BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE New Delhi)

Yelahanka, Bengaluru 560064

Bachelor of Engineering

Department of Artificial Intelligence & Machine Learning

IV Semester Scheme and Syllabus
2022 Scheme
Effective from the AY 2023-24

Approved in the BoS meeting held on 04/04/2024

Vision and Mission of the Department

Vision:

To develop professionals equipped to build sustainable and intelligent solutions that effectively interact with natural intelligence towards creating a digitally empowered environment for future generations, safeguarding social ethics.

Mission:

- To enable students with the spirit and power of interdisciplinary acumen by integrating a world of knowledge into a world of intelligent systems and subsystems.
- Boost academic outcome through place-based education and collaborations with established research labs and industries.
- Encourage entrepreneurship efforts among students and develop them into great leaders.

Program Educational Objectives (PEOs)

PEO'S	
PEO1	Possess essential professional engineering skills that make them confident to develop high-quality AI solutions for various application domains under realistic constraints.
PEO2	Demonstrate the importance of life-long learning through professional development, computing practises, and specialized certifications
PEO3	Engage and succeed in their professional careers through teamwork, ethical behaviour, proactive involvement, and effective communication.

Program Specific Outcomes (PSOs)

PSO'S	
PSO-1	Ability to apply acquired skills to build optimized solutions adhering to principles and practices of Computational Intelligence.
PSO-2	Employ ethical strategies and policies in project and product development.

BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(An Autonomous Institution Affiliated to VTU, Belagavi)
Avalahalli, Doddaballapur Main Road, Bengaluru – 560064

Date: 16.10.2023

CONTINUOUS INTERNAL EVALUATION AND SEMESTER END EXAMINATION PATTERN: 2022 BATCH ONWARDS

All students of 2022 scheme onwards are hereby informed to note the following with reference to Continuous internal evaluation and Semester end examination: The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The Minimum passing mark for the CIE is 40% of the Maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

IPCC COURSES: 4 CREDITS AND 3 CREDITS						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scale down to**	**Min. Marks to be Scored**	**Evaluation Details**
Theory Component	CIE – IA Tests	CIE – Test 1 (1.5 hr)	40	15	06	Average of two internal assessment tests each of 40 marks, scale down the marks scored to 15 marks
		CIE – Test 2 (1.5 hr)	40			
	CIE – CCAs (Comprehensive Continuous Assessment)	CCA -1	10	10	04	Any two assessment methods as per clause 22OB4.2 of regulations (if assessment is project based, then one assessment method may be adopted)
		CCA-2	10			
	Total CIE Theory			**25**	**10**	Scale down marks of tests and CCAs to 25
Practical Component	CIE - Practical		-	15	06	Conduction of experiments and preparation of laboratory records etc.
	CIE Practical Test		50	10	04	One test after all experiment's to be conducted for 50 marks
	Total CIE Practical			**25**	**10**	Scale down marks of experiments, record and test to 25
Total CIE Theory + Practical				50	20	
SEE			100	50	18	SEE exam is a theory exam, conducted for 100 marks, scored marks are scaled to 50 marks
CIE + SEE				**100**	**40**	
The minimum marks to be secured in CIE to appear for SEE shall be 10 (40% of maximum marks-25) in the theory component and 10 (40% of maximum marks -25) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included in their respective modules only.						

Professional Core Course (PCC) courses: 03 and 02 Credit Courses						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scale down to**	**Min. Marks to be Scored**	**Evaluation Details**
Theory Component	CIE – IA Tests	CIE – Test 1 (1.5 hr)	40	25	10	Average of two internal assessment tests each of 40 marks, scale down the marks scored to 25 marks.
		CIE – Test 2 (1.5 hr)	40			
	CIE - CCAs	CCA -1	25	25	10	Any two assessment methods as per clause 220B4.2 of regulations (if it is project based, one CCA shall be given)
		CCA-2	25			
	Total CIE Theory			**50**	**20**	
SEE			100	50	18	SEE exam is a theory exam, conducted for 100 marks, scored marks are scaled down to 50 marks
CIE + SEE				**100**	**40**	

NON IPCC COURSES: 01 Credit Courses-MCQ						
Evaluation Type		**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scale down to**	**Min. Marks to be Scored**	**Evaluation Details**
Continuous Internal Evaluation Component	CIE – IA Tests (MCQs)	CIE – Test 1 (1 hr)	40	25	10	Average of two internal assessment tests each of 40 marks, scale down the marks scored to 25 marks
		CIE – Test 2 (1 hr)	40			
	CIE - CCAs	CCA -1	25	25	10	Any two assessment methods as per clause 220B4.2 of regulations
		CCA-2	25			
	Total CIE Theory			**50**	**20**	
SEE (MCQ Type)				50	18	MCQ-type question papers of 50 questions with each question of 01 mark, examination duration is 01 hour
CIE + SEE				**100**	**40**	

Professional Core Course Laboratory (PCCL) course- 01 credit					
Evaluation Type	**Internal Assessments (IAs)**	**Test/ Exam Marks Conducted for**	**Marks to be scale down to**	**Min. Marks to be Scored**	**Evaluation Details**
Continuous Internal Evaluation	CIE - Practical	-	30	-	Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments shall be approved by the PAC and are made known to students at the beginning of the practical session. Record should contain all the specified experiments in the syllabus. Total marks scored by the students are scaled down to 30 marks (60% of maximum marks).
	CIE Practical Test	100	20	-	Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus. In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce. The suitable rubrics can be designed to evaluate each student's performance and learning ability by PAC. The marks scored shall be scaled down to 20 marks (40% of the maximum marks).
	Total CIE	-	**50**	**20**	
Semester End Examination		100	**50**	**18**	General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result - 60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (Rubrics shall be approved by the PAC)
CIE+SEE		**100**	**50**	**40**	

Computer Aided Engineering Drawing (BCEDK103/BCEDK203): 3 credit								
Evaluation Type		**Topics/Modules**	**Computer Printout**	**Preparatory Sketch**	**Max Marks**	**Total Marks**	**Marks to be Scaled Down to**	**Min Marks to Pass**
CIE	**Sketchbook and CAD Modelling**	Projection of Points	10	05	15	200	20	08
		Projection of Lines	10	10	20			
		Projection of Planes	20	15	35			
		Projection of Solids	40	20	60			
		Isometric Projections	20	15	35			
		Development of lateral surfaces	20	15	35			
	Test 1	Module 1 & 2	24	06	30	70	20	08
		Module 3	32	08	40			
	Test 2	Module 3	32	08	40	70		
		Module 4	24	06	30			
	CCA 1	Module 5	08	02	10	10	10	04
	CCA 2	Module 5	08	02	10			
	CIE Total						**50**	**20**
SEE		Module 1 & 2	24	06	30	**100**	**50**	**20**
		Module 3	32	08	40			
		Module 4	24	06	30			
CIE + SEE							**100**	**40**

Computer Aided Modelling for Manufacturing (BME305): 1 credit								
Evaluation Type		**Module**	**Computer Printout**	**Preparatory Calculations / Sketch**	**Max Marks**	**Total Marks**	**Marks to be Scaled Down to**	**Min Marks to Pass**
CIE	**Sketchbook and CAD Modeling**	Module 1	60	30	90	200	20	08
		Module 2	40	20	60			
		Module 3	40	10	50			
	Test 1	Module 1	20	10	30	60	20	08
		Module 2	20	10	30			
	Test 2	Module 1	20	10	30	60		
		Module 3	20	10	30			
	CCA	Module 1	30	10	40	40	10	04
	Total CIE						**50**	**20**
SEE		Module 1	30	10	40	100	**50**	**20**
		Module 2	20	10	30			
		Module 3	20	10	30			
CIE + SEE							**100**	**40**

220B 4.2 Continuous Internal Evaluation (CIE)

1) For a theory course, with an L-T-P distribution of L-0-0, the CIE will carry a maximum of 50% weightage of the total marks of a course. Before the start of the Academic session of each Semester, a faculty may choose for his course Internal Assessment Test and a minimum of two of the following assessment methods with suitable weightage for each

i) Assignments (Individual and /or Group)

ii) Seminars

iii) Oral/ Online Quizzes

iv) Group Discussions

v) Case studies/ Case lets

vi) Practical orientation on Design Thinking, Creativity & Innovation

vii) Participatory & Industry – integrated learning

viii) Practical activities/ problem-solving exercises

ix) Class presentations

x) Analysis of Industry/ Technical/ Business Reports

xi) Reports on Guest Lectures/ Webinars/ Industrial Visits

xii) Industrial/ Social/ Rural projects

xiii) Participation in Seminars/ Academic Events/ Symposia, etc.

xiv) Any other academic activity

CoE 18/10/2023

Dean (AA) 18.10.2023

Principal 18/10

Scheme of IV Semester

BMS INSTITUTE OF TECHNOLOGY AND MANAGEMENT

(Autonomous Institute affiliated to VTU)

Scheme of Teaching and Examination: Effective from AY 2023 – 24

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

UG PROGRAM: BE Artificial Intelligence and Machine Learning (AI&ML) | **Semester: IV**

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Self - Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	PCC/BSC	BCS401	Analysis & Design of Algorithms	TD : AI PSB : CS	3	0	0	0	03	50	50	100	3
2	IPCC	BAI402	Artificial Intelligence	TD : AI PSB : CS	3	0	2	0	03	50	50	100	4
3	IPCC	BCS403	Database Management Systems	TD : AI PSB : CS	3	0	2	0	03	50	50	100	4
4	PCCL	BCSL404	Analysis & Design of Algorithms Lab	TD : AI PSB : CS	0	0	2	0	03	50	50	100	1
5	ESC	BXX405x	ESC/ETC/PLC	TD: AI/Maths PSB : CS/Maths	2	2	0	0	03	50	50	100	3
6	AEC/ SEC	BDS456x	Ability Enhancement Course/Skill Enhancement Course- IV	TD : AI PSB : CS	If the course is Theory				01	50	50	100	1
					1	0	0	0					
					If the course is a lab				02				
					0	0	2	0					
4	BSC	BBOC407	Biology For InformationTechnology	TD / PSB: BT, CHE,	2	0	0	0	03	50	50	100	2
7	UHV	BUHK408	Universal human values	Any Department	1	0	0	0	01	50	50	100	1
9	MC	BNSK459	National Service Scheme (NSS)	NSS coordinator	0	0	2	0	02	100	---	100	0
		BPEK459	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		BYOK459	Yoga	Yoga Teacher									
		BMUK459	Music	Music Teacher									
		BNCK459	NCC	NCC coordinator									
									Total	**500**	**400**	**900**	**19**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability
Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation. K :This letter in the course code indicates common to all the stream of engineering.

Ability Enhancement Course / Skill Enhancement Course – IV			
BDSL456A	Scala	BDSL456C	MERN
BDSL456B	MongoDB	BDSL456D	Julia
Engineering Science Course (ESC/ETC/PLC)			
BCS405A	Discrete Mathematical Structures	BCS405C	Optimization Technique
BAI405B	Metric Spaces	BAI405D	Algorithmic Game Theory

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 /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried outbetween III semester to the VI 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, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the courses is mandatory for the
award of degree.

IV Semester Syllabus

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

Analysis and Design of Algorithms (3:0:0:0) 3
(Effective from the academic year 2023 -24)

Course Code	BCS401	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3 Hours

Course Objectives:
This course will enable students to:

- Explain the methods of analyzing the algorithms and to analyze performance of Algorithms.
- State algorithm's efficiencies using asymptotic notations.
- Solve problems using algorithm design methods such as the brute force method, greedy method, divide and conquer, decrease and conquer, transform and conquer,
- Dynamic programming, backtracking and branch and bound.
- Choose the appropriate data structure and algorithm design method for a specified Application.
- Introduce P and NP classes.

Module – I

Preamble: The advancement in science and technology enhance the performance of processor, which proportionally affect the characteristics of computer system, such as security, scalability and reusability. Important problems such as sorting, searching, string processing, graph problems, Combinational problems, numerical problems are basic motivations for designing algorithm and analyzing it. Since algorithm design techniques are growing at a fast pace, it has become important for IT professionals to upgrade their knowledge in order to meet growing industry demand.

Introduction: What is an Algorithm? It's Properties. Algorithm Specification-using natural language, using Pseudo code convention, Fundamentals of Algorithmic Problem solving, Analysis Framework-Time efficiency and space efficiency, Worst-case, Best-case and Average case efficiency.

Performance Analysis: Estimating Space complexity and Time complexity of algorithms.

Asymptotic Notations: Big-Oh notation (O), Omega notation (Ω), Theta notation ( ) with examples, Basic efficiency classes, Mathematical analysis of Non-Recursive and Recursive Algorithms with Examples problems.

Brute force design technique: Selection sort, sequential search, string matching algorithm with complexity Analysis.

Textbook 1: Chapter 1 (Sections 1.1,1.2), Chapter 2(Sections 2.1,2.2,2.3,2.4), Chapter 3(Section 3.1,3.2)
Textbook 2: Chapter 1(section 1.1,1.2,1.3) (10 Hours)

Module – II

Divide and Conquer: General method, Recurrence equation for divide and conquer, solving it using Master's theorem, Divide and Conquer algorithms and complexity Analysis, Finding the maximum &minimum, Binary search, Merge sort, Quick sort.

Decrease and Conquer Approach: Introduction, Insertion sort, Topological Sorting. It's efficiency analysis.

Textbook 2: Chapter 3(Sections 3.1,3.3,3.4,3.5,3.6)
Textbook 1: Chapter 4 (Sections 4.1,4.2,4.3), Chapter 5(Section 5.1,5.3) (08 Hours)

Module – III

Greedy Method: General method, Coin Change Problem, Knapsack Problem, solving Job sequencing with deadlines Problems.

Minimum cost spanning trees: Prim's Algorithm, Krfloyduskal's Algorithm with performance analysis.

Single source shortest paths: Dijkstra's Algorithm.

Optimal Tree problem: Huffman Trees and Codes.

Transform and Conquer Approach: Introduction, Heaps and Heap Sort.

Textbook 1: Chapter 9

Textbook 2: Chapter 4(Sections 4.1,4.3,4.5,4.6) (08 Hours)

Module – IV

Dynamic Programming: General method with Examples, Multistage Graphs, Knapsack problem, Bellman-Ford Algorithm, Travelling Sales Person problem, Optimal Binary tree method.

Textbook 1: Chapter 8(Section 8.4)

Textbook 2: Chapter 5 (Sections 5.1,5.2,5.4,5.9) (07 Hours)

Module – V

Backtracking: General method, solution using back tracking to N-Queens problem, Sum of subsets problem, Graph coloring, Hamiltonian cycles Problems.

Branch and Bound: Assignment Problem, Travelling Sales Person problem, 0/1 Knapsack problem

NP-Complete and NP-Hard problems: Basic concepts, non- deterministic algorithms, P, NP, NP-Complete, and NP-Hard classes.

Textbook 1: Chapter 12 (Sections 12.1,12.2) Chapter 11(11.3)

Textbook 2: Chapter 7 (Sections 7.1,7.2,7.3,7.4,7.5) Chapter 11 (Section 11.1) (07 Hours)

Course outcomes :

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

CO1.Analyze various algorithms, state the efficiency using asymptotic notations and mathematically represent the complexity of the algorithm.

CO2.Explain the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP-Complete.

CO3.Explain important algorithmic design paradigms (divide-and-conquer, greedy method, dynamic-programming and Backtracking) and apply when an algorithmic design situation calls for it.

CO4 Apply an algorithm using appropriate design strategies for problem solving.

Textbooks

1. Introduction to the Design and Analysis of Algorithms, Anany Levitin: 2nd Edition, 2009. Pearson.
2. Computer Algorithms/C++, Ellis Horowitz, Satraj Sahni and Rajasekaran, 2nd Edition, 2014,Universities Press.

Reference Books

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.
2. Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education)

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

Artificial Intelligence (3:0:2:0) 4
(Effective from the academic year 2023 -24)

Course Code	BAI402	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:2:0	SEE Marks	50
Total Number of Contact Hours	40 hours + 10 hours of practical	Exam Hours	3 Hours

Course Objectives:
This course aims to prepare the students to:

- Gain a historical perspective of AI and its foundations.
- Become familiar with basic principles of AI toward problem solving
- Get to know approaches of inference, perception, knowledge representation, and learning

Module – I

Preamble: Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and act like humans. It involves the development of algorithms and computer programs that can perform tasks that typically require human intelligence such as visual perception, speech recognition, decision-making, and language translation

Introduction: What is AI? Foundations and History of AI

Intelligent Agents: Agents and environment, Good Behaviour: The Concept of Rationality, The nature of environment, The structure of agents**.**

Text book 1: Chapter 1- 1.1, 1.2, 1.3, Chapter 2- 2.1, 2.2, 2.3, 2.4 **(08 Hours)**

Module – II

Problem-solving: Problem-solving agents, Example problems, Searching for Solutions Uninformed Search Strategies: Breadth First search, Depth First Search, Iterative deepening depth first search;

Informed Search Strategies: Heuristic functions, Greedy best first search, A*search. Heuristic Functions

Text book 1: Chapter 3- 3.1, 3.2, 3.3, 3.4, 3.5, 3.6 **(08 Hours)**

Module – III

Logical Agents: Knowledge–based agents, The Wumpus world, Logic, Propositional logic: A Very Simple Logic

First Order Logic: Representation Revisited, Syntax and Semantics of First Order logic, Using First Order logic.

Inference in First Order Logic: Propositional Versus First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution

Text book 1: Chapter 7- 7.1, 7.2, 7.3, 7.4, Chapter 8- 8.1, 8.2, 8.3, Chapter 9- 9.1, 9.2, 9.3, 9.4,9.5 **(08 Hours)**

Module – IV

Uncertain Knowledge and Reasoning: Quantifying Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference using Full Joint Distributions, Independence, Baye's Rule, and its use. Wumpus World Revisited.

Text book 1: Chapter 12 – 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7 **(08 Hours)**

Module – V

Machine Learning: Introduction, Machine – Learning Systems, Supervised & Unsupervised Learnings, Inductive Learning, Deductive Learning, Clustering, Support Vector Machines.

Text Book 2: Chapter 11 – 11.1, 11.2, 11.3, 11.4, 11.5, 11.6, 11.7 (**08 Hours)**

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

NOTE: Programs need to be implemented in python

Sl.NO	Experiments
1	Implement and Demonstrate Depth First Search Algorithm on Water Jug Problem.
2	Implement and Demonstrate Best First Search Algorithm on Missionaries-Cannibals Problems using Python.
3	Implement A* Search & AO* Search algorithms.
4	Solve 8-Queens Problem with suitable assumptions.
5	Implementation of TSP using heuristic approach.
6	Implementation of the problem-solving strategies: either using Forward Chaining or Backward Chaining.
7	Implement resolution principle on FOPL related problems.
8	Implement any Game and demonstrate the Game playing strategies

Course outcomes :

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

CO1: Identify the modern view of Artificial Intelligence and its applications based on agent philosophy.

CO2: Understand the concept of Intelligent agents to solve problems using uninformed and informed search strategies.

CO3: Develop knowledge base sentences using propositional logic and first order logic.

CO4: Describe the concepts of quantifying uncertainty and understand uncertainty handling using probability theory.

CO5: Understand the basics of machine learning using various learning models.

Textbooks

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence – A Modern Approach" , 4th Edition, Pearson Education, 2021.
2. Saroj Kaushik, "Artificial Intelligence", 2nd Edition, Cengage Learning India Pvt. Ltd. 2023

Reference Books

1. George F Lugar, "Artificial Intelligence – Structure and Strategies for Complex Problem Solving, Pearson Education, 6th Edition, 2021.
2. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education (India) Pvt. Ltd. 2016.

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

DATABASE MANAGEMENT SYSTEM (3:0:2:0) 4
(Effective from the academic year 2023 -24)

Course Code	BCS403	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	3:0:2:0	SEE Marks	50
Total Number of Contact Hours	40 hours + 10 hours of practical	Exam Hours	3 Hours

Course Objectives:
This course aims to prepare the students to:

- Provide a strong foundation in database concepts, technology, and practice.
- Practice SQL programming through a variety of database problems.
- Understand the relational database design principles.
- Demonstrate the use of concurrency and transactions in database.
- Design and build database applications for real world problems.
- Become familiar with database storage structures and access techniques.

Module – I

Preamble: A Database Management System (DBMS) is a software system that is designed to manage and organize data in a structured manner. It allows users to create, modify, and query a database, as well as manage the security and access controls for that database. DBMS provides an environment to store and retrieve the data in coinvent and efficient manner.

Introduction to Databases: Introduction, Characteristics of database approach, Advantages of using the DBMS approach, History of database applications.
Overview of Database Languages and Architectures: Data Models, Schemas, and Instances. Three schema architecture and data independence, database languages, and interfaces, The Database System environment. **Conceptual Data Modelling using Entities and Relationships:** Entity types, Entity sets and structural constraints, Weak entity types, ER diagrams, Specialization and Generalization.
Textbook 1:Chapter 1.1 to 1.8, 2.1 to 2.6, 3.1 to 3.10 (08 Hours)

Module – II

Relational Model: Relational Model Concepts, Relational Model Constraints and relational database schemas, Update operations, transactions, and dealing with constraint violations.
Relational Algebra: Unary and Binary relational operations, additional relational operations (aggregate, grouping, etc.) Examples of Queries in relational algebra.
Mapping Conceptual Design into a Logical Design: Relational Database Design using ER-to-Relational mapping.
Textbook 1: Chapter 5.1 to 5.3, Chapter 8.1 to 8.5; Chapter 9.1 to 9.2 ,
Textbook 2: 3.5 (08 Hours)

Module – III

Normalization: Database Design Theory – Introduction to Normalization using Functional and Multivalued Dependencies: Informal design guidelines for relation schema, Functional Dependencies, Normal Forms based on Primary Keys, Second and Third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form.
Textbook 1: Chapter 14.1 to 14.7, Chapter 6.1 to 6.5 (08 Hours)

Module – IV

SQL: SQL data definition and data types, Schema change statements in SQL, specifying constraints in

SQL, retrieval queries in SQL, INSERT, DELETE, and UPDATE statements in SQL, Additional features of SQL

SQL: Advanced Queries: More complex SQL retrieval queries, Specifying constraints as assertions and action triggers, Views in SQL.

Textbook 1: Chapter 7.1 to 7.3, Chapter 20.1 to 20.6 (08 Hours)

Module – V

Transaction Processing: Introduction to Transaction Processing, Transaction and System concepts, Desirable properties of Transactions, Characterizing schedules based on recoverability, Characterizing schedules based on Serializability, Transaction support in SQL.

Concurrency Control in Databases: Two-phase locking techniques for Concurrency control, Concurrency control based on Timestamp ordering, Multiversion Concurrency control techniques, Validation Concurrency control techniques, Granularity of Data items and Multiple Granularity Locking.

Textbook 1:Chapter 21.1 to 21.5, Chapter 24.1 to 24.6 (08 Hours)

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Create a table called Employee & execute the following. **Employee (EMPNO, ENAME, JOB, MANAGER_NO, SAL, COMMISSION)** 1. Create a user and grant all permissions to the user. 2. Insert the any three records in the employee table contains attributes EMPNO, ENAME JOB, MANAGER_NO, SAL, COMMISSION and use rollback. Check the result. 3. Add primary key constraint and not null constraint to the employee table. 4. Insert null values to the employee table and verify the result.
2	Create a table called Employee that contain attributes EMPNO, ENAME, JOB, MGR, SAL & execute the following. 1. Add a column commission with domain to the Employee table. 2. Insert any five records into the table. 3. Update the column details of job 4. Rename the column of Employ table using alter command. 5. Delete the employee whose Empno is 105.
3	Queries using aggregate functions (COUNT,AVG,MIN,MAX,SUM),Group by ,Orderby. **Employee(E_id, E_name, Age, Salary)** 1. Create Employee table containing all Records E_id, E_name, Age, Salary. 2. Count number of employee names from employee table 3. Find the Maximum age from employee table. 4. Find the Minimum age from employee table. 5. Find salaries of employee in Ascending Order. 6. Find grouped salaries of employees.
4	Create a row level trigger for the customers table that would fire for INSERT or UPDATE or DELETE operations performed on the CUSTOMERS table. This trigger will display the salary difference between the old & new Salary. **CUSTOMERS(ID, NAME,AGE,ADDRESS,SALARY)**
5	Create cursor for Employee table & extract the values from the table. Declare the variables ,Open the cursor & extract the values from the cursor. Close the cursor. **Employee(E_id, E_name, Age, Salary)**

Course outcomes:

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

CO1: Describe the basic elements of a relational database management system

CO2: Design entity relationship for the given scenario.

CO3: Apply various Structured Query Language (SQL) statements for database manipulation.

CO4: Analyze various normalization forms for the given application.

CO5: Develop database applications for the given real-world problem.

Textbooks

1. Fundamentals of Database Systems, Ramez Elmasri and Shamkant B. Navathe, 7th Edition, 2017, Pearson.
2. Database management systems, Ramakrishnan, and Gehrke, 3rd Edition, 2014, McGraw Hill

Reference Books

1. 1. Silberschatz Korth and Sudharshan, Database System Concepts, 6th Edition, Mc-GrawHill, 2013.
2. 2. Coronel, Morris, and Rob, Database Principles Fundamentals of Design, Implementation and Management, Cengage Learning 2012.

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

Analysis & Design of Algorithms Lab (0:0:2:0) 1
(Effective from the academic year 2023 -24)

Course Code	BCDL404	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0:0	SEE Marks	50
Total Number of Contact Hours	2 hours	Exam Hours	3 Hours

Course Objectives:
This course aims to prepare the students to:

- To design and implement various algorithms in C/C++ programming using suitable development tools to address different computational challenges.
- To apply diverse design strategies for effective problem-solving.
- To Measure and compare the performance of different algorithms to determine their efficiency and suitability for specific tasks.

SL.NO	Experiments
1.	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. Demonstrate using C/C++, how the brute force method works along with its time complexity analysis: worst case, average case and best case.
2.	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. Demonstrate using C/C++ how the divide-and-conquer method works along with its time complexity analysis: worst case, average case and best case.
3.	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. Demonstrate using C/C++how the divide-and-conquer method works along with its time complexity analysis: worst case, average case and best case.
4.	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Kruskal's algorithm.
5.	Design and implement C/C++ Program to find Minimum Cost Spanning Tree of a given connected undirected graph using Prim's algorithm.
6.	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.
7.	Design and implement C/C++ Program to obtain the Topological ordering of vertices in a given digraph.
8.	Design and implement C/C++ Program to solve 0/1 Knapsack problem using Dynamic Programming method.

9.	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.
10.	Design and implement C/C++ Program for N Queen's problem using Backtracking.

Course outcomes (Course Skill Set):

At the end of the course the student 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: Make use of suitable integrated development tools to develop programs.

Assessment Details (both CIE and SEE)

Lab Evaluation Scheme

1. Ten marks for every experiment (10 X 10 = 100 marks), round it off to ***30 marks***.
2. Ten marks for every experiment will be evaluated for write-up, program execution, the procedure followed while execution and viva voce after each exercise.
3. Internal practical test for 100 marks to be given and the marks scored will be scaled down to ***20 marks***.
4. A Minimum of ***20 mark*** is to be scored in CIE.
5. SEE examination for the Lab is to be conducted for 100 marks and reduced to ***50 marks***.
6. A Minimum of ***18 marks*** is to be scored in SEE.

Note: Open Ended experiment will be done by the students in the Lab session. A total mark of 40 is to be scored by the student from both CIE and SEE together out of 100.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

Virtual Labs (CSE): http://cse01-iiith.vlabs.ac.in/

DEPARTMENT OF MATHEMATICS
Choice Based Credit System (CBCS)
SEMESTER – IV

Discrete Mathematical Structures (2:2:0:0) 3
(Common to CSE/ISE/AI&ML/CSBS Branches)
(Effective from the academic year 2023-2024)

Course Code	BCS405A	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

- Understand an intense foundational introduction to fundamental concepts in discrete mathematics.
- Interpret and solve the language associated with logical reasoning, relations, and functions.

Preamble: Discrete Mathematics course introduces students to the mathematics of discrete structures which build the mathematical foundation of Information Technology. Discrete mathematics has wide variety of application in problem analysis, decision making and provides adequate basics for the IT students who will be taking advanced courses like Security, Machine Learning and the Theory of Computing. The concepts of counting, mathematical induction, functions, relations, and graph theory provides an applied introduction to model mathematical concepts to the real word applications.

Module – I

Fundamentals of Logic: Basic connectives and Truth tables, Tautologies, Logical Equivalence: The laws of logic, Logical implications, Rules of inference.
Applications: Quantifiers and proofs of Theorems. **(08 Hours)**

Module – II

Relations: Properties of relations, Equivalence relations, Partitions, Partial orders and Extremal elements in posets.
Applications: Hasse diagrams **(08 Hours)**

Module –III

Functions: Types of function, Properties of functions, Composition of functions, Inverse functions and Invertible Functions.
Applications: The pigeonhole principle **(08 Hours)**

Module – IV

Mathematical Induction, Recursive Definitions and Recurrence Relations:
Method of mathematical induction, Recursive definition, First order linear recurrence relation-Formulation problems and examples. Second order linear homogeneous recurrence relations with constant coefficients.
Applications: Statement problems on recurrence relations (applicable to real life) **(08 Hours)**

Module – V

Fundamental Principles of Counting: Overview, The rule of sum and product, Permutations, Combinations and Combinations with repetition.
Applications: **The Principles of Inclusion and Exclusion:** Generalization of the principle, Derangements- Nothing is in its right place. **(08 Hours)**

Course Outcomes:

The Students should be able to

CO1: Use set theory and its applications in solving analytical problems.

CO2: Apply mathematical logic in the analysis of logical statements and simplification of switching circuits.

CO3: Use properties of relations and functions in theoretical algorithms.

CO4: Apply mathematical induction to analyzes recursive and non-recursive concepts

Text Books:

1. Ralph P. Grimaldi and B V Ramana, Discrete and Combinatorial Mathematics- An Applied Introduction, Pearson Education, Asia, Fifth edition – 2007. ISBN 978-81-7758- 424-0.
2. J.P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, Tata – McGraw Hill, 35TH reprint 2008. ISBN 13:978-0-07-463113-3.

Reference Books:

1. Kenneth H. Rosen, Discrete Mathematics and its Applications, Tata – McGraw Hill, Sixth Edition, Sixth reprint 2008. ISBN-(13):978-0-07-064824-1.
2. C. L. Liu and D P Mohapatra, Elementary Discrete Mathematics, Tata- McGraw Hill, Sixth Edition, ISBN: 10:0-07-066913-9.

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/
4. VTU e-Shikshana Program
5. VTU EDUSAT Program.
6. http://www.themathpage.com/
7. http://www.abstractmath.org/
8. http://www.ocw.mit.edu/courses/mathematics/

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

- **Quizzes**
- **Assignments**
- **Seminar**

DEPARTMENT OF MATHEMATICS
Choice Based Credit System (CBCS)
SEMESTER – IV

METRIC SPACES (2:2:0:0) 3

(Effective from the academic year 2023-2024)

Course Code	**BAI405B**	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:

This course will enable students to:

- Provide insight into the theory of sets
- Learn basic concepts of metric spaces
- Understand the concepts of connected sets and compact spaces

Module – I

Theory of Sets : Finite and infinite sets, countable and uncountable sets, cardinality of sets, Schroder-Bernstein theorem, cantor's theorem, Order relation in cardinal numbers, Arithmetic of cardinal numbers, Partially ordered set, Zorn's lemma and axioms of choice, various set-theoretic paradoxes. **(08 hours)**

Module – II

Concepts in Metric Spaces : Definition and examples of metric spaces, Open spheres and Closed spheres, Neighborhoods, Open sets, Interior, Exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set. **(08 hours)**

Module – III

Complete Metric Spaces and Continuous Functions :Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, continuous and uniformly continuous functions, Homeomorphism. Banach contraction principle. **(08 hours)**

Module - IV

Compactness: Compact spaces, Sequential compactness, Bolzano-Weierstrass property, Compactness and finite intersection property, Heine-Borel theorem, Totally bounded set, equivalence of compactness and sequential compactness. **(08 hours)**

Module – V

Connectedness :Separated sets, Disconnected and connected sets, components, connected subsets of R, Continuous functions on connected sets. Local connectedness and arc-wise connectedness. **(08 hours)**

Course Outcomes:

The students should be able to

CO1: Explain basic facts about the cardinality of a set and various set-theoretic paradoxes.
CO2: Apply the concepts of open and closed spheres and bounded sets to solve problems.
CO3: Demonstrate standard concepts of metric spaces and their properties.
CO4: Identify the continuity of a function defined on metric spaces and homomorphism.

Text Books

1. P.K. Jain & Khalil Ahamad, "*Metric Spaces*". Narosa, 2019.
2. Micheal O; Searcoid, "Metric spaces". Springer-Verlag, 2009.

Reference Books:

1. Satish Shirali & Harikishan L. Vasudeva, "*Metric Spaces*", Springer-Verlag, 2006.
2. E.T. Copson, "*Metric spaces*", Cambridge University Press, 1988.
3. P.R. Halmos, "*Naive Set Theory*". Springer, 1974.
4. S. Kumaresan, "*Topology of Metric spaces*", 2nd edition, Narosa, 2011.
5. G.F. Simmons, "Introduction to Topology and Modern Analysis". McGraw-Hill, 2004

DEPARTMENT OF MATHEMATICS
Choice Based Credit System (CBCS)
SEMESTER – IV

OPTIMIZATION TECHNIQUE (2:2:0:0) 3
(Common to CSE/ISE/AI&ML/CSBS Branches)
(Effective from the academic year 2023-2024)

Course Code	BCS405C	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:
This course will enable students to:

- To understand the methodology of OR problem solving and formulate linear programming problem.
- To develop formulation skills in transportation models and assignment problems hence find solutions.
- To understand the basics in the field of game theory.

Module – I

Introduction to LPP and Solution to LPP: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables). **(08 hours)**

Module – II

Simplex method and Big-M method: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method, Degeneracy in LPP. **(08 hours)**

Module – III

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Unbalanced T.P, Finding optimal solution by MODI method, Maximization T.P. Degeneracy in transportation problems. **(08 hours)**

Module – IV

Assignment Problem: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. TravellingSalesman Problem (TSP). **(08 hours)**

Module – V

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn and mX2 games by graphical method. Formulation of games. **(08 hours)**

Course Outcomes:
The students should be able to

CO1: Formulate, Solve and Optimize linear programming problems using appropriate techniques theoretically as well as graphically and interpret the results obtained.
CO2: Interpret the transportation models' solutions and infer solutions to the real-world problems.
CO3: Interpret the assignment models' solutions and infer solutions to the real-world problems.
CO4: Model competitive real-world phenomena using concepts from game theory. Analyse pure

and mixed strategy games.

Text Books:

1. Operations Research - S.D.Sharma, Kedar nath Ram nath & Co, 2008.
2. Operations Research - Theory and Applications, J.K Sharma, Macmillan Publications India Ltd, 2013.
3. Kanti swaroop, P.K.Guptha and Man Mohan: Operation Research. Sultan Chand.

Reference Books:

1. Operations Research - H.A.Taha, Pearson, 7th Edition, June 2002.
2. Introduction to Operations Research - Hiller and Liberman, MGH, 7th Edition, 2002.
3. S.K Sinha: Reliability and life testing. Wiley Eastern.

Web links and Video Lectures (e-Resources):

1. http://www2.informs.org/Resources/
2. http://www.mit.edu/~orc/
3. http://www.ieor.columbia.edu/
4. http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.html

DEPARTMENT OF MATHEMATICS
Choice Based Credit System (CBCS)
SEMESTER – IV

ALGORITHMIC GAME THEORY (2:2:0:0) 3
(Effective from the academic year 2023-2024)

Course Code	BAI405D	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0:0	SEE Marks	50
Total Number of Contact Hours	40	Exam Hours	3

Course Objectives:
This course will enable students to:

- Comprehend the basics of strategic gaming and mixed strategic equilibrium.
- Enable students to develop skills on extensive gaming strategies.
- Analyze and discuss various gaming models.
- Illustrate some real-time situations.

Module – I

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.
(08 hours)

Module – II

Introduction; Strategic games in which players may randomize; Mixed strategy Nash equilibrium; Dominated actions; Pure equilibrium when randomization is allowed.
Illustration: Expert Diagnosis; Equilibrium in a single population.
(08 hours)

Module – III

Extensive games with perfect information; Strategies and outcomes; Nash equilibrium; Sub-game perfect equilibrium; Finding sub-game perfect equilibria of finite horizon games: Backward induction; Illustrations: The ultimatum game, Stackelberg's model of duopoly.
(08 hours)

Module – IV

Bayesian Games**,** Motivational 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.
(08 hours)

Module – V

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. **(08 hours)**

Course Outcomes:
The students should be able to

CO1: Interpret the basics of strategic gaming and extensive games.
CO2: Analyze gaming strategies on real-time incidence.
CO3: Develop the models of gaming on real-time incidence.
CO4: Apply game theory in the real world problems.

Text Books:

1. **Martin Osborne: "An Introduction to Game Theory",** Oxford University Press, First Indian Edition, 2009, 7th impression, ISBN – 0195128958.

Reference Books:

1. **Roger B. Myerson: "Analysis of Conflict Game Theory",** Re-print Edition, Harvard University Press, 2008, ISBN – 978-0674341166.
2. **Frederick S. Hillier and Gerald J. Lieberman: "Introduction to Operations Research, Concepts and Cases",** 9th Edition; Tata McGraw Hill, 2010, ISBN – 0073376299.
3. **Joel Watson: "An Introduction to Game Theory"** Strategy, 2nd Edition, W.W. Norton &Company, 2007, ISBN – 9780393929348.

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

Scala (0:0:2:0) 1
(Effective from the academic year 2023-2024)

Course Code	BDSL456A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course Objectives:
This course aims to prepare the students to:

- Model data using algebraic data types, represented in Scala as families of sealed traits and case classes.
- Use structural recursion and pattern matching to traverse and transform data.
- Learn programming with the common data structures of Scala
- Learn object-oriented programming in Scala

Sl.NO	Experiments
1	a. Write a Scala program to compute the sum of the two given integer values. If the two values are the same, then return triples their sum. b. Write a Scala program to check two given integers, and return true if one of them is 22 or if their sum is 32.
2	Write a Scala program to remove the character in a given position of a given string. The given position will be in the range 0...string length -1 inclusive.
3	Write a Scala program to find the largest element in an array using pattern matching
4	Write a Scala program to swap the elements of a tuple. Further print no swapping required if elements are same.
5	Write a Scala program that creates a subclass Student that extends the Person class. Add a property called grade and implement methods to get and set it.
6	a. Write a Scala program that creates an enum class Color with values for different colors. Use the enum class to represent an object's color. b. Write a Scala program that creates a class ContactInfo with properties name, email, and address. Create a class Customer that includes a ContactInfo object.
7	a. Write a Scala program to create a set and find the difference and intersection between two sets. b. Write a Scala program to create a set and find the second largest element in the set.
8	a. Write a Scala program to create a list in different ways. Note: Use Lisp style, Java style, Range list, Uniform list, Tabulate list b. Write a Scala program to flatten a given List of Lists, nested list structure.
9	a. Write a Scala program to find minimum and maximum integer using nested functions. b. Write a Scala program to transform multiple arguments into a sequence of functions using Currying.
10	Write a Scala program to demonstrate pattern matching using regular expression to match email addresses.

Course outcomes:

At the end of the course the student 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: Make use of suitable integrated development tools to develop programs.

Suggested Learning Resources:

- Virtual Labs (CSE): http://cse01-iiith.vlabs.ac.in/

Assessment Details (both CIE and SEE)

Lab Evaluation Scheme

1. Ten marks for every experiment (10 X 10 = 100 marks), round it off to 30 marks.
2. Ten marks for every experiment will be evaluated for write-up, program execution, the procedure followed while execution and viva voce after each exercise.
3. Internal practical test for 100 marks to be given and the marks scored will be scaled down to 20 marks.
4. A Minimum of 20 mark is to be scored in CIE.
5. SEE examination for the Lab is to be conducted for 100 marks and reduced to 50 marks.
6. A Minimum of 18 marks is to be scored in SEE.

Note: Open Ended experiment will be done by the students in the Lab session. A total mark of 40 is to be scored by the student from both CIE and SEE together out of 100.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. OR based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING

Choice Based Credit System (CBCS)

SEMESTER – IV

MongoDB (0:0:2:0) 1

(Effective from the academic year 2023-2024)

Course Code	BDSL456B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course Objectives:

This course aims to prepare the students to:

- Understand basic MongoDB functions, operators and types of operations in MongoDB.
- Demonstrate the use of Indexing, Advanced Indexing in MongoDB.
- Apply the aggregation and Map Reduction in MongoDB.
- Demonstrate text searching on collections in MongoDB.

Sl.NO	Experiments
1	a. Illustration of Where Clause, AND,OR operations in MongoDB. b. Execute the Commands of MongoDB and operations in MongoDB : Insert, Query, Update, Delete and Projection. (Note: use any collection) [Refer: Book 1 chapter 4].
2	a. Develop a MongoDB query to select certain fields and ignore some fields of the documents from any collection. b. Develop a MongoDB query to display the first 5 documents from the results obtained in a. [use of limit and find] [Refer: Book1 Chapter 4, book 2: chapter 5]
3	a. Execute query selectors (comparison selectors, logical selectors) and list out the results on any collection b. Execute query selectors (Geospatial selectors, Bitwise selectors) and list out the results on any collection [Refer: Book 3 Chapter 13]
4	Create and demonstrate how projection operators ($, $elematch and $slice) would be used in the MondoDB. [Refer: Book 3 Chapter 14]
5	Execute Aggregation operations ($avg, $min,$max, $push, $addToSet etc.). students encourage to execute several queries to demonstrate various aggregation operators) [Refer: Book 3 Chapter 15]
6	Execute Aggregation Pipeline and its operations (pipeline must contain $match, $group, $sort, $project,$skip etc. students encourage to execute several queries to demonstrate various aggregation operators) [refer book 2: chapter 6]
7	a. Find all listings with listing_url, name, address, host_picture_url in the listings And Reviews collection that have a host with a picture url b. Using E-commerce collection write a query to display reviews summary.

	refer Book2: chapter 6]
8	a. Demonstrate creation of different types of indexes on collection (unique, sparse, compound and multikey indexes) b. Demonstrate optimization of queries using indexes. Refer: Book 2: Chapter 8 and Book 3: Chapter 12]
9	a. Develop a query to demonstrate Text search using catalog data collection for a given word b. Develop queries to illustrate excluding documents with certain words and phrases Refer: Book 2: Chapter 9]
10	Develop an aggregation pipeline to illustrate Text search on Catalog data collection. Refer: Book 2 :Chapter 9]

Course outcomes :

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

CO1: Make use of MangoDB commands and queries.

CO2: Illustrate the role of aggregate pipelines to extract data.

CO3 Demonstrate optimization of queries by creating indexes.

CO4: Develop aggregate pipelines for text search in collections.

Suggested Learning Resources:

- **BOOK 1: "**MongoDB: The Definitive Guide", Kristina chodorow, 2nd ed O'REILLY, 2013.
- **BOOK 2: "***MongoDB in Action*" by KYLE BANKER et. al. 2nd ed, Manning publication, 2016
- **BOOK 3:** "MongoDB Complete Guide" by Manu Sharma 1st ed, bpb publication, 2023.
- **installation of MongoDB Video:** https://www.youtube.com/watch?v=dEm2AS5amyA
- **video on Aggregation:** https://www.youtube.com/watch?v=vx1C8EyTa7Y
- **MongoDB in action book Code download URL: h**ttps://www.manning.com/downloads/529
- **MongoDB Exercise UR**

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

MERN (0:0:2:0) 1
(Effective from the academic year 2023-2024)

Course Code	BDSL456C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course Objectives:

This course aims to prepare the students to:

- Understand and apply critical web development languages and tools to create dynamic and responsive web applications.
- To build server-side applications using Node.js and Express
- Develop user interfaces with React.js,
- Manage data using MongoDB, and integrate these technologies to create full stack apps
- Understanding APIs and routing.

Sl.NO	Experiments
1	a. 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 c. Upsert the record from the new file called transactions_upsert. json in Mongodb.
2	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. Calculate the total transaction amount by adding up Payment. Total in all records.
3	a. Write a program to check request header for cookies. b. write node.js program to print the car object properties, delete the second property and get length of the object.
4	a. 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	Implement all CRUD operations on a File System using Node JS
6	Develop the application which takes name and email data from HTML form index.html after submission and sends the data in the form of object from client side to Node.js server using Ajax.
7	Develop an authentication mechanism with email_id and password using HTML and Express JS (POST method)
8	Demonstrate Express JS routing mechanism by developing two routes: User and Admin route. User route returns some user details and Admin route returns some admin details.
9	Develop a React code to build a simple search filter functionality to display a filtered list based on the search query entered by the user.
10	Develop a React code to collect data from rest API.

Course outcomes (Course Skill Set):

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

CO1: Apply the fundamentals of MongoDB, such as data modelling, CRUD operations, and basic queries to solve given problem.

CO2: Use constructs of Express.js, including routing, software and constructing RESTful APIs to solve real world problems.

CO3: Develop scalable and efficient RESTful APIs using NodeJS.

CO4: Develop applications using React, including components, state, props, and JSX syntax.

Suggested Learning Resources:

- Vasan Subramanian Pro MERN Stack: Full Stack Web App Development with Mongo, Express,
- React, and Node, Apress; 1st ed. edition (1 April 2017)
- Eddy Wilson Iriarte Koroliova,MERN Quick Start Guide, Packt Publishing (31 May 2018),
- https://www.geeksforgeeks.org/mern-stack/
- https://blog.logrocket.com/mern-stack-tutorial/

DEPARTMENT OF ARTIFICAL INTELLIGENCE AND MACHINE LEARNING
Choice Based Credit System (CBCS)
SEMESTER – IV

JULIA (0:0:2:0) 1
(Effective from the academic year 2023-2024)

Course Code	BDSL456D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02
Examination type (SEE)	Practical		

Course Objectives:
This course aims to prepare the students to:

- To introduce the basics of Julia programming language
- To illustrate the data structures of the Julia programming language
- To make use of built-in functions and packages

Sl.NO	Experiments
1	a. Develop a Julia program to simulate a calculator (for integers 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). [Refer Book 2: Chapter 3, 4]
2	a. Develop a Julia program for the following problem: The following data are given for a customer in a bank: name, account number, average balance, and number of transactions made during the month. It is required to calculate the interest earned and service charge. The interest is calculated as follows: interest = 3% of the average balance and the service charge is calculated by this: service charge = 75 cents per transaction Write a program to read the data for the customer, calculate the interest and service charge, and print the customer's name, average balance, interest and service charge b. Develop a Julia program to calculate a person's regular pay, overtime pay, and gross pay based on the following: If hours worked are 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 are greater than 40, regular pay is calculated by multiplying 40 by the rate of pay, and overtime pay is calculated by multiplying the hours above 40 by the rate of pay by 1.5. Gross pay is calculated by adding regular pay and overtime pay. [Refer Book 1: Chapter 2,3]
3	a. Develop a Julia program to request a score in a test and print a letter grade based on the following: F: score < 50 B: 50 <= score < 75 A: score >= 75 b. Develop a Julia Program for Given three integer values representing the sides of a triangle, print: • **Not a triangle:** if the values cannot be the sides of any triangle. This is so if any value is negative or zero, or if the length of any side is greater than or equal to the sum of the other two. • **Scalene:** if the triangle is scalene (all sides different) • **Right-angled**: if the triangle is right-angled

	• **Isosceles**: if the triangle is isosceles (two sides equal) • **Equilateral**: if the triangle is equilateral (three sides equal). [Refer Book 1: Chapter 3]
4	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. [Refer Book 1: Chapter 4]
5	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. [Refer Book 1: Chapter 5]
6	a. Develop a Julia program to evaluate expressions consisting of rational, irrational number and floating-point 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. [Refer Book 2: Chapter 5, 8]
7	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. [Refer Book 1: Chapter 7]
8	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. [Refer Book 2: Chapter 8]
9	a. Develop a Julia program to Store information like Name, USN, and Percentage of 5 Students and display the same using Structures. b. Develop a Julia program to Store information like Account Number, Name of Account Holder, and Balance Amount of 5 Account Holders in a Bank and display the Details of 3 Account Holders with the highest Balance Amount in the Bank Account using Structures [Refer Book 1: Chapter 9]
10	a. Develop a Julia program to generate a plot of (solid & dotted) a function: $y=x^2$ (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). [Refer Book 2: Chapter 13]

Course outcomes (Course Skill Set):

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

CO1: Apply concepts of data-types, selection and looping constructs of Julia programming language.

CO2: Demonstrate the use of strings, functions, arrays and matrix operations in solving problems.

CO3: Develop programs involving data structures to handle multi-valued data items.

CO4:Make use of packages to generate plots of mathematical functions and equations

Suggested Learning Resources:

- BOOK 1: Julia – Bit by Bit (Programming for Beginners), by Noel Kalicharan, Springer: ISBN 978-3-030-73935-5, doi: https://doi.org/10.1007/978-3-030-73936-2, 2021.
- BOOK 2: Beginning Julia Programming (For Engineers and Scientists), by Sandeep Nagar, Apress-Springer: ISBN 978-1-4842-3170-8, doi: https://doi.org/10.1007/978-1-4842-3171-5, 2017.

BIOLOGY FOR INFORMATION TECHNOLOGY (2:0:0) 2
COMMON TO ALL INFORMATION TECHNOLOGY BRANCHES (CSE/ISE/AIML)
(Effective from the academic year 2023 -24)

Course Code	BBOC407	CIE Marks	50
Teaching Hours/Week (L:T:P)	2:0:0	SEE Marks	50
Total Number of Contact Hours	25	Exam Hours	3 Hours

Course Objectives:

- To familiarize the students with the basic biological concepts and their engineering applications.
- To enable the students with an understanding of bio-design principles to create novel devices and structures.
- To provide the students an appreciation of how biological systems can be re-designed as substitute products for natural systems.
- To motivate the students to develop interdisciplinary vision of biological engineering.

Teaching-Learning Process (General Instructions)

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

1. Explanation via real life problem, situation modelling, and deliberation of solutions, hands-on sessions, reflective and questioning /inquiry-based teaching.
2. Instructions with interactions in classroom lectures (physical/hybrid).
3. Use of ICT tools, including YouTube videos, related MOOCs, AR/VR/MR tools.
4. Flipped classroom sessions (~10% of the classes).
5. Industrial' visits, Guests talks and competitions for learning beyond the syllabus.
6. Students participation through audio-video based content creation for the syllabus (as assignments).
7. Use of gamification' tools (in both physical/hybrid classes) for creative learning outcomes.
8. Students seminars (in solo or group) /oral presentations.

Module – 1

Preamble Exploring "Biology for Engineers" isn't just a scientific pursuit; it's a strategic investment in nation-building and economic growth. By bridging biology with engineering, we unlock pathways to sustainable development, innovative industries, and improved healthcare solutions. This interdisciplinary approach not only enriches our understanding of living systems but also propels us towards a future where technological advancements drive societal progress and economic prosperity. Let's harness the power of biology to engineer a brighter tomorrow for our nation and the world.

CELL BASIC UNIT OF LIFE

Introduction. Structure and functions of a cell. Stem cells and their application. Biomolecules: Properties and functions of Carbohydrates, Nucleic acids, proteins, lipids. Importance of special biomolecules: Properties and functions of enzymes, vitamins and hormones.

- 5 Hours

Module – 2

APPLICATION OF BIOMOLECULES

Carbohydrates in cellulose-based water filters production, PHA and PLA in bioplastics production, Nucleic acids in vaccines and diagnosis, Proteins in food production, lipids in biodiesel and detergents production, Enzymes in biosensors fabrication, food processing, detergent formulation and textile processing.

- 5 Hours

Module – 3

ADAPTATION OF ANATOMICAL PRINCIPLES FOR BIOENGINEERING DESIGN

Brain as a CPU system. Eye as a Camera system. Heart as a pump system. Lungs as purification system.

Kidney as a filtration system.

- 5 Hours

Module – 4

NATURE-BIOINSPIRED MATERIALS AND MECHANISMS:

Echolocation, Photosynthesis. Bird flying, Lotus leaf effect, Plant burrs, Shark skin, Kingfisher beak. Human Blood substitutes - hemoglobin-based oxygen carriers (HBOCs) and perfluorocarbons (PFCs).

- 5 Hours

Module – 5

Backtracking: General method, solution using back tracking to N-Queens problem, Sum of subsets problem, Graph **TRENDS IN BIOENGINEERING:**

Muscular and Skeletal Systems as scaffolds, scaffolds and tissue engineering, Bioprinting techniques and materials. Electrical tongue and electrical nose in food science, DNA origami and Biocomputing, Bioimaging and Artificial Intelligence for disease diagnosis. Bioconcrete. Bioremediation. Biomining.

- 5 Hours

Course outcomes (Course Skill Set)

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

1. Elucidate the basic biological concepts via relevant industrial applications and case studies.
2. Evaluate the principles of design and development, for exploring novel bioengineering projects.

Question paper pattern:

1. Each internal test (two in a semester) to be conducted for forty marks.
2. Average of both the test marks are scaled down to ***25 marks***, a minimum of ten marks is to be scored by the student.
3. One AAT/Assignment is to be carried out in this scheme.
4. A Minimum of 20 marks to be scored in CIE out of 50 marks.
5. Minimum of ***18 marks*** is to be scored in SEE examination.

Note: A total mark of 40 is to be scored by the students in this course from both CIE and SEE together out of 100.

Textbooks

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
5. Biomedical Instrumentation, Leslie Cromwell, Prentice Hall 2011.
6. Biology for Engineers, Sohini Singh and Tanu Allen, Vayu Education of India, New Delhi, 2014.
7. Biomimetics: Nature-Based Innovation, Yoseph Bar-Cohen, 1st edition, 2012, CRC Press.
8. Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies, D. Floreano and C. Mattiussi, MIT Press, 2008.

9. Bioremediation of heavy metals: bacterial participation, by C R Sunilkumar, N GeethaA C Udayashankar Lambert Academic Publishing, 2019.
10. 3D Bioprinting: Fundamentals, Principles and Applications by Ibrahim Ozbolat, Academic Press, 2016.
11. Electronic Noses and Tongues in Food Science, Maria Rodriguez Mende, Academic Press, 2016.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/121106008
- https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists
- https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
- https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006
- https://www.coursera.org/courses?query=biology
- https://onlinecourses.nptel.ac.in/noc19_ge31/preview
- https://www.classcentral.com/subject/biology
- https://www.futurelearn.com/courses/biology-basic-concepts

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

- Group Discussion of Case studies
- Model Making and seminar/poster presentations
- Design of novel device/equipment like Cellulose-based water filters, Filtration system

Department of Humanities and Social Sciences
Choice Based Credit System (CBCS)
SEMESTER – IV
(Common to all branches)

Universal Human Values (UHV) (1:0:0:1) 1
(Effective for the 2022 scheme)

Course Code	BUHK408	CIE Marks	50
Teaching Hours/Week (L: T:P:S)	1:0:0:1	SEE Marks	50
Total Number of Contact Hours	15-hour Theory Session +15 hour Self study	Exam Hours	01
Credits	1		

Course Objectives:

This course is intended to:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.
4. This course is intended to provide a much-needed orientation input in value education to the young enquiring minds

Teaching-Learning Process (General Instructions)

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

1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students' theoretical and applied skills.
3. State the need for UHV activities and its present relevance in the society and provide real-life examples.
4. Support and guide the students for self-study activities.
5. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress in real activities in the field.
6. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self-evolution.
7. Encourage the students for group work to improve their creative and analytical skills.

Module – 1

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

(03 Hours)

Module – 2

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.

(03 Hours)

Module – 3

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.

(03 hours)

Module – 4

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, The Holistic Perception of Harmony in Existence

(03 hours)

Module – 5

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

(03 hours)

Course outcome (Course Skill Set)

At the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature);

1.They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability.

2. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

3. It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Expected to positively impact common graduate attributes like:

1. Ethical human conduct
2. Socially responsible behaviour
3. Holistic vision of life
4. Environmentally responsible work
5. Having Competence and Capabilities for Maintaining Health and Hygiene

6. Appreciation and aspiration for excellence (merit) and gratitude for all

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

The sum of two tests, two assignments, will be out of 100 marks and will be scaled down to 50 marks.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour**. The student has to secure a minimum of 35% of the maximum marks meant for SEE

Textbooks and Teachers Manual	
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 97893-87034- 47-1
2.	The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G
References	
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.	SThe 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	Subhas Palekar, 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

Department of Humanities and Social Sciences

B.E. Artificial Intelligence and Machine Learning

Choice Based Credit System (CBCS)

SEMESTER – III to VI

NSS

(Common to all branches)

(Effective for the 2022 scheme)

Course Code	**BNSK359/459/559/659**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of degree)

Course Objectives: National Service Scheme (NSS) will enable the students to:

1. Understand the community in general in which they work.
2. Identify the needs and problems of the community and involve them in problem solving.
3. Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.
4. Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitudes.
5. Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Module – 1

Introduction to NSS

History and growth of NSS, Philosophy of NSS, Objectives of NSS, Meaning of NSS Logo, NSS Programs and activities, administrative structure of NSS, Planning of programs / activities, implementation of NSS programs / activities, National & State Awards for NSS College / Program Officer / Volunteers.

(04 Hours)

Module – 2

Overview of NSS Programs

Objectives, special camping – Environment enrichment and conservation, Health, Family, Welfare and Nutrition program. Awareness for improvement of the status of women, Social Service program, production-oriented programs, Relief & Rehabilitation work during natural calamities, education and recreations, Selection of the problem to be addressed.

(**04 Hours)**

Module – 3

NSS Activities - Group Contributions to Society / community (Activity based Learning)

Organic Farming, Indian agriculture (Past, Present, Future) Connectivity for marketing, Waste management– Public, Private and Govt. organization, 5 R's. Water conservation techniques – role of different stakeholders – implementation, preparing an actionable business proposal for enhancing the village income and approach for implementation. Helping local schools to achieve good results and enhance their enrolment in Higher/ technical/ vocational education.

(06 Hours)

Module – 4

National Level Activities for Society / Community at large (Activity based Learning)

Developing Sustainable Water management system for rural areas and implementation approaches. Contribution to any national level initiative of Government of India. Foreg. Digital India, Skill India, Swachh Bharat, Atmanirbhar Bharath, Make in India, Mudra scheme, Skill development programs etc. **(06 Hours)**

Module – 5

Individual Activities for Local Voice (Activity based learning)

Govt. school Rejuvenation and helping them to achieve good infrastructure, Plantation and adoption of plants. Know your plants. Spreading public awareness under rural outreach programs, National integration and social harmony events. **(06 Hours)**

Course outcomes (Course Skill Set):

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

CO1: Understand the importance of his / her responsibilities towards society.

CO2: Analyse 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.

CO5: Develop capacity to meet emergencies and natural disasters & practice national integration and social harmony in general.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation
- Audio & Video Visualization Tools

Assessment Details

Weightage	**CIE – 100%**
Presentation -1 Selection of topic, PHASE-1	20 Marks
Commencement of activity and its progress – PHASE – 2	20 Marks
Case Study based Assessment – Individual performance	20 Marks
Sector wise study and its consolidation	20 Marks
Video based seminar for 10 minutes by each student at the end of the course with Report	20 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.

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

B.E. Artificial Intelligence and Machine Learning

Choice Based Credit System (CBCS)

SEMESTER – III to VI

Sports

(Common to all Branches)

(Effective for the 2022 scheme)

Course Code	BPEK359/459/559/659	CIE Marks	100
Teaching Hours/Week (L: T:P)	0:0:2	SEE Marks	--
Total Number of Contact Hours	26	Exam Hours	--

Mandatory Course (Non-Credit)

(Completion of the course shall be mandatory for the award of degree)

Course Objectives: The course will enable students to

1. Develop a healthy life style.
2. Acquire Knowledge about various stages of sports and games.
3. Focus on modern technology in sports.

Module – 1

Introduction of the game: Aim of sports and games, Brief history of the game, Nature of the game, Terminology & Modern trends of the game, Fitness & Skill tests along with Game Performance.

(06 Hours)

Module – 2

Offensive and Defensive Techno Tactical Abilities: Fitness, Fundamentals & Techniques of the game with the implementation of Biomechanics, Tactics- Drills for the Techno Tactical abilities, Individual and Group, Miner games- to implement the Techniques, Tactics and Motor abilities.

(05 Hours)

Module – 3

Team tactics and Rules of the Game: Rules and Regulations of the Game: Game rules as well as sequence of officiating, Team tactics: Offensive and Defensive team strategies and scrimmages, Practice Matches: among the group, Analysis of Techno Tactical abilities: Correction and implementation of skills and Sports Injuries and rehabilitation: First aid, PRICE treatment,

(05 Hours)

Module – 4

Sports Training: Introduction of Sports Training, Principles of Sports performance, how to increase and sustain the sports performance, Training Load & Recovery- How to increase the training load (volume/Intensity) and means and methods for Recovery, Periodization: Shorts, Medium and Long term, Physiological changes: Changes in Lung capacity, heart beats etc…

(05 Hours)

Module – 5

Organization of Sports Event: Tournament system, Planning and preparation for the competition, Ground preparation and Equipment's, Organizing an event among the group.

(05 Hours)

The above 5 modules are common to all the sports events / games, we are offering the following games**: 1. Baseball, 2. Kabaddi, 3. Table Tennis, and 4. Volleyball.**

Course outcomes:

The students will be able to:

1. Understand the importance of sports and games, inculcate healthy habits of daily exercise & fitness, Self-hygiene, good food habits, Create awareness of Self-assessment of fitness.
2. Develops individual and group techno tactical abilities of the game.
3. Increases the team combination and plan the strategies to play against opponents.
4. Outline the concept of sports training and how to adopt technology to attain high level performance.
5. Summarize the basic principles of organising sports events and concept of technology implemented to organise competitions in an unbiased manner.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation and video analysing.
- Practical classes in outdoor and indoor as per requirement.

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.
- CIE 2 for 60 marks – A practical test conducted at the end of the semester in which the student has to give fitness and skill tests and his performance in game will be assessed.

Textbooks

1. Barbara Bushman, "ACSM's complete guide to Fitness & Health", 2011, Human Kinetics USA
2. **Pankaj Vinayak Pathak, "*Sports and Games - Rules and Regulation*", 2019, Khel Sahitya Kendra.**
3. Hardayal Singh, *"Sports Training, General Theory & Methods"*, 1984 "Netaji Subhas, National Institute of Sports".
4. Keith A. Brown, "International Handbook of Physical Education and Sports Science", 2018, (5 Volumes) Hardcover.

References

1. Tudor O Bompa,*" Periodization Training for Sports*", 1999, Human Kinetics, USA
2. Michael Boyle, "New Functional Training for Sports" 2016, Human Kinetics USA
3. Michael Kjaer, Michael Rogsgaard, Peter Magnusson, Lars Engebretsen & 3 more, "Text book of Sports Medicine: Basic Science and Clinical Aspects of Sports Injury and Physical Activity", 2002, Wiley Blackwell.
4. Scott L. Delp and Thomas K. Uchida, "Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation", 2021, The MIT Press
5. MCARDLE W.D. "Exercise Physiology Nutrition Energy And Human Performance" 2015, LWW IE (50)

Department of Humanities and Social Sciences

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SEMESTER – III to VI

Yoga

(Common to all Branches)

(Effective for the 2022 scheme)

Course Code	**BYOK359/459/559/659**	CIE Marks	100
Teaching Hours/Week (L:T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Course Objectives:

This course will enable students to:

6. Understand the importance of practicing yoga in day-to-day life.
7. Be aware of therapeutic and preventive value of Yoga.
8. Have a focussed, joyful and peaceful life.
9. Maintain physical, mental and spiritual fitness.
10. Develop self-confidence to take up initiatives in their lives.

Module – 1

Introduction to Yoga: Introduction, classical and scientific aspects of yoga, Importance, Types, Healthy Lifestyle, Food Habits, Brief Rules, Sithalikarana Practical classes. **(04 Hours)**

Module – 2

Ph Physical Health: Introduction, Pre-requisites, Asana-Standing, Sitting, Supine and Prone, Practical classes. **(06 Hours)**

Module – 3

Psychological Health: Introduction Thought Forms, Kriya (Kapalabhati), Preparation to Meditation, Practical classes. **(06 Hours)**

Module – 4

Therapeutic Yoga: Mudra Forms, Acupressure therapy, Relaxation techniques Practical classes. **(06 Hours)**

Module – 5

Spirituality & Universal Mantra: Introduction, Being Human, Universal Mantra, Universal LOVE, Benefits of practice of Spirituality in day-to-day life, practical classes. **(04 Hours)**

Course Outcomes:

Students will be able to:

1. Understand the requirement of practicing yoga in their day-to-day life.
2. Apply the yogic postures in therapy of psychosomatic diseases
3. Train themselves to have a focussed, joyful and peaceful life.
4. Demonstrate the fitness of Physical, Mental and Spiritual practices.
5. Develops self-confidence to take up initiatives in their lives.

Teaching Practice:

- Classroom teaching (Chalk and Talk)
- ICT – Power Point Presentation
- Audio & Video Visualization Tools

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.

- CIE 2 for 60 marks – A practical test conducted at the end of the semester in which the student have to perform asanas.

Textbooks

1. George Feuerstein: The yoga Tradition (Its history, literature, philosophy and practice.)
2. Sri Ananda: The complete Book of yoga Harmony of Body and Mind. (Orient paper Backs: vision Books Pvt.Ltd., 1982.
3. B.K.S Iyenkar: Light on the Yoga sutras of patanjali (Haper Collins Publications India Pvt.,Ltd., New Delhi.)
4. Science of Divinity and Realization of Self – Vethathiri Publication, (6-11) WCSC, Erode

References

1. Principles and Practice of Yoga in Health Care, Publisher: Handspring Publishing Limited, ISBN: 9781909141209, 9781909141209
2. Basavaraddi I V: Yoga in School Health, MDNIY New Delhi, 2009
3. Dr. HR. Nagendra: Yoga Research and applications (Vivekanda Kendra Yoga Prakashana Bangalore)
4. Dr. Shirley Telles: Glimpses of Human Body (Vivekanda Kendra Yoga Prakashana Bangalore)

Web resources

Web links and Video Lectures (e-Resources): Refer links

1. https://youtu.be/KB-TYlgd1wE
2. https://youtu.be/aa-TG0Wg1Ls

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Music
(Common to all Branches)
(Effective for the 2022 scheme)

Course Code	BMUK359/459/559/659	CIE Marks	100
Teaching Hours/Week (L: T:P)	0:0:2	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)
(Completion of the course shall be mandatory for the award of the Degree)

Course Objectives:

The course will enable the students to:

1. Identify the major traditions of Indian music, both through notations and aurally.
2. Analyze the compositions with respect to musical and lyrical content.
3. Demonstrate an ability to use music technology appropriately in a variety of settings.

Module – 1

Preamble: Contents of the curriculum intend to promote music as a 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. **(03 Hours)**

Module – 2

Compositions: Introduction to the types of compositions in Carnatic Music - Geethe, Jathi Swara, Swarajathi, Varna, Krithi, and Thillana, Notation system. **(03 Hours)**

Module – 3

Composers: Biography and contributions of Purandaradasa, Thyagaraja, Mysore Vasudevacharya. **(03 Hours)**

Module – 4

Music Instruments: Classification and construction of string instruments, wind instruments, percussion instruments, Idiophones (Ghana Vaadya), Examples of each class of Instruments **(03 Hours)**

Module – 5

Abhyasa Gana: Singing the swara exercises (Sarale Varase Only), Notation writing for Sarale Varase and Suladi Saptha Tala (Only in Mayamalavagowla Raga), Singing 4 Geethein Malahari, and one Jathi Swara, One Nottu Swara OR One krithi in a Mela raga, a patriotic song **(14 Hours)**

Course Outcomes (COs):

The students will be able to:

CO1: Discuss the Indian system of music and relate it to other genres (Cognitive Domain)

CO2: Experience the emotions of the composer and develop empathy (Affective Domain)

CO3: Respond to queries on various patterns in a composition (Psycho-Motor Domain)

Teaching Practice:

- Classroom teaching
- ICT – PowerPoint Presentation
- Audio & Video Visualization Tools

CIE: 100 Marks

- **CIE 1** for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester
- **CIE 2** for 60 marks – A practical test conducted at the end of the semester in which the student has to recite one Sarale Varase mentioned by the examiner in three speeds. Sing / Play the Geethe in Malahari. Singing / Playing Jathi Swara / Krithi.

Textbooks

1. Vidushi Vasantha Madhavi, "Theory of Music", Prism Publication, 2007.
2. T Sachidevi and T Sharadha (Thirumalai Sisters), Karnataka Sangeetha Dharpana - Vol. 1 (English), Shreenivaasa Prakaashana, 2018.

References

1. Lakshminarayana Subramaniam, Viji Subramaniam, "Classical Music of India: A Practical Guide", Tranquebar 2018.
2. R. Rangaramanuja Ayyangar, "History of South Indian (Carnatic) Music", Vipanci Charitable Trust; Third edition, 2019.
3. Ethel Rosenthal, "The Story of Indian Music and Its Instruments: A Study of the Present and a Record of the Past", Pilgrims Publishing, 2007.
4. Carnatic Music, National Institute of Open Schooling, 2019.

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NCC
(Common to all Branches)
(Effective for the 2022 scheme)

Course Code	BNCK359/459/559/659	CIE Marks	100
Teaching Hours/Week (L: T:P:S)	0:0:2:0	SEE Marks	-
Total Number of Contact Hours	26	Exam Hours	-

Mandatory Course (Non-Credit)
(Completion of the course shall be mandatory for the award of degree)

Course Objectives:
This course will enable students to:
- Understand the vision of NCC and its functioning.
- Understand the security set up and management of Border/Coastal areas.
- Acquire knowledge about the Armed forces and general awareness.

Module– 1

Introduction to National Cadet Corp: What is NCC, who can join NCC, benefits, Establishment, history, 3 wings, motto, core values, Aims, flag, song, pledge, cardinals, Organization, Director General NCC, Directorates, Uniform and Cadet ranks, Camps, Certificate exams, Basic aspects of drill.

National Integration: Importance of national integration**,** Factors affecting national integration, Unity in diversity**,** Role of NCC in nation building.

Disaster Management: What is a Disaster**,** Natural and Man-made disasters**,** Earthquake, Floods. **(04 Hours)**

Module– 2

Indian Army: Introduction to Indian Army, Command and control, Fighting & supporting arms**,** Rank structure, Major Regiments of the Army**,** Major Wars and Battles**,** Entry to the Indian Army, Renowned leaders and Gallantry Awardees.

(02 Hours)

Module– 3

Indian Air Force: Introduction to Indian Air Force, Command and control**,** Rank structure**,** Major Aircrafts, Entry to the Indian Air Force, Renowned leaders.

Indian Navy: Introduction to Indian Navy, Command and control, Rank structure, Major Ships and Submarines**,** Entry to the Indian Navy, Renowned leaders. **(02 Hours)**

Module– 4

Health and Hygiene: First Aid Protocols - CPR, Understanding Types of Bandages, Fire Fighting

Field & Battle Crafts: Field Signals using hands, Judging distance -Types of Judging Distance, Section formations-types of Section Formation **(10 Hours)**

Module– 5

Drill Practicals: Savdhan, Vishram, Salute, Turning, Marching.

(08 Hours)

Course outcomes:

The students will be able to:

CO1: Develop qualities like character, comradeship, discipline, leadership, secular outlook, spirit of adventure, ethics and ideals of selfless service.

CO2: Get motivated and trained to exhibit leadership qualities in all walks of life and be always available for the service of the nation.

CO3: Familiarize on the issues related to social & community development and disaster management and equip themselves to provide solutions.

CO4: Get an insight of the defense forces and further motivate them to join the defense forces.

Teaching Practice:

- Blackboard/Multimedia Assisted Teaching.
- Class Room Discussions, Brainstorming Sessions, Debates.
- Activity: Organizing/Participation in Social Service Programs.
- On Ground: Drill training.

CIE: 100 Marks

- CIE 1 for 40 marks – A theory paper which is MCQ / Descriptive conducted during the semester.
- CIE 2 for 60 marks – A practical test conducted at the end of the semester.

Textbooks:

1. NCC Cadets Handbook –Common Directorate General of NCC, New Delhi.
2. NCC Cadets Handbook –Special(A), Directorate General of NCC, New Delhi.

References:

- Chandra B. Khanduri, "Field Marshal KM Cariappa: a biographical sketch", Dev Publications,2000.
- Gautam Sharma, "Valour and Sacrifice: Famous Regiments of the Indian Army", Allied Publishers,1990.