on Timestamp ordering, Recovery concepts, NO-UNDO/REDO Recovery Based on Deferred Update, Recovery based on deferred update and Immediate Update. **Text Book 1**: **Ch. 20**: 20.1 to 20.6, **Ch. 21**: 21.1 – 21.2, **Ch. 22**: 22.1 to 22.3	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand database concepts, architecture, and classifications, and design relational schemas from ER diagrams.
CO2	Design relational models, constraints and apply relational algebra operations to formulate queries.
CO3	Develop SQL queries to manipulate and retrieve data from relational databases.
CO4	Apply normalization to design efficient relational schemas.
CO5	Develop reliable databases using transactions, concurrency control, and recovery.

Text Books	
1	Elmasri and Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2016, ISBN-13: 978-0-13-397077-7.

Reference Books	
1	Silberschatz, Korth and Sudharshan ,"Database System Concepts", McGraw-Hill 6th Edition, 2016, ISBN 0-07-352332-1.
2	Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems", McGraw-Hill, 3rd Edition, 2003, ISBN-10: 0072465638.

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/watch?v=IoL9Ve2SRwQ&list=PLIwC9bZ0rmjSkm1VRJROX4vP2YMIf4Ebh
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/

Laboratory Programs

Instructions:

- 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.

Sl.NO	Experiments
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. j. Write an SQL statement to DROP the EMPLOYEE table from the database.
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).
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. Retrieve the SNAME and AGE of the youngest sailor. 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.
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)**
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.
6	**Consider the schema for COMPANY DATABASE:** **EMPLOYEE (SSN, NAME, ADDRESS, SEX, SALARY, SUPERSSN, DNO)** **DEPARTMENT (DNO, DNAME, MGRSSN, MGRSTARTDATE)**

	DLOCATION (DNO, DLOC) **PROJECT (PNO, PNAME, PLOCATION, DNO)** **WORKS_ON (SSN, PNO, HOURS)** 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. Make a list of all PNO values for projects that involve an employee whose NAME is 'SCOTT', either as a worker or as a manager of the department that controls the project. c. Show the resulting SALARY values if every employee working on the 'IOT' project is given a 10 percent raise. d. Find the SUM, MAX, MIN, and AVERAGE of SALARY for all employees of the ACCOUNTS department. e. Retrieve the NAME of each employee who works on all the projects controlled by department number 5, using the NOT EXISTS operator. f. For each DNO that has more than five employees, retrieve the DNO and the number of its employees who are making more than 600000**.**

CO – PO MAPPING MATRIX:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1
CO1	3	2					1				2
CO2	3	2	3		2		1				2
CO3	2	3	2		3		1				2
CO4	3	3	2	1	2	1	1			1	2
CO5	3	3	2	2	3	2	1	1	1	1	2

Semester: IV						
Biology for Engineers **Stream: CSE/ECE/ME/CV**						
Course Code	**:**	**BBI404**		**Credits**	**:**	**2**
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	30		**SEE**	**:**	50 Marks
Course Type	**:**	BSC		**SEE Duration**	**:**	3 Hrs

Prerequisites:	
Courses	Biology, Chemistry
Knowledge on Fundamental Concepts	**-**
Knowledge on Connected Tools	**NA**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamental biological structures and biomolecules
CLO2	Analyze the practical applications of biomolecules in biotechnology and daily life.
CLO3	Relate human organ systems to engineered designs and solutions
CLO4	Appreciate bioinspired materials and mechanisms derived from nature
CLO5	Explore emerging trends in bioengineering and biotechnology

Module – 1	**6 Hrs**
Introduction to Biology The cell: the basic unit of life, Structure and functions of a cell. The Plant Cell and animal cell, Prokaryotic and Eukaryotic cell, Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules; Enzymes (Classification (with one example each),Properties and functions), vitamins and hormones. **Textbook 1. Ch.1, Textbook 2, Textbook 3.**	
Module – 2	**6 Hrs**
Biomolecules and Their Applications (Qualitative) Carbohydrates (cellulose-based water filters, PHA and PLA as bioplastics), Nucleic acids (DNA Vaccine for Rabies and RNA vaccines for Covid19, Forensics – DNA fingerprinting), Proteins (Proteins as food – whey protein and meat analogs, Plant based proteins), lipids (biodiesel, cleaning agents/detergents), Enzymes (glucose-oxidase in biosensors, lignolytic enzyme in bio-bleaching). **Textbook 1. Ch.5, Textbook 2. Textbook 3. Ch. 5,**	
Module-3	**6 Hrs**
Human Organ Systems and Bio Designs (Qualitative) Brain as a CPU system (architecture, CNS and Peripheral Nervous System, signal transmission, EEG, Robotic arms for prosthetics. Engineering solutions for Parkinson's disease).Eye as a Camera system (architecture of rod and cone cells, optical corrections, cataract, lens materials, bionic eye). Heart as a pump system (architecture, electrical signalling - ECG monitoring and heart related issues, reasons for blockages of blood vessels, design of stents, pace makers, defibrillators). Lungs as purification system	

(architecture, gas exchange mechanisms, spirometry, abnormal lung physiology - COPD, Ventilators, Heart-lung machine). Kidney as a filtration system (architecture, mechanism of filtration, CKD, dialysis systems).

Textbook 3. Ch.6, Textbook 4.

Module-4	**6 Hrs**

Nature-Bioinspired Materials and Mechanisms (Qualitative)

Echolocation (ultrasonography, sonars), Photosynthesis (photovoltaic cells, bionic leaf). Bird flying (GPS and aircrafts), Lotus leaf effect (Super hydrophobic and self-cleaning surfaces), Plant burrs (Velcro), Shark skin (Friction reducing swim suits), Kingfisher beak (Bullet train). Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and per flouro carbons (PFCs).

Textbook 3. Ch. 7, Textbook 4.

Module-5	**6 Hrs**

Trends in Bioengineering (Qualitative)

Muscular and Skeletal Systems as scaffolds (architecture, mechanisms, bioengineering solutions for muscular dystrophy and osteoporosis), scaffolds and tissue engineering, Bioprinting techniques and materials, 3D printing of ear, bone and skin. 3D printed foods. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Selfhealing Bioconcrete (based on bacillus spores, calcium lactate nutrients and biomineralization processes) and Bioremediation and Biomining via microbial surface adsorption (removal of heavy metals like Lead, Cadmium, Mercury, Arsenic).

Textbook 3. Ch. 8, Textbook 4.

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the structure and function of cells and major biomolecules essential for life processes.
CO2	Describe the applications of biomolecules in healthcare, environment, and biotechnology.
CO3	Elucidate the human organ systems using engineering analogies and identify associated bioengineering interventions.
CO4	Illustrate nature-inspired biological mechanisms and their technological applications in engineering and material science.
CO5	Discuss emerging trends and tools in bioengineering for diagnostics, therapeutics and environmental sustainability.

Text Books	
1	**Biology for Engineers,** Rajendra Singh C and Rathnakar Rao N, Rajendra Singh C and Rathnakar Rao, N Publishing, Bengaluru, 2023.
2	**Human Physiology,** Stuart Fox, Krista Rompolski, McGraw-Hill eBook. 16th Edition, 2022
3	**Biology for Engineers,** Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, 2012.
4	**Biology for Engineers,** Arthur T. Johnson, CRC Press, Taylor and Francis, 2011

Reference Books	
1	**Biomedical Instrumentation**, Leslie Cromwell, Prentice Hall 2011.
2	**Biology for Engineers,** Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
3	**Biomimetics: Nature-Based Innovation**, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.

Web links and Video Lectures (e – Resources)	
1	https://nptel.ac.in/courses/121106008
2	https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
3	https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
4	https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
5	https://www.coursera.org/courses?query=biology
6	https://onlinecourses.nptel.ac.in/noc19_ge31/preview
7	https://www.classcentral.com/subject/biology
8	https://www.futurelearn.com/courses/biology-basic-concepts

CO – PO MAPPING

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

Semester: IV					
Analysis And Design of Algorithm Lab					
Course Code	**:**	BCSL405	**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	0:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	14P	**SEE**	**:**	50 Marks
Course Type	**:**	PCCL	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Data Structures and Applications, Problem Solving through Programming**
Knowledge on Fundamental Concepts	**C Programming Fundamentals and Data Structure Concepts.**
Knowledge on Connected Tools (If any)	

Course Learning Objectives: This course will enable the students to	
CLO1	Design and implement various algorithms in C/C++ programming using suitable development tools to address different computational challenges.
CLO2	Apply diverse design strategies for effective problem-solving.
CLO3	Measure and compare the performance of different algorithms to determine their efficiency and suitability for specific tasks.
CLO4	Understand limitations and computability of problems related to NP-Completeness and Approximation algorithm
CLO5	Compare algorithm design strategies (divide-and-conquer, greedy, dynamic programming, backtracking, graph algorithms) by developing equivalent programs and analyzing empirical results.

Experiments	
Sl. No.	List of problems for which student should develop program and execute in the Laboratory
1.	Design and implement C/C++ Program to sort a given set of n integer elements using Selection Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
2.	Design and implement C/C++ Program to sort a given set of n integer elements using Quick Sort method and compute its time complexity. Run the program for varied values of n> 5000 and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
3.	Design and implement C/C++ Program to sort a given set of n integer elements using Merge Sort method and compute its time complexity. Run the program for varied values of n> 5000, and record the time taken to sort. Plot a graph of the time taken versus n. The elements can be read from a file or can be generated using the random number generator.
4.	Design and implement C/C++ Program to obtain the Topological ordering of vertices in a given digraph.

5.	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm.
6.	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.
7.	a. Design and implement C/C++ Program to solve All-Pairs Shortest Paths problem using Floyd's algorithm. b. Design and implement C/C++ Program to find the transitive closure using Warshal's algorithm.
8.	Design and implement C/C++ Program to find shortest paths from a given vertex in a weighted connected graph to other vertices using Dijkstra's algorithm.
9.	Design and implement C/C++ Program to solve 0/1 Knapsack problem using Dynamic Programming method.
10.	Design and implement C/C++ Program to solve discrete Knapsack and continuous Knapsack problems using greedy approximation method.
11.	Design and implement C/C++ Program to find a subset of a given set S = {sl , s2,.....,sn} of n positive integers whose sum is equal to a given positive integer d.
12.	Design and implement C/C++ Program for N Queen's problem using Backtracking.

Course Outcomes: After completing the course, the students will be able to	
CO1	Develop programs to solve computational problems using suitable algorithm design strategy.
CO2	Compare algorithm design strategies by developing equivalent programs and observing running times for analysis (Empirical).
CO3	Apply integrated development tools (IDEs) effectively to design, develop, and test programs.
CO4	Choose appropriate algorithm design techniques to develop solution to the computational and complex problems.
CO5	Demonstrate and present the development of program, its execution and running time(s) and record the results/inferences

Web links and Video Lectures (e – Resources)	
1	Virtual Labs : http://cse01-iiith.vlabs.ac.in/

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

Semester: IV						
DISCRETE MATHEMATICAL STRUCTURES AND LINEAR ALGEBRA						
Course Code	**:**	BAD406A		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	50 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Introduction to Logic, Set Theory, matrix operations and Calculus
Knowledge on Fundamental Concepts	Understanding of logic, rules of counting and understanding of vectors, matrices, vector spaces, and matrix operations
Knowledge on Connected Tools (If any)	Mathematical software like Wolfram Alpha, MATLAB, Octave for matrix calculations and visualization

Course Learning Objectives: This course will enable the students to	
CLO1	Analyze logical statements using truth tables, rules of inference, and quantifiers to construct valid logical arguments
CLO2	Fundamental principles of counting, permutations, combinations, recurrence relations, and generating functions to solve combinatorial problems.
CLO3	Define the fundamental properties of vector spaces, subspaces, and linear dependence concepts, construct orthogonal bases and solve least square problems using inner product space techniques.
CLO4	Apply concepts of eigenvalues, eigenvectors, and the Cayley-Hamilton theorem to solve matrix-related problems.
CLO5	Analyze and implement optimization techniques using diagonalization, SVD, and PCA.

Module – 1	**10Hrs**
Fundamentals of Logic Basic Connectives and Truth Tables, Tautologies, Logical Equivalence: The laws of logic, Logical Implications, Rules of inference. Open Statement, Quantifiers, Definition and the use of Quantifiers and the proofs of theorems. **Applications:** Designing logic gates and circuits (AND, OR, NOT, etc.) **Self-study:** Proof Methods and Strategy **Text Book 1: Ch. 2:** 2.1-2.5	
Module – 2	**10Hrs**
Fundamental Principles of Counting and Combinatorics The Rule of Sum and Product, Permutations, Combinations, Principle of Inclusion and Exclusion, Derangements, The Binomial Theorem, Combinations with repetition. **Recursive Definitions, Recurrence Relations** Recursive definition, First order linear recurrence relation- Formulation problems and	

examples, Second order linear recurrence relations with constant coefficients- Homogeneous and Non homogeneous, Generating functions.

Applications: Counting Internet Addresses and Divide-and-Conquer Algorithms.
Self-study: The Pigeonhole Principle.
Text Book 1: Ch. 1: 1.1 - 1.4, **Ch. 10:** 10.1 - 10.3, **Ch. 8:** 8.3

Module – 3	**10Hrs**

VECTOR SPACES and INNER PRODUCT SPACES:
VECTOR SPACES: Introduction, Vector spaces, Subspaces, Linear Combinations, Linear Spans, row space and column space of a Matrix, Linear Dependence and Independence, Basis and Dimension, inner product spaces.

Applications: Applications to difference equations.
Self-study: QR-factorization, least squares problem and least square error.
Text Book2: Ch-4: 4.1-4.5
Text Book3: Ch-2: 2.1-2.4

Module – 4	**10Hrs**

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. Complex eigen values.

Applications: Discrete dynamical systems.
Self-study: Complex eigen values.
Text Book2: Ch-5: 5.1, 5.2
Text Book3: B

Module – 5	**10Hrs**

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 — Principal component analysis.

Applications: Applications to the linear models, PCA
Self-study: PCA
Text Book2: Ch-7: 7.1 - 7.5

Course Outcomes: After completing the course, the students will be able to	
CO1	Analyze the concepts of discrete mathematics to various fields of computer science.
CO2	Apply the concepts of discrete mathematical structures for effective computation and relating problems in the computer science domain.
CO3	Understand the structure of vector spaces and determine the basis and dimension of subspaces.
CO4	Utilize the projection and orthogonal projection approximation contexts.
CO5	Evaluate quadratic forms and use SVD and PCA for optimization and dimensionality reduction in real-world applications.

Text Books	
1	**"Discrete and Combinatorial Mathematics- An Applied Introduction"**, Ralph P. Grimaldi and B V Ramana, Pearson Education, Asia, 5th Edition — 2017, ISBN 978- 0321385024
2	**"Linear Algebra and its applications**", David C. Lay, Steven R. Lay, Judi J Mc. Donald: Pearson Education, 6th Edition, 2021.
3	**"Linear Algebra and its applications"**, Gilbert Strang: Brooks Cole, 4th edition, 2005.

Reference Books	
1	**"Discrete Mathematical Structures Theory and Applications"**, D.S. Malik and M.K. Sen: Latest Edition, Thomson, 2004.
2	**"Discrete Mathematics and its Applications"**, Kenneth H. Rosen, Tata — McGraw Hill, 6 Edition, 7 edition 2017, ISBN-(13): 978-0070681880
3	"Linear Algebra", Seymous Lipschutz, Maec Lars Lipson: fourth edition, Tata – McGrow Hill, 2009.

CO – PO MAPPING

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

Semester: IV						
Graph Theory						
Course Code	:	BAD406B		**Credits**	:	3
Hours/Week(L:T:P)	:	3:0:0		**CIE**	:	50 Marks
Total Hours	:	40 Hrs		**SEE**	:	50 Marks
Course Type	:	ESC		**SEE Duration**	:	3 Hours

Prerequisites:	
Courses	**Probability and statistics, Data Structures and Algorithms**
Knowledge on Fundamental Concepts	**Sets, Relations, Functions, Proof Techniques, and Basics of Trees and Graphs**
Knowledge on Connected Tools (If any)	**Linux editors.**

Course Learning Objectives: This course will enable the students to	
CLO1	Understanding of the fundamental concepts and types of graphs.
CLO2	Explore the properties of Eulerian and Hamiltonian graphs, with emphasis on problems.
CLO3	Gain insights into trees, spanning trees, and connectivity for modeling and solving graph-theoretical problems.
CLO4	Build knowledge of planar graphs and their representations through matrix forms.
CLO5	Learn the graph coloring techniques, chromatic numbers, matchings, and coverings.

Module – 1	**08Hrs**
Introduction to Graphs: Introduction- Basic definition – Application of graphs – finite, infinite and bipartite graphs – Incidence and Degree – Isolated vertex, pendant vertex and Null graph. Paths and circuits – Isomorphism, sub-graphs, walks, paths and circuits, connected graphs, disconnected graphs and components. **Textbook 1: Ch 1: 1.1-1.5, Ch 2: 2.1-2.5.**	
Module – 2	**08Hrs**
Eulerian and Hamiltonian graphs: Euler graphs, Operations on graphs, Hamiltonian paths and circuits, Travelling salesman problem. Directed graphs – types of digraphs, Digraphs and binary relation. **Textbook 1: Ch 2: 2.6-2.10.**	
Module – 3	**08Hrs**
Trees – properties, pendant vertex, Distance and centres in a tree - Rooted and binary trees, counting trees, spanning trees. **Connectivity Graphs**: Vertex Connectivity, Edge Connectivity, Cut set and Cut Vertices, Fundamental circuits. **Textbook 1: Ch 3: 3.7, 3.8, Ch:4.**	
Module – 4	**08Hrs**
Planar Graphs: Planar graphs, Kuratowski's theorem (proof not required), Different representations of planar graphs, Euler's theorem, Geometric dual. **Graph Representations:** Matrix representation of graphs-Adjacency matrix, Incidence Matrix, Circuit Matrix, Path Matrix. **Textbook 1: Ch 6: 6.2-6.4, Ch 7 :7.1-7.4.**	
Module – 5	**08Hrs**
Graph Colouring: Colouring-Chromatic number, Chromatic polynomial, Matchings, Coverings, Four colour problem and Five colour problem. Greedy colouring algorithm. **Textbook 1: Ch:8, Ch:9.**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Outline the fundamental concepts of properties and representation of graphs.
CO2	Solve the problems involving characterization and operations on graphs.

CO3	Apply the properties of trees, spanning trees, and connectivity in graph-theoretic models.
CO4	Evaluate planar graphs, dual graphs using matrices.
CO5	Implement graph colouring techniques, matching, coverings, and coloring algorithms.

Text Books	
1	Graph theory with the applications to engineering & Computer Science, Narsingh Deo, Dovers Publications, 2016, ISBN 978-0486807935.
Reference Books	
1	Introduction to Graph Theory, Garry Chartand and Ping Zhang, Tata McGraw-Hill, 2006.
2	Graph Theory, Frank Harary, Narosa Publishing House, Latest edition.
3	Graph Theory, R. Diestel, free online edition, 2016: diestel-graph-theory.com/basic.html.
4	Introduction to Graph Theory, Douglas B. West, Prentice Hall India Ltd.,2001
5	Introduction to Graph Theory, Robin J. Wilson, Longman Group Ltd.,2010

Web links and Video Lectures (e-Resources):
• **https://www.geeksforgeeks.org/dsa/graph-theory-tutorial**
• **http://www.class-central.com/subject/math(MOOCs)**
• **http://academicearth.org/**

CO – PO MAPPING

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

Semester: IV						
NUMERICAL TECHNIQUES						
Course Code	**:**	BCS406C		**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	50Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	ESC		**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	**Calculus, Linear Algebra, Differential Equations**
Knowledge on Fundamental Concepts	**Numerical methods for solving equations, interpolation, numerical integration, and error analysis**
Knowledge on Connected Tools (If any)	**MATLAB, GNU Octave**

Course Learning Objectives: This course will enable the students to	
CLO1	Describe the concepts and methods of numerical differentiation and integration including adaptive and Gaussian techniques.
CLO2	Implement various numerical methods for solving ordinary differential equations including Runge-Kutta and predictor-corrector techniques.
CLO3	Apply finite difference and iterative techniques for solving partial differential equations numerically.
CLO4	Solve systems of linear algebraic equations using direct and iterative numerical methods.
CLO5	Construct solutions for engineering problems using the finite element method, Rayleigh-Ritz, and Galerkin approaches.

Module – 1	**10Hrs**
Numerical Differentiation and Integration Introduction, Numerical Differentiation, Numerical Integration, Euler-Maclaurin Formula, Adaptive Quadrature Methods, Gaussian Integration, Singular Integrals, Fourier Integrals, Numerical Double Integration. **Applications:** Link of Robotic Arm using MATLAB **Self-study:** Multiple Integrals **Text Book1: Ch -11, Ch-12:** 12.2, 12.3, 12.4, 12.5, 12.8 **Text Book2: Ch -5:** 5.2, 5.4, 5.5, 5.6, 5.7, 5.9, 5.10	
Module – 2	**10Hrs**
Numerical Solution of Ordinary Differential Equations Introduction, Solution by Taylor's Picard's Method, Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, the Cubic Spline Method, Simultaneous and Higher Order Equations, Boundary Value Problems: The Shooting Method, Finite-Difference Method. **Applications:** Phase-Locked Loop using MATLAB **Self-study:** Error estimation for the Euler method **Text Book1: Ch -13:** 13.2, 13.3, 13.6, 13.11, **Ch -14:** 14.2, 14.3 **Text Book2: Ch-7:** 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.10	

Module – 3	**10Hrs**
Numerical Solution of Partial Differential Equations Introduction, Finite-Difference Approximations, Laplace's Equation: Jacobi's Method, Gauss-Seidel Method, SOR Method, ADI Method, Parabolic Equations, Iterative Methods, Hyperbolic Equations. **Applications:** Plate Deflection using MATLAB **Self-study:** Laplace equation **Text Book1: Ch-15:** 15.2, 15.3, 15.4, 15.5 **Text Book2: Ch-8:** 8.1, 8.2, 8.3, 8.3.1, 8.3.2, 8.3.3, 8.3.4, 8.4, 8.5, 8.6	
Module – 4	**10Hrs**
System of Linear Algebraic Equations Introduction, Solution of Centro-symmetric Equations, Direct Methods, LU- Decomposition Methods, Iterative Methods, ILL-conditioned Linear Systems. **Applications:** Singular value decomposition **Self-study:** Consistency of linear system of equations **Text Book2: Ch-6:** 6.1, 6.3, 6.3.6, 6.3.10, 6.3.11	
Module – 5	**10Hrs**
The Finite Element Method: Functionals- Base Function Methods of Approximation- The Rayleigh – Ritz Method -The Galerkin Method, Application to two dimensional problems Finite element Method for one and two dimensional problems. **Applications:** Application to two dimensional problems **Self-study:** Finite element method for two dimensional. **Text Book2: Ch-10:** 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3, 10.4.1, 10.4.2	

Course Outcomes: After completing the course, the students will be able to	
CO1	Explain the principles of numerical integration, including singular and Fourier integrals and their practical applications.
CO2	Demonstrate the use of ODE solvers such as Euler's, Taylor's, and spline methods to compute approximate solutions.
CO3	Utilize numerical methods like Jacobi, Gauss-Seidel, SOR, and ADI to solve PDEs in different forms.
CO4	Analyze and compare the accuracy and stability of LU-decomposition and iterative methods in solving linear systems.
CO5	Develop approximate solutions for 1D and 2D boundary value problems using Finite Element Methods.

Text Books	
1	Numerical Methods, Balagurusamy, E., Tata McGraw –Hill, 978-0074633113 Standard Edition, July 2017
2	Introductory Methods of Numerical Analysis, S.S. Sastry., Prentice Hall of India Private Limited, 81-203-2761-6, 4th ed, February 2005

Reference Books	
1	Numerical Analysis and Algorithms, Niyogi, Pradip, Tata McGraw –Hill, 9780070494930 2003
2	Applied Numerical Methods for Engineers using MATLAB and C by Robert j, Schilling and Sandra L. Harris., Thomson Asia Pte Ltd., 981-240-602-6, 2002
3	Numerical Analysis, Ranganatham, Prasad, Ramesh Babu, S. Chand & Company PVT.LTD., 978-525-3345-9, 4th ed, 2016

CO – PO MAPPING

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

Semester: IV					
Algorithmic Game Theory					
Course Code	**:**	BAD406D	**Credits**	**:**	3
Hours/Week(L:T:P)	**:**	3:0:0	**CIE**	**:**	50 Marks
Total Hours	**:**	40 Hrs	**SEE**	**:**	50 Marks
Course Type	**:**	ESC	**SEE Duration**	**:**	3 Hours

Prerequisites:	
Courses	Introduction to Internet of Things (IoT)
Knowledge on Fundamental Concepts	Basic Data Communication Principles, Discrete Mathematics, Probability theory, Algorithms & Data Structures.
Knowledge on Connected Tools (If any)	Eclipse.

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the Basics of strategic gaming and mixed strategy equilibrium.
CLO2	Gain the knowledge into strategic decision-making involving pure and mixed strategies among rational agents.
CLO3	Build conceptual clarity on equilibrium principles in extensive-form games with perfect information.
CLO4	Grasp the framework of games with incomplete information through Bayesian perspectives and belief systems.
CLO5	Explore the structure and implications of repeated and competitive strategic environments.

Module – 1	**08Hrs**
Introduction to Strategic Games: What is game theory? The theory of rational choice, Strategic games; Examples: The prisoner's dilemma, Bach or Stravinsky, Matching pennies; Nash equilibrium; Examples of Nash equilibrium; Best response functions; Dominated actions. **Textbook 1: Ch 2: 2.1-2.4, 2.6-2.9.**	
Module – 2	**08Hrs**
Introduction; Strategic game s in which players may randomize; Mixed strategy Nash equilibrium; Dominated action s; Pure equilibrium when randomization is allowed. **Illustration:** Expert Diagnosis; Equilibrium in a single population. **Textbook 1: Ch 4: 4.1-4.7.**	
Module – 3	**08Hrs**
Extensive games with perfect information; Strategies and outcomes; Nash equilibrium; Subgame perfect equilibrium; Finding sub-game perfect equilibria of finite horizon games: Backward induction; **Illustrations:** The ultimatum game, Stackelberg's model of duopoly. **Textbook 1: Ch 5: 5.1-5.7.**	
Module – 4	**08Hrs**
Bayesian Games, Motivation al examples; General definitions; Two examples concerning information; Illustrations: Cournot's duopoly game with imperfect information, Providing a public good; Auctions: Auctions with an arbitrary distribution of valuations. **Textbook 1: Ch 9: 9.1-9.6.**	
Module – 5	**08Hrs**
Competative Games: Strictly competitive games and maximization. **Repeated games:** The main idea; Preferences; Repeated games; Finitely and infinitely repeated Prisoner's dilemma; Strategies in an infinitely repeated Prisoner's dilemma; Nash equilibrium of an infinitely repeated Prisoner's dilemma, Nash equilibrium payoffs of an infinitely repeated Prisoner's dilemma. **Textbook 1: Ch 7, Ch 14: 14.1-14.7.**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Interpret the basics of strategic gaming and extensive games.
CO2	Apply game-theoretic concepts to real-world scenarios and strategic decision-making problems.
CO3	Analyze strategic interactions using pure and mixed strategies in static and dynamic settings.
CO4	Evaluate different equilibrium concepts and predict outcomes in strategic, extensive, and Bayesian games.
CO5	Develop models of strategic behavior in real-time situations using appropriate game theory frameworks.

Text Book	
1	"An Introduction to Game Theory", Martin Osborne, Oxford University Press, Re- print Edition, 2012, 7th impression, ISBN – 0195128958.
Reference Books	
1	"Analysis of Conflict Game Theory", Roger B. Myerson, Re-print Edition, Harvard University Press, 2013, ISBN – 978-0674341166.
2	"Introduction to Operations Research, Concepts and Cases", Frederick S. Hillier and Gerald J. Lieberman, 10th Edition; Tata McGraw Hill, 2015, ISBN – 0073376299.
3	"An Introduction to Game Theory", Joel Watson, Strategy, 3rd Edition, W.W. Norton &Company, 2013, ISBN – 9780393123876.

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)
3	http://academicearth.org/

CO – PO MAPPING

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

Semester: IV					
Universal Human Values (UHV)					
Course Code	:	BUH407	**Credits**	:	01
Hours/Week(L:T:P)	:	1:0:0	**CIE**	:	50 Marks
Total Hours	:	15	**SEE**	:	50 Marks
Course Type	:	UHV	**SEE Duration**	:	1 Hr.

Course Objectives: This course will enable the students to	
1	Understand the need, purpose, and content of value-based education.
2	Facilitate self-exploration as a process to understand human aspirations and their fulfillment.
3	Understand harmony at various levels – individual, family, society, nature, and existence.
4	Promote ethical competence and awareness of professional ethics.
5	Encourage the adoption of a holistic and humanistic approach in personal and professional life.

Module-1	**03 Hrs**
Introduction to Value Education Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations. **Textbook1- Ch.1&2**	
Module-2	**03 Hrs**
Harmony in the Human Being Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health. **Textbook1- Ch.3**	
Module-3	**03 Hrs**
Harmony in the Family and Society Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order. **Textbook1- Ch.4&5**	
Module-4	**03 Hrs**
Harmony in the Nature/Existence Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels and The Holistic Perception of Harmony in Existence. **Textbook1- Ch.6&7**	

Module-5	**03 Hrs**

Implications of the Holistic Understanding – a Look at Professional Ethics

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession

Textbook1- Ch.8&9

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the need and importance of value education and the process of self-exploration.
CO2	Explain the concept of harmony in the human being, differentiating the needs of the self and the body.
CO3	Apply the principles of trust, respect, and justice to improve relationships within the family and society.
CO4	Analyze and appreciate the interconnectedness and mutual fulfillment among the four orders of nature.
CO5	Demonstrate ethical behavior and decision-making in professional and personal contexts by integrating human values.

Text Books	
1	The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
2	The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 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 – Pandit Sunderlal
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)
13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.

19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e – Resources)

- Value Education websites,
- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM

CO – PO MAPPING

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

Semester: IV						
Embedded & Microcontroller Lab						
Course Code	**:**	BCI408A		**Credits**	**:**	01
Hours/Week (L:T:P)	**:**	0:0:2		**CIE**	**:**	50 Marks
Total Hours	**:**	14 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	AEC		**SEE Duration**	**:**	2 Hours

Prerequisites:	
Courses	**Computer Organization, Basic programing.**
Knowledge on Fundamental Concepts	**Basic Mathematics.**
Knowledge on Connected Tools (If any)	**IDE, Compiler.**

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the architecture, instruction set, and programming model of ARM microcontrollers
CLO2	Develop proficiency in writing and debugging programs for ARM microcontrollers to perform arithmetic and logical operations.
CLO3	Gain practical skills in interfacing external devices such as UART, stepper motors, DACs, and LEDs with ARM microcontrollers.
CLO4	Apply embedded system design principles to implement hardware-software co-design for real-world applications.
CLO5	Select appropriate hardware components and develop embedded systems based on functional and performance requirements.

Sl.No.	**Experiments** *(Experiments can be conducted using Keil IDE /Embedded C)*
	Study experiment
1	Study of Architecture and Instruction set of ARM Microcontroller.
	Practical Experiment
1	Develop an ALP to multiply two 16-bit binary numbers.
2	Implement an ALP to find the sum of first 10 integer numbers.
3	Implement an ALP to find factorial of a number.
4	Implement an ALP to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
5	Implement an ALP to find the square of a number (1 to 10) using look-up table.
6	Implement an ALP to find the largest/smallest number in an array of 32- numbers.
7	Display “Hello World” message using Internal UART.
8	Interface a Stepper motor and rotate it in clockwise and anti-clockwise direction
9	Interface a DAC to generate Waveforms.
10	**Implement a program to Interface a DC motor.**
11	**Display the Hex digits 0 to F on a 7-segment LED interface, with an appropriate delay in between**
12	**Interface a 4x4 keyboard and display the key code on an LCD.**
	Mini Project
1	**Develop a project on to illustrate the application on** i. Agriculture ii. Home Automation iii. Health iv. Smart city v. Other

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the architectural features and instruction set of ARM microcontroller
CO2	Apply the knowledge gained for Programming ARM for different applications.
CO3	Demonstrate Interfacing of external devices and I/O with ARM microcontroller.
CO4	Interpret the basic hardware components and their selection method based on the characteristics and attributes of an embedded system.
CO5	Develop the hardware /software co-design design approaches.

Text Books	
1	*ARM System-on-Chip Architecture* ,Steve Furber, 2nd Edition, Addison-Wesley, 2000, ISBN: 978-0-201-67519-1.
2	Joseph Yiu, *The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors*, 3rd Edition, Newnes, 2013, ISBN: 978-0-12-408082-9.

Reference Books	
1	Andrew Sloss, Dominic Symes, and Chris Wright, *ARM System Developer's Guide: Designing and Optimizing System Software*, Morgan Kaufmann, 2004, ISBN: 978-1-55860-874-0.
2	Trevor Martin, *The Insider's Guide to the STM32 ARM-based Microcontroller*, Hitex (UK) Ltd., 2018, ISBN: 978-0-9929736-2-9.

Web links and Video Lectures (e–Resources)	
1	ARM Microcontroller Programming https://nptel.ac.in/courses/108102045
2	Embedded Systems: https://nptel.ac.in/courses/108102069
3	ARM Cortex-M Microcontrollers: https://www.coursera.org/learn/arm-cortex-m
4	Introduction to Embedded Systems Software and Development Environments: https://www.coursera.org/learn/introduction-embedded-systems

CO – PO MAPPING

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

Semester: IV					
Julia					
Course Code	**:**	BAD408B	**Credits**	**:**	1
Hours/Week (L:T:P)	**:**	0:0:2	**CIE**	**:**	50 Marks
Total Hours	**:**	15 Hrs	**SEE**	**:**	50 Marks
Course Type	**:**	AEC	**SEE Duration**	**:**	2 Hours

Prerequisites: Courses	Object oriented programming with Java
Knowledge on Fundamental Concepts	Object oriented programming basic concepts
Knowledge on Connected Tools (If any)	Linux editors

Course Learning Objectives: This course will enable the students to	
CLO1	Fundamental the concepts of Julia programming including data types, control structures, and syntax
CLO2	Explore the various structural characteristics available in Julia.
CLO3	Knowledge on tuples, dictionaries, and sets in relation to problem-solving.
CLO4	Make use of user-defined functions, packages, and file handling in Julia.
CLO5	Focus on performance enhancement through debugging, profiling, and optimization techniques in Julia programming.

SI.NO	**Experiments**
1	a. Develop a Julia program to simulate a calculator (for integer and real numbers). b. Develop a Julia program to add, subtract, multiply and divide complex numbers. c. Develop a Julia program to evaluate expressions having mixed data types (integer, real, floating-point number and complex).
2	a. Develop a Julia program for the following problem: A computer repair shop charges $100 per hour for labour plus the cost of any parts used in the repair. However, the minimum charge for any job is $150. Prompt for the number of hours worked and the cost of parts (which could be $0) and print the charge for the job. b. Develop a Julia program to calculate a person's regular pay, overtime pay and gross pay based on the following: If hours worked is less than or equal to 40, regular pay is calculated by multiplying hours worked by rate of pay, and overtime pay is 0. If hours worked is greater than 40, regular pay is calculated by multiplying 40 by the rate of pay, and overtime pay is calculated by multiplying the hours in excess of 40 by the rate of pay by 1.5. Gross pay is calculated by adding regular pay and overtime pay.
3	a. An amount of money P (for principal) is put into an account which earns interest at r% per annum. So, at the end of one year, the amount becomes P + P×r/100. This becomes the principal for the next year. Develop a Julia program to print the amount at the end of each year for the next 10 years. However, if the amount ever exceeds 2P, stop any further printing. Your program should prompt for the values of P and r. b. Develop a Julia program which reads numbers from a file (input.txt) and finds the largest number, smallest number, count, sum and average of numbers.
4	a. Develop a Julia program and two separate functions to calculate GCD and LCM. b. Develop a Julia program and a recursive function to calculate factorial of a

	number. c. Develop a Julia program and a recursive function to generate Fibonacci series.
5	a. Develop a Julia program which reads a string (word) and prints whether the word is palindrome. b. Develop a Julia program which reads and prints the words present in a file (input.txt) having Random Data in which words are dispersed randomly (Assumption: a word is a contiguous sequence of letters. A word is delimited by any non-letter character or end-of-line).
6	a. Develop a Julia program to determine and print the frequency with which each letter of the alphabet is used in a given line of text. b. A survey of 10 pop artists is made. Each person votes for an artist by specifying the number of the artist (a value from 1 to 10). Develop a Julia program to read the names of the artists, followed by the votes, and find out which artist is the most popular.
7	a. Given a line of text as input, develop a Julia program to determine the frequency with which each letter of the alphabet is used (make use of dictionary) b. Develop a Julia program to fetch words from a file with arbitrary punctuation and keep track of all the different words found (make use of set and ignore the case of the letters: e.g. to and To are treated as the same word).
8	a. Develop a Julia program to evaluate expressions consisting of rational, irrational number and floatingpoint numbers) b. Develop a Julia program to determine the following properties of a matrix: determinant, inverse, rank, upper & lower triangular matrix, diagonal elements, Euclidean norm and Square Root of a Matrix.
9	a. Develop a Julia program to determine addition and subtraction of two matrices (element -wise). b. Develop a Julia program to perform multiplication operation on matrices: scalar multiplication, element-wise multiplication, dot product, cross product.
10	a. Develop a Julia program to generate a plot of (solid & dotted) a function: y=x2 (use suitable data points for x). b. Develop a Julia program to generate a plot of mathematical equation: y = sin(x) + sin(2x). c. Develop a Julia program to generate multiple plots of mathematical equations: y = sin(x) + sin(2x) and y = sin(2x) + sin(3x).

Course Outcomes: After completing the course, the students will be able to	
CO1	Understanding of fundamental programming concepts and syntax relevant to problem-solving.
CO2	Apply appropriate programming constructs, libraries, and tools to implement solutions for problems.
CO3	Analyze the efficiency, scalability, and accuracy of solutions using different programming approaches or data structures.
CO4	Evaluate the performance of the programs through debugging, testing, and optimization techniques.
CO5	Develop software solutions or applications that integrate advanced programming concepts to address real-world or domain-specific problems.

Suggested Learning Resources:
https://doi.org/10.1007/978-3-030-73936-2, 2021. https://doi.org/10.1007/978-1-4842-3171-5,2017

CO – PO MAPPING

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

Semester : IV					
MERN					
Course Code	:	BAD408C	**Credits**	:	1
Hours/Week (L:T:P)	:	0:0:2	**CIE**	:	50 Marks
Total Hours	:	15 Hrs	**SEE**	:	50 Marks
Course Type	:	AEC	**SEE Duration**	:	2 Hours

Prerequisites: Courses	Object oriented programming with Java, Web application development using HTML and PHP
Knowledge on Fundamental Concepts	Object oriented programming basic concepts, HTML Tags
Knowledge on Connected Tools (If any)	-

Course Learning Objectives: This course will enable the students to	
CLO1	Insight on web development languages and tools to create dynamic and responsive web applications
CLO2	Exposure the server-side applications using Node.js and Express
CLO3	Fundamental knowledge of user interfaces with React.js
CLO4	Showcases full-stack developments in frontend and backend process.
CLO5	Manage data using MongoDB, and integrate these technologies to create full stack apps

Sl.No.	**Experiments**
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	Read the data of a student containing usn, name, sem, year_of_admission from node js and store it in the mongodb b. For a partial name given in node js, search all the names from mongodb student documents created in Question(a)
5	a. Write a program to check request header for cookies. b. Write node.js program to print the a 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 and find_cube_100 which prints prime numbers less than 100 and cubes less than 100 using Express JS routing mechanism

8	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.
9	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. DELETE /:id: Deletes a product. Add middleware to log requests to the console. Use express.json() to parse incoming JSON payloads.
10	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 componentDidMount (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	Understand the routing, software and constructing RESTful APIs to solve real world problems.
CO2	Apply the fundamentals of MongoDB, such as data modelling, CRUD operations, and basic queries to solve given problem.
CO3	Develop scalable and efficient RESTful APIs using NodeJS.
CO4	Illustrate applications using React, including components, state, props, and JSX syntax.
CO5	Use constructs of React.js, including routing, software and constructing RESTful APIs to solve real world problems.

Suggested Learning Resources:
● https://www.geeksforgeeks.org/mern-stack/ ● https://blog.logrocket.com/mern-stack-tutorial/

CO PO MAPPING

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

Semester: IV					
Technical Writing using LaTeX					
Course Code	:	BIS408D	**Credits**	:	1
Hours/Week(L:T:P)	:	0:0:2	**CIE**	:	50Marks
Total Hours	:	12P	**SEE**	:	50Marks
Course Type	:	AEC	**SEE Duration**	:	2 Hours

Prerequisites:	
Courses	**Technical English.**
Knowledge on Fundamental Concepts	**Document structure and Algorithm presentation.**
Knowledge on Connected Tools (If any)	TeXStudio, MiKTeX.

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the fundamentals of LaTeX and its role in scientific and academic documentation.
CLO2	Work with documents that contain sections, tables, figures, and math content to format them properly.
CLO3	Use LaTeX to include referencing, theorem Environments, and bibliographies in documents.
CLO4	Prepare documents with clear structure, such as reports, articles, and project files.
CLO5	Utilize LaTeX packages for drawing diagrams, writing algorithms, and preparing conference templates.

Sl. NO	**Experiments**
1	Develop a LaTeX script to create a simple document that consists of 2 sections [Section1, Section2], and a paragraph with dummy text in each section. And also include header [title of document] and footer [institute name, page number] in the document.
2	Develop a LaTeX script to create a document that contains the following table with proper labels.

S.No	USN	Student Name	Marks (Subjects of 4th Semester)		
			Subject1	Subject2	Subject3
1	1XX22XX001	Name1	89	60	90
2	1XX22XX002	Name2	78	45	98
3	1XX22XX003	Name3	67	55	59

3	Develop a LaTeX script to include the side by side graphics /pictures /figures in the document by using the sub graph concept.
4	Develop a LaTeX script to create a document that consists of the following two mathematical equations $x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$ $= \frac{-2 \pm \sqrt{2^2-4*(1)*(-8)}}{2*1}$ $= \frac{-2 \pm \sqrt{4+32}}{2}$ $\varphi_\sigma^\lambda A_t = \sum_{\pi \in C_t} \operatorname{sgn}(\pi) \varphi_\sigma^\lambda \varphi_\pi^\lambda$ $= \sum_{\tau \in C_{\sigma t}} \operatorname{sgn}(\sigma^{-1}\tau\sigma) \varphi_\sigma^\lambda \varphi_{\sigma^{-1}\tau\sigma}^\lambda$ $= A_{\sigma t} \varphi_\sigma^\lambda$

5	Develop a LaTeX script to demonstrate the presentation of Numbered theorems, definitions, corollaries, and lemmas in the document.
6	DevelopaLaTeXscripttocreateadocumentthatconsistsoftwoparagraphswithaminimumof10 citations in it and display the reference in the section.
7	Develop a LaTeX script to design a simple tree diagram or hierarchical structure in the document with appropriate labels using the Tikz library.
8	DevelopaLaTeXscripttopresentanalgorithminthedocumentusingalgorithm/algorithmic/algorithm2e library
9	Develop a LaTeX script to create a simple title page of the VTU SJCIT project Report [Use suitable Logos and text formatting].
10	Develop a LaTeX script to create the Certificate Page of the Report of SJCIT [Use suitable commands to leave the blank spaces for user entry].
11	Develop a LaTeX script to create a simple report and article by using suitable commands and formats of user choice.
12	Develop a LaTeX script to create an article of IEEE/Springer (Conference) template.

Course Outcomes: After completing the course, the students will be able to	
CO1	Create well-structured documents using LaTeX including sections, headers, and footers.
CO2	Design and format tables, figures, mathematical content, and bibliographies.
CO3	Demonstrate LaTeX libraries to include graphics, theorems, and reference management.
CO4	Develop technical and academic documents such as reports and project files.
CO5	Apply advanced LaTeX packages like TikZ, algorithmic environments, and IEEE templates.

Text Book	
1	A Short Introduction to LaTeX :A book for beginners ,Firuza Karmali (Aibara), Createspace Independent Publishing Platform,2019, ISBN-13 : 978-1543162646.
Reference Book	
1	Formatting Information: A Beginner's Introduction to Typesetting with LaTeX, Peter Flynn, 1st edition,2005, Comprehensive TeX Archive Network.

Web links and Video Lectures (e – Resources)	
1	https://latex-tutorial.com/tutorials/
2	https://www.javatpoint.com.cach3.com/what-is-latex.html
3	https://www.youtube.com/watch?v=ydOTMQC7np0

CO – PO MAPPING

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

Semester: IV						
Metaphysical Science						
Course Code	**:**	BMP409		**Credits**	**:**	01
Hours/Week(L:T:P)	**:**	1:0:0		**CIE**	**:**	50 Marks
Total Hours	**:**	15 Hrs		**SEE**	**:**	50 Marks
Course Type	**:**	HSSMC		**SEE Duration**	**:**	01 Hr.

Course Learning Objectives: This course will enable the students to	
CLO1	Explore the philosophical and spiritual aspects of the universe.
CLO2	Compare and contrast ontological & **Epistemology** theories
CLO3	Analyze metaphysical perspectives on time, space, and the origin of the universe.
CLO4	Inculcate the Metaphysical inquiries into the nature of mind and consciousness.
CLO5	Apply and analyze the nature of reality, existence, and universe beyond the physical sciences.

Module 1	**03 Hrs**
Introduction to Metaphysics: Definition **of Metaphysics**, scope, and historical roots (Aristotle, Plato, Kant). Distinction between metaphysics, physics and spirituality. **Branches of Metaphysics:** Ontology, cosmology, epistemology, and their interconnections. **Key Metaphysical Questions:** Why is there something rather than nothing? The nature of abstract entities (numbers, moral values). **Textbook2, Ch.1&2**	
Module 2	**03 Hrs**
Ontology & Epistemology **Ontology (Study of Being):** Materialism vs. Idealism vs. Dualism, The Problem of Universals (Realism vs. Nominalism). **Epistemology (Study of Knowledge):** Rationalism (Descartes) vs. Empiricism (Locke, Hume). Theories of truth (Correspondence, Coherence, Pragmatic). **Skepticism & Constructivism:** Can we truly know reality? (Descartes' Evil Demon, Simulation Theory). **Textbook2, Ch.3-5**	
Module 3	**03 Hrs**
Cosmology – Metaphysical Perspectives on the Universe Philosophical cosmology vs. physical cosmology, Metaphysical views on time, space, and the origin of the universe, The Anthropic Principle and Fine-Tuning debate, Creation, causality, and the infinite regress problem, Multiverse theory and its metaphysical implications, Spiritual and ancient cosmologies: Vedic, Taoist, and Indigenous models. **Textbook1, Ch.1, Textbook2, Ch.6-7**	
Module 4	**03 Hrs**
Mind and Consciousness Definition of mind and consciousness, Mind-body problem: Dualism vs. Physicalism, Theories of consciousness: Integrated Information Theory (IIT), Global Workspace, Panpsychism, Eastern and Western views of the self and mind; Artificial intelligence and	

machine consciousness, Role of consciousness in observation and decision-making. **Textbook1, Ch.2, Textbook2, Ch.8**	
Module 5	**03 Hrs**
Quantum Healing and Energy Medicine Basics of quantum mechanics (superposition, entanglement, observer effect), Quantum theory and the mind: Role of consciousness in quantum collapse, Overview of Quantum Healing – Deepak Chopra's model, Energy fields: Biofield theory, chakras, subtle energy systems, Placebo effect, intention and non-local healing, Implications for engineering bio-resonant technologies. **Textbook1, Ch. 3-15**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Assess the nature of reality, existence and the universe.
CO2	Evaluate the competing **ontology** and epistemological frameworks.
CO3	Interpret the various multiverse models and their philosophical significance.
CO4	**Analyze** the *mind-body problem* and theories of consciousness.
CO5	Differentiate the theoretical and practical intersections between quantum physics, quantum healing and meditation.

Text Books	
1	Quantum Metaphysics, Tarja Kallio-Tamminen, ISBN 952-10-1927-1 Otamedia, Oy 2004.
2	Metaphysics-A Very Short Introduction, Stephen Mumford, Sl. No. 20129780191640261, 0191640263, OUP Oxford, 2012

Reference Books	
1	Deepak Chopra M.D., Quantum Healing (Revised and Updated): Exploring the Frontiers of Mind/Body Medicine, 2015.
2	Deepak Chopra M.D., Quantum Body: The New Science of Living a Longer, Healthier, More Vital Life, 2023.

Weblinks	
1	**https://www.yogajournal.com/meditation/**
2	**https://youtube.com/shorts/JgCVh6wwgNg?si=R87-PGIrUSII774w**
3	**https://www.youtube.com/watch?v=XvyuUqlX7fE**
4	**https://core.ac.uk/download/pdf/14914967.pdf**
5	**https://www.youtube.com/watch?v=_ba0yIAZ9ok**
6	**https://www.youtube.com/watch?app=desktop&v=fzxohf49loU**
7	**https://www.youtube.com/watch?v=SSGKowtXS3Y**
8	**https://www.youtube.com/watch?v=r_piRatnFlY**

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CO–PO Mapping

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

Semester: IV						
National Service Scheme						
Course Code	**:**	BNS410		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	0:0:2		**CIE**	**:**	100 Marks
Total Hours	**:**	24		**SEE**	**:**	-
Course Type	**:**	NCMC		**SEE Duration**	**:**	-

Course Learning Objectives: This course will enable the students to	
CLO1	Understand the community in general in which they work
CLO2	Identify the needs and problems of the community and involve them in problem – solving
CLO3	Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions t
CLO4	Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
CL05	Appraise the importance of ethical issues and team working abilities pertaining to the social services

Activity– 1	**08 Hrs**
Water conservation techniques – Role of different stakeholders– Implementation	
Activity – 2	**08 Hrs**
Preparing an actionable business proposal for enhancing the village income and approach for implementation.	
Activity – 3	**08 Hrs**
Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.	

Pedagogy – Guidelines, it may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution

Sl.	**Topic**	**Group Size**	**Location**	**Activity Execution**	**Reporting**	**Evaluation of the Topic**
1	**Water conservation techniques – Role of different stakeholders – Implementation.**	**May be individual al or team**	**Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.....**	**Site selection /proper consultation/Continuous monitoring/ Information board**	**Report should be submitted by individual to the concerned evaluation authority**	**Evaluation as per the rubrics Of scheme and syllabus by NSS officer**
2	**Preparing an actionable business proposal for enhancing the village income and**	**May be individual al or team**	**Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc.....**	**Group selection /proper consultation/Continuous monitoring/ Information board**	**Report should be submitted by individual to the concerned**	**Evaluation as per the rubrics Of scheme and syllabus by NSS**

	approach for implementation.				**evaluation authority**	**officer**
3	**Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.**	**May be individual or team**	**Local government / private/ aided schools/Government Schemes officers/ etc.....**	**School selection/pro per consultation/Continuous monitoring/ Information board**	**Report should be submitted by individual to the concerned evaluation authority**	**Evaluation as per the rubrics Of scheme and syllabus by NSS officer**

Plan of Action (Execution of Activities for 4th Semester)

Sl. No.	Practice Session Description
1.	**Lecture session by NSS Officer**
2.	**Selection of topic, Commencement of activity and its progress**
3.	**Execution of Activity**
4.	**Case study based Assessment, Individual performance**
5.	**Sector wise study and its consolidation**
6.	**Video based seminar for 10 minutes by each student At the end of semester with Report.**

- **In the 4th semester, each student should do activities according to the scheme and syllabus.**
- **At the end of the semester student performance has to be evaluated by the NSS Officer for the assigned activity progress and its completion.**
- **At the end of the 4th semester, consolidated report of all activities compiled report should be submitted as per the instructions.**

Course Outcomes: After completing the course, the students will be able to	
CO1	Exploit the importance of his / her responsibilities towards society.
CO2	Analyze the environmental and societal problems/issues and will be able to design solutions for the same.
CO3	Evaluate the existing system and to propose practical solutions for the same for sustainable development.
CO4	Implement government or self-driven projects effectively in the field of societal problems.
CO5	Appraise the importance of ethical issues and team working abilities pertaining to the social services.

Assessment Details for CIE (100 Marks)

Weightage	CIE- 100 Marks
Selection of Topic, Commencement of activity and its progress	**40 Marks**
Case study based Assessment	**20 Marks**
Sector wise study and its consolidation	**20 Marks**
Video based seminar for 10 minutes by each student at the end of semester with Report	**20 Marks**
Total Marks for the course in each semester	**100 Marks**

Suggested Learning Resources:	
Books:	
1	NSS Course Manual, Published by NSS Cell, VTU Belagavi.
2	Government of Karnataka, NSS cell, activities reports and its manual.
3	Government of India, NSS cell, Activities reports and its manual.

CO-PO Matrix

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

Semester: IV						
Physical Education (PE) (Sports & Athletics)						
Course Code	:	BPE410		**Credits**	:	0
Hours/Week(L:T:P)	:	0:0:1		**CIE**	:	100 Marks
Total Hours	:	24		**SEE**	:	-
Course Type	:	NCMC		**SEE Duration**	:	-

Course Learning Objectives: This course will enable the students to	
CLO1	Develop an understanding of ethical principles and moral values and their importance in sportsmanship, fair play, and personal conduct in games and athletic activities.
CLO2	Acquire practical skills and demonstrate technical proficiency in selected sports or athletic events through structured physical training and performance.
CLO3	Understand the role of effective organization, administration, and management in the successful conduct of sports events and athletic programs.

Module – 1	**4 Hrs**
Ethics and Moral Values A. Ethics in Sports B. Moral Values in Sports and Games	
Module – 2	**16 Hrs**
Specific Games (Any one to be selected by the student) A. Volleyball – Attack, Block, Service, Upper Hand Pass and Lower hand Pass. B. Athletics (Track Events) – Any event as per availability of Ground	
Module-3	**4 Hrs**
Role of Organization and administration	

Course Outcomes: After completing the course, the students will be able to	
CO1	Understand the principles of ethics and moral values and their application in sports and games.
CO2	Demonstrate fundamental skills, techniques and rules of the selected game or athletic event.
CO3	Apply sportsmanship, fairness and respect for rules during practice and competition
CO4	Analyze the role of organization and administration in conducting sports events effectively
CO5	Develop teamwork, leadership and decision-making skills through participation in sports activities

Scheme and Assessment for auditing the course and Grades:

Sl. No.	Activity	Marks
1.	Participation of student in all the modules	20
2.	Quizzes – 2, each of 15 marks	30
3.	Final presentation / exhibition / Participation in competitions/ practical on specific tasks assigned to the students	50
	Total	**100**

CO – PO MAPPING

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

Semester: IV						
Yoga						
Course Code	:	BYO410		**Credits**	:	0
Hours/Week(L:T:P)	:	0:0:2		**CIE**	:	100 Marks
Total Hours	:	12 Hrs		**SEE**	:	-
Course Type	:	NCMC		**SEE Duration**	:	-

Course Learning Objectives: This course will enable the students to	
CLO1	Describe patanjali's ashtanga yoga and its role in holistic well-being.
CLO2	Perform the suryanamaskar sequence with correct breathing and posture.
CLO3	Identify different types of asanas with their techniques and benefits.
CLO4	Utilize the knowledge of kapalabhati with proper technique and safety measures.
CLO5	Apply pranayama techniques to enhance physical and mental health.

Module - 1	**02 Hrs**
Patanjali's Ashtanga Yoga: Introduction, its need and importance, Eight limbs of Yoga – overview, **Yama:** Ahimsa, Satya, Asteya, Brahmacharya, Aparigraha **Niyama:** Shoucha, Santosha, Tapa, Svaadhyaya, Eshvarapranidhana **Text Book 1: Ch. 1 (Part 1)**	
Module - 2	**02 Hrs**
Surya Namaskar: Concept and significance of Surya Namaskar, 12-step Surya Namaskar sequence, Practice - 4 rounds of Surya Namaskar, Breathing coordination and posture alignment. **Text Book 1: Ch. 2 (Part 2)**	
Module - 3	**03 Hrs**
Asanas: Meaning of Asana, Need and importance of practicing Asanas, Classification of Asanas, Sitting Asanas - Sukhasana, Paschimottanasana, Standing Asanas - Ardhakati Chakrasana, Parshva Chakrasana, Prone Line Asana - Dhanurasana, Supine Line Asanas - Halasana, Karna Peedasana, For each Asana - Meaning by name, Technique of performing, Precautionary measures, Benefits **Text Book 1: Ch. 2 (Part 2)**	
Module - 4	**02 Hrs**
Kriyas: Introduction to Shatkarmas (Cleansing practices), Meaning and importance of Kapalabhati, Technique of Kapalabhati (40 strokes/min, 3 rounds), Precautionary measures and benefits. **Text Book 1: Ch. 3 (Part 3)**	
Module - 5	**03 Hrs**
Pranayama: Meaning, need, and importance of Pranayama, Types of Pranayama and their benefits, For each type - Meaning by name, Technique, Precautionary measures, Benefits, Types included – Suryanuloma-Viloma, Chandranuloma–Viloma, Suryabhedana, Chandra Bhedana, Nadishodhana **Text Book 1: Ch. 3 (Part 3)**	
Course Outcomes: After completing the course, the students will be able to	

CO1	Summarize patanjali's ashtanga Yoga and its significance in promoting daily well-being.
CO2	Demonstrate surya namaskar with correct sequence, breathing and posture alignment.
CO3	Classify various types of asanas with their benefits and precautions.
CO4	Utilize the knowledge to practice kapalabhati with correct technique, breathing rhythm and safety guidelines.
CO5	Apply pranayama to improve overall physical fitness and mental wellness.

Text Book	
1	"The Illustrates Light on Yoga" by BKS Iyengar, HarperCollins Publishers, ISBN-81:7223-606-9

Reference Books	
1	Teaching Methods for Yogic practices by Dr. M L Gharote & Dr. S K Ganguly, 4th Edition, Kaivalyadhama Publishers, ISBN-10 : 9788189485245
2	Yoga Instructor Course hand book published by SVYASA University, Bengaluru
3	Yogapravesha in Kannada by Ajitkumar
4	Yoga for Children –step by step – by Yamini Muthanna

Web links and Video Lectures (e – Resources)	
1	https://www.youtube.com/playlist?list=PLzF4lOyPf_Z9yQ_Gphjh1wZ5fEhMg6hmP
2	https://www.youtube.com/playlist?list=PLOzRYVm0a65cCcY4qKX5MIyJxBt7hJgQY
3	https://youtu.be/KB-TYlgd1wE
4	https://youtu.be/aa-TG0Wg1Ls

CO – PO MAPPING

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

Semester: IV					
Music					
Course Code	:	BMU410	**Credits**	:	0
Hours/Week(L:T:P)	:	0:0:2	**CIE**	:	100 Marks
Total Hours	:	26	**SEE**	:	-
Course Type	:	NCMC	**SEE Duration**	:	-

Course Objectives: This course will enable the students to	
1	Understand the foundational concepts of Indian classical music, including the evolution and structure of Shruthi, Nada, Swara, Laya, Raga, Tala and Mela systems.
2	Recognize and describe various types of Carnatic compositions such as Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, along with the basics of the notation system.
3	Appreciate the contributions of key composers like Purandaradasa, Thyagaraja and Mysore Vasudevacharya to Indian music and understand their musical legacy.
4	Identify and explain the classification and basic construction of traditional Indian musical instruments, including string, wind, percussion and idiophones, with appropriate examples.
5	Demonstrate basic vocal proficiency through the practice of Sarale Varase exercises, notations for Suladi Sapta Tala in Mayamalavagowla raga and performance of selected compositions such as Geethe, Jathi Swara and Krithi.

Module -I	**03 Hrs**
Preamble Contents of the curriculum intended to promote music as language to develop an analytical, creative and intuitive understanding. For this the student must experience music through study and direct participation in improvisation and composition. Origin of the Indian Music: Evolution of the Indian music system, understanding of Shruthi, Nada, Swara, Laya, Raga, Tala, Mela **Textbook1, V-1 Ch. 1-4**	
Module – II	**03 Hrs**
Compositions Introduction to the types of composition in Carnatic Music – Geethe, Jathi, Swara, Swarajathi, Varna, Krithi and Thillana, Notation System. **Textbook2 – Ch. 4-7**	
Module –III	**03 Hrs**
Composers Biography and contributions of Purandaradasa, Thyagaraja, Mysoro asudevacharya, Kanakadasa **Textbook3 – Ch. 2-5**	
Module –IV	**03 Hrs**
Music Instruments Classification and construction of string instruments, wind instruments, percussion Instruments, Idiophones (Ghana Vaadya), Examples of each class of instruments. **Textbook1,V-4 – Ch. 2-6**	
Module –V	**14 Hrs**
Abhyasa Gana Singing the swara exercises (Sarale Varase Only), Botatio writing for sarale varase and sulafi sapta tala (Only in mayamalavagowla raga), singing 4 geethe in malahari and one jathi swara, oe krithi in a mela raga	

Textbook1, V-1&2

Course Outcomes: After completing the course, the students will be able to	
CO1	Outline the evolution of Indian music and key concepts like Shruthi, Swara, Raga and Tala.
CO2	Identify and interpret basic Carnatic compositions using standard notation.
CO3	Summarize the contributions of composers.
CO4	Classify Indian musical instruments and describe their construction and use.
CO5	Demonstrate basic Carnatic vocal skills through selected exercises and compositions.

Text Books	
1	South Indian Music – Vol. I to VI, Prof. P. Sambamoorthy, The Indian Music Publishing House, Chennai.
2	A Textbook of Carnatic Music, Dr. S. Bhagyalekshmy, CBH Publications
3	Karnataka Sangeetha Charitre, Dr. V. S. Sampathkumaracharya, Kannada University, Hampi.

Reference Books	
1	Music of India, B. Chaitanya Deva, Munshiram Manoharlal Publishers
2	Essentials of Musicology in South Indian Music, Prof. S. R. Janakiraman, Asian Educational Services

CO – PO MAPPING

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

Semester: IV						
Competency Enhancement Course-2 **Stream: CSE/ECE/ME/CV**						
Course Code	**:**	**BCE411**		**Credits**	**:**	0
Hours/Week(L:T:P)	**:**	2:0:0		**CIE**	**:**	**100 Marks**
Total Hours	**:**	40		**SEE**	**:**	-
Course Type	**:**	NCMC		**SEE Duration**	**:**	-

Prerequisites:	
Courses	**Competency enhancement course-1**
Knowledge on Fundamental Concepts	**Arithmetic operations, fractions, decimals and elementary algebra. comprehension of basic English**
Knowledge on Connected Tools (If any)	**NA**

Course Learning Objectives: This course will enable the students to	
CLO1	Enhance Quantitative Problem-Solving Skills
CLO2	Master Data Interpretation and Visual Analysis
CLO3	Strengthen Logical Reasoning and Spatial Intelligence
CLO4	Develop Advanced Verbal Aptitude and Communication Accuracy
CLO5	Sharpen Critical Thinking through Assumptions and Analytical Judgement

Module – 1	**8 Hrs**

Partnership

Definition of Partnership, Types of Partnerships (Simple and Compound), Calculation of Profit Sharing Ratio, Capital and Time of Investment, Working and Sleeping Partners, Admission and Retirement of Partners, Distribution of Profits and Losses, Partnership Formulas, Complex Partnership Problems.

Time and Work

Definition and Concept of Time and Work, Relation between Work, Time, and Efficiency, Calculation of Individual and Combined Work, Work Rate and Work Done in a Given Time, Efficiency Comparison of Different Workers, Time Taken by Individuals or Groups, Alternate Work and Negative Work (Destructive Work), M:W:D Rule (Men:Work:Days Problems), Work Equivalence Formula, Problems Involving Wages Based on Work, Pipes and Cisterns (Work with Inlets and Outlets), Successive Work Distribution, Complex Time and Work Questions

Coding and Decoding

Letter Coding, Number Coding, Symbol Coding, Mixed Letter-Number Coding, Substitution Coding, Decipher Coding, Direct Coding-Decoding, Conditional Coding, Message Coding, Operations-Based Coding-Decoding, and Complex Coding-Decoding Problem

Analogy

Number Analogy, Alphabet Analogy (using letter sequences or codes), Symbol Analogy, Figure/Pattern Analogy, Geometrical Shapes Analogy, Matrix-Based Analogy, Series-Based Numeric Analogy, Mirror and Water Image Analogy, Classification-Based Figure Analogy, Embedded Figure Analogy, Complex Numerical and Visual Analogy Problems.

Textbook-1, Ch-36

Module – 2	8 Hrs

Time, Speed and Distance

Definition and Relationship of Time, Speed, and Distance, Units and Conversion of Speed and Distance, Average Speed, Relative Speed, Problems on Trains, Problems on Boats and Streams, Upstream and Downstream Concepts, Races and Games, Time to Meet/Opposite Direction Problems, Circular Tracks, Shortcut Tricks and Application-Based Problems.

Trains, Boats and Streams, Races

Trains: Problems on Trains, Time Taken to Cross a Stationary Object, Time Taken to Cross Another Moving Train, Relative Speed in Same and Opposite Direction, Length of Train and Platform Calculations, Speed and Time Conversions, Overtaking and Passing Scenarios, Shortcut Tricks for Train Problems.

Boats and Streams: Upstream and Downstream Concepts, Speed of Boat in Still Water, Speed of Stream, Calculation of Effective Speed (Upstream and Downstream), Time and Distance in Streams, Problems on Boats Overtaking/Meeting, Relative Speed in Water, Application-Based Boat and Stream Questions.

Races: Types of Races (Straight, Circular, Relay), Start Types (Head Start, Dead Heat), Calculating Winner and Margin, Calculation of Lead or Lag, Relative Speed in Races, Time Calculations to Meet or Overtake, Race Completion Time, Use of Ratio and Proportion in Races, Application-Based Race Problems.

Seating Arrangement

Linear Arrangement, Circular Arrangement, Square/Rectangular Arrangement, Single-Row and Double-Row Arrangements, Facing Inside and Outside Arrangements, Arrangement Based on Directions (Left/Right/Clockwise/Counterclockwise), Seating Based on Conditions or Constraints, Position and Order Determination, Seating with Blood Relations or Attributes, Arrangement with Vacant Seats.

Data Arrangement

Linear Data Arrangement, Circular Data Arrangement, Matrix/Table-Based Data Arrangement, Parallel/Double Row Arrangement, Attributes/Property-Based Arrangement (with multiple characteristics), Sequencing and Ranking Arrangement, Floor/Building Arrangement, Conditional Arrangement (with Direct and Indirect Clues), Application of Consolidated Table and Matrix Methods.

Textbook -1, Ch-14-18

Module-3	8 Hrs

Permutation and Combination

Understanding the difference between the permutation and combination, Rules of Counting-rule of addition, rule of multiplication, factorial function, Concept of step arrangement, Permutation of things when some of them are identical, Concept of 2n, Arrangement in a circle.

Probability

Single event probability, multi event probability, independent events and dependent events, mutually exclusive events, non-mutually exclusive events, combination method for finding the outcomes.

Clocks and Calendars

Clocks: Calculation of Angle Between Hands (Hour, Minute, Second), Time Gains and Losses by Clocks, Number of Times Hands Coincide or Oppose, Incorrect/Slow/Fast Clocks, Mirror and Water Image Questions on Clocks, Alarm and Time Calculation Problems, Calculation of Overlapping/Adjacent Hands, Problems on Clock Striking.

Calendars: Odd Days Concept, Leap Year and Ordinary Year Calculation, Counting Odd Days in Multiple Years, Day of the Week Calculation for a Given Date, Calendar Repetition, Month and Year Code Methods, Finding Dates with Same Day, Calculation of Future/Past Day from a Given Day, Number of Sundays/Saturdays/Specific Weekdays in a Period, Day-Difference Problems.

Textbook -1, Ch6-9 & 13-16

Module-4	**8 Hrs**

Data Interpretation

Tables, Bar Graphs, Line Graphs, Pie Charts, Caselets (Paragraph-based Data Sets), Radar Charts, Mixed or Combination Graphs (Multiple Data Forms Together), Data Comparison and Analysis, Calculation-Based Data Interpretation, Ratio and Percentage Interpretation, Data Sufficiency in Data Interpretation.

Ages

Present age and future age calculations, past age calculations, age problems in ratios, age difference problems, multiple or submultiple age relations, product of ages problems, age problems involving sum of ages, age relationships in family contexts, age-based word problems with equation formulation, and age problems involving time intervals such as years ago or years hence.

Crypt arithmetic

Basic concepts, addition, subtraction, multiplication of coded alphabets, Types of cryptarithm.

Syllogisms

Basic Concepts of Syllogism, Types of Statements (A, E, I, O), Venn Diagram Representation, Rules of Syllogism, Direct and Indirect Syllogism Questions, Condition-based Syllogism, Coded Syllogism, Double/Triple Syllogism Problems, Syllogism with Quantifiers, Syllogism in Data Interpretation, and Conclusions Drawing from Statements.

Textbook -1, Ch28-29

Module-5	**8 Hrs**

Mensuration

Basic Geometrical Figures, Perimeter and Area of Plane Figures (Square, Rectangle, Triangle, Parallelogram, Rhombus, Trapezium), Area and Circumference of Circle, Area of Sector and Segment of a Circle, Surface Area and Volume of Cuboid, Surface Area and Volume of Cube, Surface Area and Volume of Cylinder, Surface Area and Volume of Cone, Surface Area and Volume of Sphere and Hemisphere, Frustum of a Cone, Conversion between Units of Measurement, Application-Based Problems on Mensuration.

Data sufficiency

Statement Evaluation, Identifying Sufficient and Insufficient Statements, Dealing with Irrelevant Information, Definite vs. Indefinite Information, Elimination Method, Data Sufficiency on Blood Relations, Data Sufficiency on Order and Ranking, Data Sufficiency on Direction and Distance, Data Sufficiency on Coding-Decoding, Data Sufficiency on Seating Arrangement, Data Sufficiency on Puzzles, Data Sufficiency on Syllogism, Data Sufficiency on Alphanumeric Series.

Visual Reasoning and Cubes

Visual Reasoning: Figure/Image Series Completion, Odd-One-Out (Visual Discrimination), Mirror Images, Water Images, Embedded Figures, Paper Folding and Cutting, Analytical Puzzles with Patterns, Figure Counting, Pattern Completion, Analogy in Figures, Classification of Visual Data, Venn Diagrams, Direction and Distance with Visuals.

Cubes: Basic Properties of Cubes (Faces, Vertices, Edges), Cube and Dice Basics, Counting of Smaller Cubes, Painted Cube Problems (Counting Cubes with 0/1/2/3

Painted Faces), Cube Cutting and Partitioning, Dice (Number/Colour/Letter Arrangements), Unfolded (Net) Cube to Folded Cube Problems, Opposite and Adjacent Faces of Dice, Identification of Hidden Surfaces, Face Rotation and Positioning, Shortcuts and Tricks for Cubes and Dice Problems

Para Jumbles and Cloze Test

Sentence Jumble/Ordering, Identification of Opening/Closing Sentences, Logical Sequencing and Linking, Transitional Words and Connectors, Theme Identification in Jumbled Passages, Cloze Test with Contextual Blanks, Vocabulary and Grammar-based Blanks, Contextual Inference for Blank Filling, Error Detection in Cloze Test.

Reading Comprehension

Main Idea Identification, Factual/Inference-based Questions, Tone and Attitude Analysis, Vocabulary in Context, Passage Summarization, Structure and Organization of Passage, Logical Completion of Paragraphs, Supporting/Contradicting Evidence, Eliminating Irrelevant Information, Comparative Comprehension Passages.

Critical Reasoning

Assumption-Based Questions, Strengthen/Weaken the Argument, Inference Drawing, Conclusion Identification, Evaluating Arguments and Evidence, Identifying Flaws in Reasoning, Paradox/Discrepancy Resolution, Cause-and-Effect Reasoning, Analogy and Parallel Reasoning, Application of Logical Principles.

Textbook 1,Ch22-25, Textbook 2 & 3

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply arithmetic and logical reasoning to solve problems.
CO2	Develop spatial and logical skills to solve cube, dice, puzzle and seating arrangement questions.
CO3	Develop reading, vocabulary and grammar through para jumbles, sentence completion and idioms.
CO4	Enhance verbal reasoning by solving analogies, rearranging sentences and identifying assumptions and conclusions.
CO5	Apply combinatorics and probability to solve permutation, combination and crypt arithmetic problems.

Text Books	
1	**Quantitative Aptitude for Competitive Examinations,** R.S. Aggarwal Chand Publishing. – 2023.
2	**Word Power Made Easy,** Norman Lewis, Published by PENGUIN INDIA – 2015, (ISBN- 978-0143424680)
3	**How to Prepare for Quantitative Aptitude for the CAT,** Arun Sharma 6th Edition, McGraw-Hill Education – 2014, (ISBN- 978-9339205126)

Reference Books	
1	**Puzzle Test & Seating Arrangements,** K. Kundan,1st Edition, BSC Publishing Company Pvt Ltd. – 2023, (ISBN: 9789394666023)
2	**A Modern Approach to Verbal & Non-Verbal Reasoning,** R.S. Aggarwal, 2025-26 Edition, S. Chand Publishing -2024
Web links and Video Lectures (e – Resources)	
1	https://youtu.be/KWZ0lR8cCwc
2	https://youtu.be/mBtBD1N7ywQ
3	https://youtu.be/B9MhxmcwnpQ
4	https://youtu.be/VaEbefWFIlc
5	https://youtu.be/3AL_6EQmnkY

CO – PO MAPPING

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

Prerequisites:	
Courses	Problem Solving through Programming and Data Structures and Application
Knowledge on Fundamental Concepts	Programming skills, Data structures
Knowledge on Connected Tools (If any)	Editor

Course Learning Objectives: This course will enable the students to	
CLO1	Learn the methods for analyzing the fundamentals of algorithmic problem solving, algorithm efficiency, and important problem.
CLO2	Apply and implement various algorithmic paradigms including brute force, divide and conquer, decrease and conquer, and transform and conquer to solve computational problems.
CLO3	Develop solutions using advanced techniques such as dynamic programming and greedy algorithms for optimization and graph-related problems
CLO4	Evaluate and compare algorithmic strategies considering time–space trade-offs, efficiency classes, and mathematical analysis of recursive and non-recursive algorithms.
CLO5	Classify and apply methods for handling limitations of algorithmic power, including P, NP, NP-complete classes, backtracking, branch-and-bound, and approximation algorithms.

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

An Autonomous Institution under VTU from 2024-25

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