CURRICULUM AND DETAILED SYLLABI

FOR

B. TECH DEGREE PROGRAMME

IN

COMPUTER SCIENCE AND ENGINEERING

SEMESTER III & IV

2023 SCHEME

(AUTONOMOUS)

MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY
(Approved by AICTE, Autonomous Institution Affiliated to APJ Abdul Kalam Technological University)
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MAR BASELIOS COLLEGE OF ENGINEERING AND TECHNOLOGY

Vision and Mission of the Institution

Vision:
To be an Institution moulding globally competent professionals as epitomes of Noble Values.

Mission:
To transform the Youth as technically competent, ethically sound and socially committed professionals, by providing a vibrant learning ambience for the welfare of humanity.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

Vision and Mission of the Department

Vision:
To be a Centre of Excellence in Computer Science and Engineering providing quality education and research for the betterment of the society.

Mission:
To impart sound knowledge in theoretical and applied foundations of Computer Science and Engineering, and to train the students to solve real life issues to effectively define and shape life.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be successful professionals in Industries of core or interdisciplinary nature or entrepreneurs, demonstrating effective leadership and excellent team work.
2. Graduates will expand the horizon of knowledge through higher education orresearch, leading to self-directed professional development.
3. Graduates will demonstrate professional attitude and ethics while providing solutions in societal and environmental contexts.

PROGRAMME OUTCOMES (POs)

Engineering graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

. Engineering Graduates will have the ability to:

1. Apply Algorithmic Principles, Programming Skills and Software Engineering Principles to design, develop and evaluate Software Systems of varying complexities.
2. Apply knowledge of System Integration to design and implement computer-based systems.
3. Solve real world and socially relevant problems with the knowledge in recent and advanced Computing Technologies.

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

For the students admitted from 2023

Scheduling of Courses

i) Knowledge Segments and Credits

Every course of B. Tech Programme is placed in one of the nine categories as listed in the following table. No semester shall have more than six lecture-based courses and two laboratory courses, and/or drawing/seminar/project courses in the curriculum.

Sl. No.	Category	Category Code	2020(REVISED)	2023(REVISED)
1	Humanities and Social Sciences including Management Courses	HSC	5	6
2	Basic Science Courses	BSC	26	26
3	Engineering Science Courses	ESC	22	22
4	Programme Core Courses, Comprehensive Course Work and Viva Voce	PCC	79	69
5	Programme Elective Courses	PEC	15	18
6	Institute Elective Courses	OEC/IEC	3	6
7	Project Work and Seminar	PWS	10	13
8	Mandatory Non-credit Courses (P/F) with Grade	MNC	---	--
9	Mandatory Student Activities (P/F)	MSA	2	3
Total Mandatory Credits			**162**	**163**
	Value Added Courses (Optional) – Honours/Minor	VAC	15	15

ii) Semester-wise Credit Distribution

Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	***Total Credits***
Credits for Courses	17	21	22	23	22	22	18	15	**160**
	38		45		44		33		**160**
Credits for Activities	3								**3**
Total Credits									**163**
Value Added Courses (Optional) – Honours / Minor									**15**
Total Credits									**178**

SEMESTER III						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P-J**	**Hours**	**Credit**
A	BSC	23MAL20B	Discrete Mathematical Structures	3-1-0-0	4	4
B	PCC	23CSL20A	Data Structures	3-1-0-0	4	4
C	PCC	23CSL20B	Computer Organization and Architecture	3-1-0-0	4	4
D	PCC	23CSB20C	Object Oriented Programming Concepts	3-0-2-0	5	4
E	ESC	23ESL00A	Design and Engineering	2-0-0-0	2	2
G	MNC	23NCL20A	Professional Ethics	2-0-0-0	2	---
S	PCC	23CSP20A	Hardware Lab	0-0-3-0	3	2
T	PCC	23CSP20B	Data Structures Lab	0-0-3-0	3	2
M	VAC		Minor Course	3-0-0-0	3	3
TOTAL					27/30	22/25

SEMESTER IV						
Slot	**Category Code**	**Course Number**	**Courses**	**L-T-P-J**	**Hours**	**Credit**
A	BSC	23MAL20D	Mathematics for Artificial Intelligence	3-1-0-0	4	4
B	PCC	23CSL20D	Operating Systems	3-1-0-0	4	4
C	PCC	23CSL20E	Database Management Systems	3-1-0-0	4	4
D	PCC	23CSL20F	Formal Languages and Automata Theory	3-1-0-0	4	4
E	HSC	23HSL20A	Universal Human Values- II	3-0-0-0	3	3
G	MNC	23NCL20B	Industrial Safety Engineering	2-1-0-0	3	---
S	PCC	23CSP20C	Operating Systems Lab	0-0-3-0	3	2
T	PCC	23CSP Database Lab 20D	Database Lab	0-0-3-0	3	2
M/H	VAC		Minor/Honours Course	3-0-0-0	3	3
TOTAL					28/31	23/26

MINOR

Semester	BASKET I Specialization: SOFTWARE ENGINEERING				BASKET II Specialization: MACHINE LEARNING				BASKET III Specialization: NETWORKING			
	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
S3	23CSL2MA	Object Oriented Programming	3-0-0-0	3	23CSL2MC	Mathematics for Machine Learning	3-0-0-0	3	23CSL2ME	Data Communication	3-0-0-0	3
S4	23CSL2MB	Programming Methodologies	3-0-0-0	3	23CSL2MD	Concepts in Machine Learning	3-0-0-0	3	23CSL2MF	Introduction to Computer Networks	3-0-0-0	3
S5	23CSL3MA	Concepts in Software Engineering	3-0-0-0	3	23CSL3MC	Concepts in Deep Learning	3-0-0-0	3	23CSL3ME	Client Server Systems	3-0-0-0	3
S6	23CSL3MB	Introduction to Software Testing	3-0-0-0	3	23CSL3MD	Reinforcement Learning	3-0-0-0	3	23CSL3MF	Wireless Networks and IoT Applications	3-0-0-0	3
S7/ S8	23CSJ4MA	Mini Project	0-0-6-0	3	23CSJ4MA	Mini Project	0-0-6-0	3	23CSJ4MA	Mini Project	0-0-6-0	3

Semester	Basket IV Specialization: Data Science				Basket V Specialization: Network Security			
	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
S3	23CSL2MG	Statistics for Data Science and Time Forecasting	3-0-0-0	3	23CSL2MI	Basics of Computer Systems	3-0-0-0	3
S4	23CSL2MH	Data Visualization & ML	3-0-0-0	3	23CSL2MJ	Cyber Security	3-0-0-0	3
S5	23CSL3MG	Natural Language Processing	3-0-0-0	3	23CSL3MI	Introduction to Blockchain technologies	3-0-0-0	3
S6	23CSL3MH	Deep Learning	3-0-0-0	3	23CTL3MJ	Privacy and security in IoT	3-0-0-0	3
S7/S8	23CSJ4MA	Mini Project	0-0-6-0	3	23CSJ4MA	Mini Project	0-0-6-0	3

HONOURS

Semester	Basket I Specialization: SECURITY IN COMPUTING				Basket II Specialization: COMPUTATIONAL BIOLOGY				Basket III Specialization: COMPUTER VISION			
	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit	Course Number	Course	L-T-P-J	Credit
S4	23CSL2HB	Number Theory	3-0-0-0	3	23CTL2HB	Computational Fundamentals for Bioinformatics	3-0-0-0	3	23CTL2HD	Advanced Topics in Computer Graphics	3-0-0-0	3
S5	23CSL3HA	Cryptographic Algorithms	3-0-0-0	3	23CTL3HA	Computational Biology	3-0-0-0	3	23CTL3HC	Advanced Concepts In Computer Vision	3-0-0-0	3
S6	23CSL3HD	Network Security	3-0-0-0	3	23CTL3HB	Machine Learning in Computational Biology	3-0-0-0	3	23CTL3HD	Image And Video Processing	3-0-0-0	3
S7	23CSL4HA	Cyber Forensics	3-0-0-0	3	23CTL4HA	Computational Health Informatics	3-0-0-0	3	23CTL4HC	Surveillance Video Analytics	3-0-0-0	3
S8	23CTJ4HA	Mini Project	0-0-6-0	3	23CTJ4HB	Mini Project	0-0-6-0	3	23CTJ4HD	Mini Project	0-0-6-0	3

SEMESTER III

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL20A	**Data Structures**	**PCC**	**3**	**1**	**0**	**0**	**4**	**2023**

i. COURSE OVERVIEW

This course aims to introduce the various data structures, their organization and operations. It covers abstract concepts for data organization and manipulation using data structures such as stacks, queues, linked lists, binary trees, heaps and graphs. It helps the learner to apply appropriate data structures and associated algorithms for solving real world problems efficiently.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Design an algorithm for a computational task and calculate the time/space complexities.	Apply
CO 2	Identify suitable data structure (array or linked list) to represent a data item required to be processed to solve a given computational problem and write an algorithm to find the solution of the computational problem.	Apply
CO 3	Design an algorithm to find the solution of a computational problem by selecting an appropriate data structure (binary tree/graph) to represent a data item to be processed.	Apply
CO 4	Apply appropriate Hash Function to store a given dataset and enable efficient access of data in the given set.	Apply
CO 5	Make use of appropriate sorting algorithms based on specific circumstances.	Apply

iii. SYLLABUS

Introduction: Basic Concepts of Data Structures, Algorithms, Performance Analysis, Asymptotic Notation, Complexity Calculation of Simple Algorithms.

Arrays and Searching: Sparse matrix, Stacks and Queues, Linear Search and Binary Search.

Linked List and Memory Management: Operations on Linked List, Types of Linked Lists, Stacks and Queues, Memory allocation and deallocation -First-fit, Best-fit and Worst-fit.

Trees and Graphs: Binary Trees, Binary Search Trees, Graph Representations, Depth First Search and Breadth First Search, Applications of Graphs.

Sorting and Hashing: Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions.

iv(a)TEXTBOOKS

1. Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C.

(b) REFERENCES

1. Samanta D., Classic Data Structures, Prentice Hall India.
2. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
3. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson
4. Publication.
   Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction: Basic Concepts of Data Structures, System Life Cycle, Algorithms, Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notation, Complexity Calculation of Simple Algorithms	**8**
II	Arrays and Searching: Polynomial representation using Arrays, Sparse matrix, Stacks, Queues-Circular Queues, Priority Queues, Double Ended Queues, Evaluation of Expressions, Linear Search and Binary Search	**14**
III	Linked List and Memory Management: Self-Referential Structures, Dynamic Memory Allocation, Operations on Linked List-Singly Linked List, Doubly Linked List, Circular Linked List. Stacks and Queues using Linked List, Polynomial representation using Linked List, Memory allocation and deallocation-First-fit, Best-fit and Worst-fit allocation schemes	**14**

IV	Trees and Graphs: Trees, Binary Trees-Tree Operations, Binary Tree Representation, Tree Traversals, Binary Search Trees- Binary Search Tree Operations, Graphs, Representation of Graphs, Depth First Search and Breadth First Search on Graphs, Applications of Graphs	**14**
V	Sorting and Hashing: Sorting Techniques – Selection Sort, Insertion Sort, Quick Sort, Merge Sort and Heap Sort, Hashing- Hashing Techniques, Collision Resolution, Overflow handling, Hashing functions – Mid square, Division, Folding, Digit Analysis	**10**
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	**:**	**40 marks**
End Semester Examination	**:**	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL20B	**Computer Organization and Architecture**	**PCC**	**3**	**1**	**0**	**0**	**4**	**2023**

PRE-REQUISITE: 23ESL10Q Digital Electronics

i. COURSE OVERVIEW:

The aim of this course is to enable students to understand the fundamental architecture of a digital computer. Study of Computer Organization and Architecture is essential to understand the hardware behind the code and its execution at physical level by interacting with existing memory and I/O structure. It helps the learners to understand the fundamentals about computer system design so that they can extend the features of computer organization to detect and solve problems occurring in computer architecture.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the relevance of basic components, I/O organization, types of memory systems and pipelining schemes in a computer.	Understand
CO 2	Solve cache mapping problems used in memory systems.	Apply
CO 3	Develop the control signals required for the execution of a given instruction.	Apply
CO 4	Model Arithmetic Logic Unit and its registers.	Apply
CO 5	Solve the numerical problems using arithmetic algorithms in a computer.	Apply
CO 6	Develop the control logic for a given arithmetic problem.	Apply

iii. SYLLABUS

Fundamental building blocks and functional units of a computer. Memory locations and addresses. Execution phases of an instruction.

Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations. Processor logic design: Design of arithmetic circuit, logic circuit, arithmetic logic unit, shifter, accumulator.

Arithmetic Algorithms, Pipelining, Basic principles, classification of pipeline processors, instruction and arithmetic pipelines, hazard detection and resolution.

Design of the processing unit – how arithmetic and logic operations are performed. Design of the control unit – hardwired and microprogrammed control.

I/O organisation – interrupts, DMA, different interface standards. Memory Subsystem – different types.

iv.(a) TEXT BOOKS

1. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization and Embedded Systems ,6/e, McGraw Hill, 2023.
2. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013
3. M. Morris Mano, Computer System Architecture, 3/e, Pearson Education, 2007.

(b) REFERENCES

1. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.

v. COURSE PLAN

Module	Contents	No. of hours
I	Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes. Basic processing unit – fundamental concepts – instruction cycle – execution of a complete instruction - single bus and multiple bus organization	**12**
II	Register transfer logic: inter register transfer – arithmetic, logic and shift micro operations. Processor logic design: - processor organization – Arithmetic logic unit - design of arithmetic circuit - design of logic circuit - Design of arithmetic logic unit - status register – design of shifter - processor unit – design of accumulator.	**12**
III	Arithmetic algorithms: Algorithms for multiplication and division (restoring method) of binary numbers. Array multiplier, Booth's multiplication algorithm. Pipelining: Basic principles, classification of pipeline processors, instruction and arithmetic pipelines (Design examples not required), hazard detection and resolution.	**12**
IV	Control Logic Design: Control organization – Hardwired control- microprogram control –control of processor unit - Microprogram sequencer, micro programmed CPU organization -horizontal and vertical micro instructions.	**11**

V	I/O organization: accessing of I/O devices – interrupts, interrupt hardware - Direct memory access. Memory system: basic concepts – semiconductor RAMs. memory system considerations –ROMs, Content addressable memory, cache memories - mapping functions.	**13**
	Total Hours	**60**

vi. ASSESMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSB20C	**Object Oriented Programming Concepts**	**PCC**	**3**	**0**	**2**	**0**	**4**	**2023**

i. COURSE OVERVIEW

Aim of the course is to introduce Object oriented concepts in programming. The course introduces Object Oriented Principles, Object Oriented Programming in Java, Exception handling, Event handling, multithreaded programming, and graphical user interface programming. The course will enable learners to solve problems by breaking it down to object level while designing software and implementing it using Java.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Summarize the Basic features and architecture of Java	Understand
CO 2	Construct Object Oriented Design using Unified Modelling Language (UML)	Apply
CO 3	Apply the object-oriented concepts - classes, objects, constructors, data hiding, inheritance, and polymorphism to write Java programs.	Apply
CO 4	Utilize packages & interfaces, input/output streams, files and string-handling mechanisms to develop programs	Apply
CO 5	Utilize exception handling, multithreading and database connectivity to develop java applications.	Apply
CO 6	Apply event handling features and swing to develop Graphical User Interface based Java application programs	Apply

iii. SYLLABUS

Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Object Modeling Using Unified Modeling Language (UML) – Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram. Introduction to Java - Java programming Environment and Runtime Environment, Java Virtual Machine (JVM), Java compiler, Bytecode.

Core Java Fundamentals: Data types, Operators, Control Statements, Object Oriented Programming in Java - Class Fundamentals, Constructors, Method Overloading, Access Control, Command Line Arguments, Inheritance - Method Overriding, Abstract Classes and Methods.

Packages and Interfaces, Interfaces, String Handling, Comparison of String Buffer and String, Input/ Output - Reading Console Input, Writing Console Output, Object Streams and Serialization, Working with Files.

Exception Handling, Collections framework, Collections Class, Event handling - Delegation Event

Model, Multithreaded Programming.

Swings fundamentals - Model View Controller (MVC), Event Handling in Swings, Exploring Swings, Java Database Connectivity (JDBC).

iv (a) TEXTBOOKS

1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.
2. Bahrami A., Object Oriented Systems Development using the Unified Modeling Language, McGraw Hill, 1999.
3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

(b) REFERENCES

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008
3. Balaguruswamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014.

v. COURSE PLAN

Module	Contents	Hours
I	Approaches to Software Design - Functional Oriented Design, Object Oriented Design, Object Modeling Using Unified Modeling Language (UML) – Basic Object Oriented concepts, UML diagrams, Use case model, Class diagram, Interaction diagram, Activity diagram, State chart diagram. Introduction to Java - Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. Java Virtual Machine (JVM), Java compiler, Bytecode, Java Buzzwords, Java program structure, Comments, Garbage Collection.	**8**
	Basic programs using datatypes, operators, and control statements in Java.	**4**
II	Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, using final with Inheritance.	**12**
	Object Oriented Programming Concepts: Problem on the use of constructors, inheritance, method overloading & overriding, polymorphism	**5**

III	Java Library - String Handling – String Constructors, String Length, Special String Operations - Character Extraction, String Comparison, Searching Strings, Modifying Strings, using value Of(), Comparison of String Buffer and String. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Input/ Output - I/O Basics, Reading Console Input, Writing Console Output, PrintWriter Class, Object Streams and Serialization, Working with Files.	**8**
	File Handling: Problems on performing I/O operations using streams and files	**6**
IV	Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch Clauses, Nested try Statements, throw, throws and finally. Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – Array List class. Accessing a Collection via an Iterator. Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, and Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads.	**9**
	Exception handling and multi-threading applications	**5**
V	Graphical User Interface and Database support of Java: Swings fundamentals - Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, JTextField. Java Database Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select.	**8**
	Graphics Programming and database connectivity	**5**
	Binary Search and Sorting Algorithms (Quick Sort or Merge Sort)	**5**
	Total Hours	**75**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 60: 40

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks

Assignment	:	15 marks
Lab Work	:	10 marks
Lab Exam	:	10 marks
Total	:	**60 marks**
End Semester Examination	:	**40 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 40
- Exam Duration: 2 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSP20A	Hardware Lab	PCC	0	0	3	0	2	2023

PRE-REQUISITE: 23ESL10Q Digital Electronics

i. COURSE OVERVIEW: This course aims to familiarize students with the Digital Logic Design and the implementation of logic circuits using ICs of basic logic gates and flip flops. Also expose the students to the various arithmetic circuits used in computers by enabling them to perform simulation of experiments with support of a virtual environment. This course helps the learners to develop a digital logic and apply it to solve real life problems.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Design and implement combinational logic circuits using logic gates	Apply
CO 2	Design and implement sequential logic circuits using Integrated Circuits	Apply
CO 3	Design and simulate experiments related to computer architecture with support of a virtual environment.	Apply

LIST OF EXPERIMENTS
Part-A

- A two-hour session should be spent to make the students comfortable with the use of trainer kit/breadboard and ICs.
- The following experiments can be conducted on breadboard or trainer kits.

1. Realization of functions using basic and universal gates (SOP and POS forms).
2. Design and realization of half adder, full adder, half subtractor and full subtractor using basic gates.
3. Design and implement a 4-bit adder/subtractor circuit using IC7483.
4. Implementation of Flip Flops: SR, D, T, JK using basic gates.
5. Asynchronous Counter: Realization of Mod N counters (At least one up counter and one down counter to be implemented).
6. Synchronous Counter: Realization of Mod-N counters and sequence generators. (At least one mod N counter and one sequence generator to be implemented)
7. Realization of Shift Register (Serial input left/right shift register), Ring counter and Johnson Counter using flip flops.
8. Realization of combinational circuits using MUX & DEMUX ICs (74150, 74154).

Part-B

The following experiments aim at training the students to the various key aspects of Digital Logic and Computer Architecture by enabling them to perform simulation of experiments with support of a virtual environment.

Experiment 1. Design of Ripple Carry Adders.

Experiment 2. Design a 4-bit Booth's multiplier circuit.

Experiment 3: Design of 4-bit ALU

Experiment 4: Design of 4X3 RAM memory.

iii. (a) TEXT BOOKS

1. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013.
2. Hamacher C., Z. Vranesic and S. Zaky, Computer Organization and Embedded Systems ,6/e, McGraw Hill, 2023.
3. T. L. Floyd, *Digital Fundamentals*, 11/e, Pearson Education, 2018.
4. Arun Kumar Singh, Digital Principles Foundation of Circuit Design and Application- New Age Publishers, 2006.

(b) REFERENCE

1. http://vlabs.iitkgp.ernet.in/coa/

2.http://vlabs.iitkgp.ac.in/coa/exp8/alut/alut.html

iv. COURSE PLAN

Experiment No.	List of exercises/experiments	No. of hours
1	Realization of functions using basic and universal gates (SOP and POS forms).	3
2	Design and realization of half adder, full adder, half subtractor and full subtractor using basic gates and universal gates.	3
3	Design and implement a 4-bit adder/subtractor circuit using IC7483.	3
4	Implementation of Flip Flops: SR, D, T, JK and Master Slave JK Flip Flops using basic gates.	3
5	Asynchronous Counter: Realization of Mod N counters (At least one up counter and one down counter to be implemented).	3
6	Synchronous Counter: Realization of Mod-N counters and sequence generators. (At least one mod N counter and one sequence generator to be implemented)	3

7	Realization of Shift Register (Serial input left/right shift register), Ring counter and Johnson Counter using flip flops.	3
8	Realization of combinational circuits using MUX & DEMUX ICs (74150, 74154).	3
9	Design of Ripple Carry Adders.	3
10	Design a 4-bit Booth's multiplier circuit.	6
11	Design of 4-bit ALU	6
12	Design of 4X3 RAM memory	6
	Total	**45**

v. Assessment Pattern

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment	:	55 marks
Final Assessment	:	40 marks
Total	**:**	**100 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSP20B	**Data Structures Lab**	**PCC**	**0**	**0**	**3**	**0**	**2**	**2023**

i. COURSE OVERVIEW

The aim of this course is to give hands-on experience in creating and using different Data Structures. It also covers various applications of linear and nonlinear Data Structures. This course helps the learners to select appropriate data structures to solve computational problems.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Implement different data structures like stacks, queues, linked lists, trees and graphs efficiently.	Apply
CO 2	Apply appropriate data structures to solve problems efficiently.	Apply
CO 3	Design an efficient program to search/sort a list of records.	Apply
CO 4	Implement different hashing techniques.	Apply

iii. SYLLABUS

Searching techniques. Stack, queue and their applications. Linked lists and its applications. Trees and its applications, Graph traversals, Different sorting techniques, Different Hashing Techniques.

iv.REFERENCE BOOKS

1. Ellis Horowitz, SartajSahni and Susan Anderson-Freed, Universities Press, Fundamentals of Data Structures in C.

2. Samanta D., Classic Data Structures, Prentice Hall India.

3. Richard F. Gilberg, Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning.
4. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication.
5. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill.

v. COURSE PLAN

Experiment No.	List of Exercises	No. of hours
I	Implementation of different searching techniques.	**3**
II	Implementation of stack, queue and their applications.	**9**
III	Implementation of linked lists and its applications.	**9**
IV	Implementation of trees and its applications	**9**
V	Implementation of graph traversals.	**3**
VI	Implementation of different sorting techniques	**6**
VII	Implementing different hashing techniques.	**6**
	Total Hours	**45**

vi. Assessment Pattern

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment	:	55 marks
Final Assessment	:	40 marks
Total	**:**	**100 marks**

MINOR

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MA	**Object Oriented Programming**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

The purpose of this course is to enable learners to solve problems by breaking it down to object level while designing software and to implement it using Java. This course introduces Object Oriented Principles, Object Oriented Programming in Java, Inheritance, Exception handling, Event handling, multithreaded programming and working with window-based graphics. This course helps the learners to develop Mobile applications, Enterprise Applications, Scientific Applications and Web based Applications.

ii. COURSE OUTCOMES

Course Outcomes	Description	Level
CO 1	Summarize the basic features and architecture of Java	Understand
CO 2	Construct Object Oriented Design using Unified Modelling Language (UML)	Apply
CO 3	Apply the object-oriented concepts – classes, objects, constructors, data hiding, inheritance and polymorphism to write Java programs	Apply
CO 4	Utilize packages and interfaces, input/output streams, files and exception handling mechanism to develop programs	Apply
CO 5	Utilize multithreading to develop Java applications	Apply
CO 6	Apply event handling features and swing to develop Graphical User Interface based Java application programs	Apply

iii. SYLLABUS

Introduction - Approaches to Software Design, Object Modeling using UML, Introduction to Java - JVM, Java Compiler, Bytecode.

Core Java Fundamentals – Primitive Data types, Operators, Control Statements, Object Oriented Programming in Java - Class and Object fundamentals, Constructors, Access Control, Command-line Arguments.

More features of Java – Inheritance, Packages and Interfaces, Abstract Classes and Methods, Exception Handling.

Advanced Features of Java – Input/ Output, Java Library, String Handling, Collections Framework.

GUI Programming, Event Handling and Multithreaded Programming – Swing Fundamentals,

Event Handling, Multithreaded Programming.

iv (a) TEXT BOOKS

1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill,2011.
2. Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI,2014.
3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.

(b) REFERENCES

1. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson,2013.
2. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press,2008.
3. Flanagan D., Java in A Nutshell, 5/e, O'Reilly,2005.
4. Barclay K., J. Savage, Object Oriented Design with UML and Java, Elsevier,2004.
5. Sierra K., Head First Java, 2/e, O'Reilly,2005.
6. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill,2014.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction - Approaches to Software Design- Functional Oriented Design, Object-Oriented Design, Object Modeling Using UML – Basic object oriented concepts. Basic object oriented concepts. UML diagrams, Use case model. Class diagram. Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise. JVM, Java compiler, Bytecode. Java Buzzwords, Java program structure, Comments, Garbage Collection.	8
II	Primitive Data types - Integers, Floating Point Types, Characters, Boolean. Literals, Type Conversion and Casting, Variables, Arrays, Strings, Vector class. Operators - Arithmetic Operators, Bitwise Operators, Relational Operators, Boolean Logical Operators, Assignment Operator, Conditional (Ternary) Operator, Operator Precedence. Control Statements - Selection Statements, Iteration Statements and Jump Statements. Object Oriented Programming in Java - Class Fundamentals, Declaring Objects. Introduction to Methods. Constructors, **this** Keyword. Method Overloading, Recursion. Access Control, static Members. Final Variables, Inner Classes. Command-Line Arguments.	10
III	Inheritance - Super class, Sub class, the keyword super, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes and Methods, Using final with Inheritance. Packages and Interfaces - Defining Package, CLASSPATH, Access Protection, Importing Packages. Interfaces. Exception Handling - Checked Exceptions, Unchecked Exceptions, **try** Block and **catch** Clause, Multiple **catch** Clauses, Nested **try** Statements, **throw**, **throws** and **finally.**	9
IV	Input/output - I/O Basics, Reading Console Input. Writing Console Output, PrintWriter Class. Object Streams and Serialization, Serialization, Working with Files. Java Library - String Handling – String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, Modifying Strings Using valueOf( ), Comparison of string Buffer and String. Collections framework – Collections overview, Collections	9

	Class – Array List. Accessing Collections via an Iterator.8	
V	Swings fundamentals, Swing Key Features. MVC, Swing Controls, Components and Containers. Exploring Swing –JFrame, JLabel, JButton, JTextField. Event handling - Event Handling Mechanisms, Delegation Event Model, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming- The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Suspending, Resuming and Stopping Threads.	9
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5
Continuous Assessment Tests	:	20
Assignment	:	15
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MC	**Mathematics for Machine Learning**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

PRE REQUISTE: 23MAL10A Linear Algebra & Calculus

i. COURSE OVERVIEW: This is the foundational course for awarding B. Tech. Minor in Computer Science and Engineering with specialization in Machine Learning. The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability and Distributions, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand & debug existing ones, and learn about the inherent assumptions & limitations of the current methodologies.

ii. COURSE OUTCOMES

After the completion of the course the student will be able to:

Course Outcomes	Description	Level
CO 1	Make use of the concepts of linear algebra and matrices.	Apply
CO 2	Compute solutions by applying analytical geometry methods.	Apply
CO 3	Solve machine learning problems using gradients and partial differentiation	Apply
CO 4	Perform operations on random variables and compute probability	Apply
CO5	Develop Machine Learning Models using unconstrained and constrained optimization methods	Apply

iii. SYLLABUS

Linear Algebra: Systems of Linear Equations, Matrices**,** Analytic geometry.

Matrix Decompositions: Norms, Eigen decomposition and Diagonalization.

Vector Calculus: differentiation of Univariate Functions, Useful Identities for Computing Gradients**.**

Probability and Distributions: Data and Learning Model Empirical Risk Minimization**,** Summary Statistics and Independence.

Optimization: Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

iv (a) TEXT BOOKS

1. J. Stewart, Essential Calculus, Cengage, 2nd Edition, 2017.

(b)REFERENCES

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2. Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press

v. COURSE PLAN

Module	Contents	No. of hours
I	**LINEAR ALGEBRA:** Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.	**9**
II	**ANALYTIC GEOMETRY, MATRIX DECOMPOSITIONS:** Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation.	**9**
III	**VECTOR CALCULUS:** Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives Linearization and Multivariate Taylor Series.	**7**
IV	**Probability and Distributions:** Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution - Conjugacy and the Exponential Family - Change of Variables/Inverse Transform.	**8**
V	**Optimization:** Optimization Using Gradient Descent - Gradient Descent with Momentum, Stochastic Gradient Descent. Constrained Optimization and Lagrange Multipliers - Convex Optimization - Linear Programming - Quadratic Programming	**12**
	Total hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks

Total	:	**40marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2ME	Data Communication	VAC	3	0	0	0	3	2023

i. COURSE OVERVIEW

The purpose of this course is to prepare learners to understand the communication entities and the associated issues in the field of Computer Science. This course covers fundamental concepts of data transmission &media, digital &analog transmissions, multiplexing & spread spectrum, error detection &correction and switching. Concepts in data communication help the learner to understand the concepts in networking and mobile communication.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the characteristics of signals used for Analog and Digital Transmissions.	Understand
CO 2	Discuss the features, issues in data transmission and selection of transmission media based on characteristics and propagation modes.	Understand
CO 3	Apply appropriate signal encoding techniques for a given scenario.	Apply
CO 4	Illustrate multiplexing, spread spectrum technologies and switching techniques used in data communication.	Understand
CO 5	Apply error detection & correction techniques.	Apply

iii. SYLLABUS

Data Transmission Basics - Communication model - Periodic Analog signals - Analog & digital data and signals - Transmission Impairments-Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.

Transmission Media - Guided Transmission Media - Unguided media -Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.

Digital Transmission and Analog Transmission - Digital data to Digital signal - Analog data to Digital signal - Digital data to Analog signal - Analog data to Analog signal.

Multiplexing and Spread Spectrum - Multiplexing - FDM, WDM,TDM, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - DSSS, FHSS, CDM, CDMA.

Error Detection, Correction and Switching - Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors- Detection Methods - Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.

iv (a) TEXT BOOKS

1. Forouzan B. A., Data Communications and Networking, 5/e, McGraw Hill, 2013.
2. William Stallings, Data and Computer Communication 9/e, Pearson Education, Inc.

(b) REFERENCES

1. Schiller J., Mobile Communications, 2/e, Pearson Education, 2009.
2. Curt M. White, Fundamentals of Networking and Communication 7/e, Cengage learning.

v. COURSE PLAN

Module	Contents	Hours
I	**Data Transmission Basics** Communication model - Simplex, Half duplex, Full duplex transmission. Periodic Analog signals - Sine wave, Amplitude, Phase, Wavelength, Time and frequency domain, Bandwidth. Analog & digital data and signals. Transmission impairments - Attenuation, Delay distortion, Noise. Data rate limits - Noiseless channel, Nyquist bandwidth, Noisy channel, Shannon's capacity formula.	**8**
II	**Transmission Media** Guided Transmission Media - Twisted pair, Coaxial cable, Optical fiber. Unguided media - Radio waves, Terrestrial microwave, Satellite microwave, Infrared. Wireless Propagation - Ground wave propagation, Sky Wave propagation, Line-of-Sight (LoS) Propagation.	**7**
III	**Digital Transmission and Analog Transmission** Digital data to Digital signal – Non-Return-to-Zero (NRZ), Return- to-Zero (RZ), Multilevel binary, Biphase. Analog data to Digital signal - Sampling theorem, Pulse Code Modulation (PCM), Delta Modulation (DM). Digital data to Analog signal: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying(PSK). Analog data to Analog signal: Amplitude Modulation (AM),Frequency Modulation (FM), Phase Modulation (PM).	**11**
IV	**Multiplexing and Spread Spectrum** Multiplexing - Frequency Division Multiplexing (FDM), Wave length Division Multiplexing (WDM), Time Division Multiplexing (TDM), Characteristics, Synchronous TDM, Statistical TDM. Spread Spectrum Techniques - Direct Sequence Spread Spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS), Code Division Multiplexing, Code Division Multiple Access (CDMA).	**10**

V	**Error Detection, Correction and Switching** Digital data communication techniques - Asynchronous transmission, Synchronous transmission. Detecting and correcting errors - Types of Errors, Parity check, Checksum, Cyclic Redundancy Check (CRC), Forward Error Correction (FEC), Hamming Distance, Hamming Code. Basic principles of Switching - Circuit Switching, Packet Switching, Message Switching.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MG	Statistics for Data Science and Time Forecasting	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

This course provides a comprehensive introduction to statistical concepts, data analysis techniques, and time series forecasting methods, with a focus on practical implementation using Python. Through a combination of theoretical lectures, hands-on exercises, and case studies, students will learn to analyze data, build predictive models, and forecast time series data for various applications.

ii. COURSE OUTCOMES

Course Outcomes	Description	Level
CO 1	Explain the fundamental concepts in statistics and probability theory	Understand
CO 2	Comprehend the importance of sampling distributions and the Central Limit Theorem in statistical inference.	Understand
CO 3	Interpret visualizations to identify relationships and trends within the data.	Apply
CO 4	Explain the components of time series data and their implications for analysis	Understand
CO 5	Evaluate forecast accuracy and performance metrics to assess the effectiveness of forecasting models.	Apply

iii. SYLLABUS

Statistics and probability theory, Sampling distributions and the Central Limit Theorem, Parametric vs. non-parametric tests, Understanding EDA and its importance, Correlation analysis and heatmap visualization, ARIMA Models and Forecasting Seasonal decomposition techniques, Forecast evaluation and performance metrics

iv(a)TEXT BOOKS

1. Richard Golden, Statistical Machine Learning A Unified Framework (1st ed.), CRC Press 2020. ISBN 9781351051490.
2. An Introduction to Statistical Learning with Applications in R" by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani
3. "Time Series Analysis and Its Applications: With R Examples" by Robert H. Shumway and David S. Stoffer

(b) REFERENCES

1. Masashi Sugiyama, Introduction to Statistical Machine Learning on (1st ed.),

Morgan Kaufmann, 2017. ISBN 978-0128021217.

2. VanderPla, 2016. Jake. Python Data Science Handbook.
3. Andrew Park, 2021, Data Science for Beginners
4. Muller, A.C. and Guido, S., 2017. Introduction to machine learning with Python. O'Reilly.

v. COURSE PLAN

Module	Contents	Hours
I	Overview of statistics and probability theory Descriptive statistics: measures of central tendency and dispersion Probability concepts: random variables, probability distributions, and probability rules. Case study Using Python implementation	9
II	Sampling distributions and the Central Limit Theorem,Confidence intervals and hypothesis testing,Parametric vs. non-parametric tests, Case study Using Python implementation	12
III	Exploratory Data Analysis (EDA) Understanding EDA , Visual EDA - Univariate, Bivariate, and Multivariate Analysis- Correlation and Heatmaps. Case study Using Python implementation	9
IV	Introduction to time series data, Time series components: trend, seasonality, and noise. Autocorrelation and partial autocorrelation functions. Stationarity and its implications, ARIMA (AutoRegressive Integrated Moving Average) models Case study Using Python implementation	9
V	Model identification, estimation, and diagnostics ,Exponential smoothing methods ,Seasonal decomposition techniques , Forecast evaluation and performance metrics	6
	Total Hours	**45**

vi. ASSESMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MI	BASICS OF COMPUTER SYSTEMS	VAC	3	0	0	0	3	2023

i. COURSE OVERVIEW

This course mainly deals with basic working technology and concepts of computer organization, operating systems and computer networks. This course provides basic understanding about working of a personal computer and uses of I/O devices. This course also provides the basic concepts of operating systems including process management, memory management, process synchronization and file management. Also various aspects of network communication, understand the concept of networking devices are explained in the course.

ii. **COURSE OUTCOMES**: After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Recognize and express the relevance of basic components, I/O organization,memory systems and pipelining schemes in a digital computer.	Understand
CO2	Explain concepts of process management and process scheduling mechanisms and process synchronization employed in Operating Systems.	Understand
CO3	Explain the concepts of process and memory management mechanisms deployed in computing devices.	Understand
CO4	Explain the features of computer networks, protocols, and network design models.	Understand
CO5	Recognize appropriate routing algorithms, congestion control techniques and analyze the functions and protocols of the network layer, transport layer, and application layer in inter-networking.	Understand

iii. SYLLABUS

Functional units of a computer: CPU, memory, I/O; Data representation; Processor design: Instruction set architecture, pipelining; Memory: Concept of hierarchical memory organization, cache memory, mapping functions and replacement algorithms, main memory organization; Input-Output: I/O transfers - program-controlled, interrupt-driven and DMA. Processes and threads and their scheduling, synchronization, deadlocks in concurrent processes; Memory management basics, demand paging and virtual memory implementation; File system design and implementation. OSI and TCP/IP Model; Local area networks: Multiple access techniques – wired and wireless; Concepts of switched networks, Internet addressing and routing algorithms; Transport protocols, UDP, TCP, flow control, congestion control; Application Layer: Client-Server and P2P architecture, API; Application layer protocols such as DNS, SSL, WWW, HTTP.

iv (a) TEXT BOOKS

1. A.Silberschatz, P.B. Galvin and G,Gagne, Operating system concepts, 9th Edition, Wiley India 2009.

2. **Carl Hamacher, Zvonko Vranesic, Safwat Zaky ,Computer Organization, 5th Edition, McGraw Hill, 2002.**

3. Computer Networks by Andrew S. Tanenbaum, 4/e, PHI (Prentice Hall India).

(b) REFERENCE

1. Andrew S Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice Hall, 2015.

2. William Stallings, “Operating systems”, 6th Edition, Pearson, Global Edition, 2015.

3. William Stallings, Computer Networking with Internet Protocols, Prentice-Hall, 2004.

4. Larry L Peterson and Bruce S Dave, Computer Networks – A Systems Approach, 5/e, Morgan Kaufmann.

5. M. Morris Mano, Digital Logic & Computer Design, 4/e, Pearson Education, 2013 .

6. Patterson D.A. and J. L. Hennessy, Computer Organization and Design, 5/e, Morgan Kaufmann Publishers, 2013.

7. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson, 9/e, 2013.

v. COURSE PLAN

Module	Contents	No. of hours
I	Basic Structure of computers – functional units - basic operational concepts - bus structures. Memory locations and addresses - memory operations, Instructions and instruction sequencing, addressing modes. Pipelining: Basic principles, classification of pipeline processors. Memory system: basic concepts – semiconductor RAMs and ROMs, Cache memories - mapping functions.	**8**
II	I/O organization: accessing of I/O devices – interrupts, interrupt hardware - Direct memory access. Introduction to Operating systems: Functions of an operating system. Processes and threads – Process Management: Process Concept – Processes-States – Process Control Block – Threads. Scheduling- CPU Scheduling . Process synchronization.	**9**
III	Deadlocks – Conditions, Modelling using graphs. Handling – Prevention – Avoidance – Banker's Algorithm and its implementation (P) – Detection- Recovery. Memory Management: Main Memory- – Segmentation – Paging – Demand Paging-Page replacement algorithms. File System Interface: File Concepts – Attributes – operations – types – structure – access methods.	**10**
IV	Introduction – Uses of computer networks, Network hardware, Network software. Reference models – The OSI reference model, The TCP/IP reference model, Comparison of OSI and TCP/IP reference models. Physical Layer – Physical topologies, Repeaters and hub, Transmission media overview. Data link layer - Data link layer design issues, Error detection and correction, Multiple access protocols.	**9**
V	Network layer-IP addressing, Routing Protocols . Transport layer-User Datagram Protocol (UDP). Transmission Control Protocol (TCP)- Congestion control algorithms. Application Layer –File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, Multipurpose Internet Mail Extension (MIME), Simple Network Management Protocol (SNMP), World Wide Web(WWW) – Architectural overview.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	: 5 Marks
Continuous Assessment Tests	: 20 Marks
Continuous Assessment Assignment	: 15 Marks
Total	: 40 Marks
End Semester Examination	**: 60 Marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

SEMESTER IV

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23MAL20E	**MATHEMATICS FOR ARTIFICIAL INTELLIGENCE**	BSC	3	1	0	0	4	2023

i. COURSE OVERVIEW

The purpose of this course is to introduce mathematical foundations of basic Machine Learning concepts among learners, on which Machine Learning systems are built. This course covers Linear Algebra, Vector Calculus, Probability, Optimization and Machine Learning problems. Concepts in this course help the learners to understand the mathematical principles in Machine Learning and aid in the creation of new Machine Learning solutions, understand and debug existing ones, and learn about the inherent assumptions and limitations of the current methodologies.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Make use of the concepts, rules and results about linear equations, matrix algebra, vector spaces, eigenvalues and eigenvectors to solve computational problems	Apply
CO2	Apply concepts of orthogonality and matrix decompositions to solve Engineering problems	Apply
CO3	Apply calculus operations on functions of several variables and matrices, including partial derivatives and gradients	Apply
CO4	Utilize the concepts, rules and results about probability and Bayes' theorem to find solutions of computational problems	Apply
CO5	Use unconstrained and constrained optimization methods in machine learning problems	Apply

iii. SYLLABUS

Systems of Linear Equations, vector spaces, Linear mappings, Orthogonality, Matrix Decompositions: Norms, Eigen decomposition and Diagonalization, Singular Value Decomposition, differentiation of Univariate Functions, Useful Identities for Computing Gradients, Concepts of probability, Baye's theorem, correlation, Independence, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

iv. a) TEXTBOOKS

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong published by Cambridge University Press (freely available at https://mml - book.github.io)

b) REFERENCES

1. Linear Algebra and Its Applications, 4th Edition by Gilbert Strang
2. Linear Algebra Done Right by Axler, Sheldon, 2015 published by Springer
3. Introduction to Applied Linear Algebra by Stephen Boyd and Lieven Vandenberghe, 2018 published by Cambridge University Press ,Engineering Optimization by S.S. Rao, 4th Edition, 2009 published by John Wiley and Sons Inc

v) ASSESSMENT PATTERN

Module	Contents	No. of hours
I	LINEAR ALGEBRA: Systems of Linear Equations – Matrices, Solving Systems of Linear Equations. Vector Spaces –Vector Spaces, Linear Independence, Basis and Rank. Linear Mappings – Matrix Representation of Linear Mappings, Basis Change, Image and Kernel.	**14**
II	ORTHOGONALITY and MATRIX DECOMPOSITIONS: Norms, InnerProducts, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Orthogonal Projections – Projection into One Dimensional Subspaces, Projection onto General Subspaces, Gram-Schmidt Orthogonalization. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition.	**14**
III	VECTOR CALCULUS: Differentiation of Univariate Functions - Partial Differentiation and Gradients, Gradients of Vector Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients. Back propagation and Automatic Differentiation – Gradients in Deep Network, Automatic Differentiation. Higher Order Derivatives Linearization and Multivariate Taylor Series.	**10**
IV	Probability and Distributions: Construction of a Probability Space - Discrete and Continuous Probabilities, Sum Rule, Product Rule, Conditional probability and Bayes' Theorem. Summary Statistics and Independence – Gaussian Distribution –Linear Correlation-Curve fitting-Co variance matrix-independence.	**12**
V	Classical optimization Techniques -Necessary and sufficient conditions for optimality, Lagrange multiplier, Optimization Using Gradient Descent.	**10**
	Total	**60**

Continuous Assessment: End Semester Examination – 40 : 60

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
End Semester Examination	:	**60 marks**
TOTAL	:	**100 marks**

vi) CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

vii) END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL20D	Operating Systems	PCC	3	1	0	0	4	2023

i.COURSE OVERVIEW

Study of operating system is an essential to understand the overall working of a computer system, tradeoffs between performance and functionality and the division of jobs between hardware and software. This course introduces the concepts of memory management, device management, process management, file management and security & protection mechanisms available in an operating system. The course helps the learner to understand the fundamentals about any operating system design so that they can extend the features of operating system to detect and solve many problems occurring in operating system and to manage the computer resources appropriately.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the relevance, structure and functions of Operating Systems in computing devices.	Understand
CO 2	Apply the concepts of process management and process scheduling mechanisms employed in Operating Systems.	Apply
CO 3	Explain process synchronization in Operating Systems and illustrate process synchronization mechanisms using Mutex Locks, Semaphores and Monitors.	Understand
CO 4	Apply strategies and algorithms for deadlock management to ensure system stability in Operating Systems.	Apply
CO 5	Develop problem solving skills through memory management techniques and disk scheduling algorithms.	Apply
CO 6	Explain the file and storage management, protection and fundamentals of virtualization in Operating Systems.	Understand

iii. SYLLABUS

Introduction: Functions of an operating system-overview. Kernel Data Structures-Operating System Interfaces and implementation - User Interfaces, System Calls. Operating System implementation and Structure, System Boot process.

Process Management, Threads, Scheduling Queues- Context Switching-Process Creation and Termination-CPU Scheduling -Inter Process Communication.

Process Synchronization, Critical Section-Synchronization – Locks, Semaphores, Monitors, Classical Problems and its implementation- Deadlocks- Handling – Prevention – Avoidance-Detection Recovery.

Memory Management-Swapping - Segmentation – Paging – Page replacement algorithms. Storage Management-RAID- Disk structure, Disk scheduling and implementation

File System Interface- Protection in Operating Systems-Directory implementation – allocation methods-Protection-Access Matrix

iv (a) TEXT BOOKS

1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.

(b) REFERENCES

1. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2015.
2. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.
3. Garry Nutt, Nabendu Chaki, Sarmistha Neogy, "Operating Systems", 3rd Edition, Pearson Education,2016.
4 D.M. Dhamdhere, "Operating Systems", 2nd Edition, Tata McGraw Hill, 2011.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction: Functions of an operating system. Single processor, multiprocessor and clustered systems – overview. Kernel Data Structures Operating System Interfaces and implementation - User Interfaces, System Calls – examples. Operating System implementation - approaches. Operating System Structure – Monolithic, Layered, Micro-kernel, Modular. System Boot process.	**10**
II	Process Management: Process Concept – Processes-States – Process Control Block – Threads. Scheduling – Queues – Schedulers – Context Switching. Process Creation and Termination. CPU Scheduling – Scheduling Criteria – Scheduling Algorithms. Inter Process Communication: Shared Memory, Message Passing, Pipes	**12**
III	Process Synchronization: Critical Section - Peterson's solution. Synchronization – Locks, Semaphores, Monitors, Classical Problems and its implementation – Producer Consumer, Dining Philosophers and Readers-Writers Problems (P). Deadlocks – Conditions, Modeling using graphs. Handling – Prevention – Avoidance – Banker's Algorithm – Detection- Recovery.	**13**
IV	Memory Management: Main Memory – Swapping - fixed partitions - variable partitions - – Contiguous Memory allocation – Segmentation – Paging – Demand Paging-Page replacement algorithms. Storage Management: Overview of mass storage structure- disks and tapes. Disk structure – accessing disks. Disk scheduling algorithms.	**12**
V	File System Interface: File Concepts – Attributes – operations – types – structure – access methods. Protection. File system implementation. Directory implementation – allocation methods. Protection– Goals, Principles, Domain. Access Matrix.	**13**

	Virtual machines -overview, Building blocks, Types of virtual machines and their implementations.	
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL20E	**Database Management Systems**	**PCC**	**3**	**1**	**0**	**0**	**4**	**2023**

PRE-REQUISITE: 23MAL20B Discrete Mathematical Structures, 23CSL20A Data Structures

i. COURSE OVERVIEW

This course provides a clear understanding of fundamental principles of Database Management Systems and relational databases. Students will be able to manage data efficiently by identifying suitable structures to maintain data assets of organizations and to develop applications that utilize database technologies.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Model real world scenarios using Entity Relationship diagrams	Apply
CO 2	Design solutions for efficiently representing and querying data using relational model.	Apply
CO 3	Choose an indexing method for database applications.	Apply
CO 4	Make use of the concept of Concurrency Control and Recovery in Database systems.	Apply
CO 5	Explain basic concepts of relational and NoSQL databases.	Understand

iii. SYLLABUS

Types of data, database and DBMS, Languages and users. Software Architecture, E-R Modelling, Relational Model – concepts and languages, relational algebra SQL, views,

Assertions and triggers, relational database design, Functional Dependency and normal forms, Secondary storage organization, indexing, query optimization, concurrent transaction processing and recovery principles, Introduction to NoSQL.

iv (a) TEXT BOOKS

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 7/e, 2017.

2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.
.

(b) REFERENCES

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction to Database and Entity Relationship (ER) Model Concept & Overview of Database Management Systems (DBMS) - Characteristics of Database system, Database Users, structured, semi-structured and unstructured data. Data Models and Schema - Three Schema architecture. Database Languages, Database architectures and classification. ER model - Basic concepts, entity set & attributes, notations, Relationships and constraints, cardinality, participation, notations, weak entities, relationships of degree 3. Structure of Relational Databases - Integrity Constraints, Synthesizing ER diagram to relational schema	**9**
II	Relational Model Relational Algebra - select, project, Cartesian product operations, join - Equi-join, natural join. query examples, introduction to Structured Query Language (SQL), Data Definition Language (DDL), Table definitions and operations – CREATE, DROP, ALTER, INSERT, DELETE, UPDATE. SQL DML (Data Manipulation Language) - SQL queries on single and multiple tables, Nested queries (correlated and non- correlated), Aggregation and grouping, Views, assertions, Triggers, SQL data types	**14**
III	**Normalization** Different anomalies in designing a database, The idea of normalization, Functional dependency, Armstrong's Axioms (proofs not required), Closures and their computation, Equivalence of Functional Dependencies (FD), Minimal Cover (proofs not required). First Normal Form (1NF), Second Normal Form (2NF), Third Normal Form (3NF), Boyce Code Normal Form (BCNF), Lossless join and dependency preserving decomposition, Algorithms for checking Lossless Join (LJ) and Dependency Preserving (DP) properties.	**12**
IV	**Physical Data Organization** Physical Data Organization - Review of terms: physical and logical records, blocking factor, pinned and unpinned organization. Indexing, Primary and Secondary indexing, Single level indices, numerical examples, Multi-level-indices, numerical examples, Clustered and non-	**12**

	clustered indexing. B-Trees & B+-Trees (structure only, algorithms not required).	
V	**Transactions, Concurrency Control, Recovery and Recent Topics** Transaction Processing Concepts - overview of concurrency control, Transaction Model, Significance of concurrency Control & Recovery, Transaction States, System Log, Desirable Properties of transactions. Serial schedules, Concurrent and Serializable Schedules, Conflict equivalence and conflict serializability, Recoverable and cascadeless schedules, Locking, Two-phase locking and its variations. Log-based recovery, Deferred database modification, check-pointing. Introduction to NoSQL Databases.	**13**
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL20F	FORMAL LANGUAGES AND AUTOMATA THEORY	PCC	3	1	0	0	4	2023

i. COURSE OVERVIEW

Formal Languages and automata theory is a core course in theoretical computer science. It deals with automata and grammar representations for languages in Chomsky Hierarchy. The topics covers in this course have applications in various domains including compiler design, decidability and complexity theory.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Classify a given formal language into Regular, Context-Free, Context Sensitive, Recursive or Recursively Enumerable.	Understand
CO 2	Construct finite automaton for regular language.	Apply
CO 3	Construct a Pushdown Automaton and a Context-Free Grammar for a given context-free language.	Apply
CO 4	Model a Turing machine as language acceptors or transducers.	Apply
CO 5	Explain the notion of decidability.	Understand

iii. SYLLABUS

Regular Grammar

Finite Automata: DFA, NFA, NFA with epsilon transition, Equivalence of DFA, NFA and ε-NFA.

Regular grammar, Regular expression, Closure Properties of Regular Languages, pumping lemma, DFA state minimization.

Context Free Grammar

Representation of CFG, Derivation, Ambiguity, Simplification of CFG, Normal Forms, Pumping lemma, Closure Properties of CFG.

Pushdown Automata(PDA), Language acceptance by PDA, Equivalence of PDAs and CFGs.

Context Sensitive Grammar (CSG)

Linear Bounded Automata. Language accepted by LBA.

Unrestricted Grammar

Turing Machine, Instantaneous Description, Variants of Turing Machine, Recursive and Recursively Enumerable Languages, Decidability, undecidability problems on TM.

Chomsky classification of formal languages.

iv (a) TEXT BOOKS

1 John E Hopcroft, Rajeev Motwani and Jeffrey D Ullman, Introduction to Automata Theory, Languages and Computation, 3/e Pearson Education, 2007.

(b) REFERENCES

1. Dexter C. Kozen, Automata and Computability, Springer (1999).

2. Michael Sipser, Introduction to Theory of Computation, Cengage Publishers, 2013.

v. COURSE PLAN

Module	Contents	Hours
I	Introduction– Alphabets, Strings, Languages. Representation of Finite automata. Regular Languages - Deterministic Finite State Automata (DFA) (Proof of correctness of construction not required) Formal Definition, State transition diagram, Transition table, Language of DFA. Nondeterministic Finite State Automata (NFA), Formal Definition, State transition diagram, Transition table, Language of NFA. NFA with epsilon transition. Equivalence of DFA and NFA, Equivalence of ε-NFA and NFA.	**11**
II	Regular Grammar (RG), Equivalence of RGs and DFA, Regular Expression (RE), Equivalence of REs and ε-NFA, DFA to RE, Pumping Lemma for regular languages(proof not required), Closure Properties of Regular Languages, Myhill-Nerode Theorem, DFA state minimization. Application and limitation of finite automata.	**11**
III	Context Free Grammar (CFG)- Representation of Context Free Languages (proof of correctness is required), Derivation of strings (Left most and Right most derivation), derivation trees and ambiguity, Simplification of CFG, Normal forms for CFG- CNF, GNF. Pumping Lemma for Context-Free Languages (Proof not required), Closure Properties of Context Free Languages.	**12**
IV	Pushdown Automata- Definition and representation, Instantaneous Description, Language acceptance by PDA, Acceptance by empty stack, Acceptance by final state. Nondeterministic Pushdown Automata (NPDA), Deterministic Pushdown Automata (DPDA), Equivalence of PDAs and CFGs (Proof not required). Context Sensitive Grammar (CSG), Linear Bounded Automata. (Concept only).	**12**
V	Turing Machines- Basic model, definition and representation, Instantaneous Description, Language acceptance by TM, Variants of Turing Machine- Multitape TM, Universal TM, Halting Problem, Recursive and Recursively Enumerable Languages. Introduction to decidability, undecidability problems on TM. Chomsky classification of formal languages.	**14**
	Total Hours	**60**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks

Total	:	**40marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23HSL2NB	**UNIVERSAL HUMAN VALUES-II**	**HSC**	**3**	**0**	**0**	**0**	**1**	**2023**

i. COURSE OVERVIEW

The objectives of the course are:

1. To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS'
2. To facilitate the development of a holistic perspective among students towards life and profession leading towards a value-based living
3. To help the students to have ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with nature

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Understand themselves and their surroundings (family, society, nature)	Understand
CO2	Show more commitment towards what they have learnt about Human values, Human relationship and Human society	Understand
CO3	Apply Sustainable Solutions to Real Life problems based on the learning gained through Universal Human Values	Apply

iii. SYLLABUS

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course, recapitulation from Universal Human Values-I

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

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

Understanding Harmony in the Human Being - Harmony in Myself!

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'

Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding thecharacteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

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

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

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

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

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

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all pervasive space Holistic perception of harmony at all levels of existence.
(Include practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.)

Implications of the above Holistic Understanding of Harmony on Professional Ethics,
Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,

c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

Case studies of typical holistic technologies, management models and production systems

Strategy for transition from the present state to Universal Human Order

a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers.

b. At the level of society: as mutually enriching institutions and

organizations Sum up.

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

iv(a)TEXTBOOKS

1. Gaur P.R, Asthana R, Bagaria G.P, Human Values and Professional Ethics (2ndrevised Edition) Excel Books, New Delhi, 2019

2. Tripathi A. N, Human Values, New Age Intl. Publishers, New Delhi, 2004.

(b)REFERENCES

1. Gaur R.R, Sangal R, Bagaria G P ‘A Foundation Course in Human Values and Professional Ethics (Teacher Manual), Excel Books, 1stEdition 2013.

2. Parichaya E K, Nagaraj A,Jeevan Vidya, Jeevan Vidya Prakashan, Amarkantak, 1999.

3. Mohandas K Gandhi, ’The story of my Experiments with Truth’ Fingerprint,2009

4. Cecile Andrews ‘Slow is Beautiful’,New Society Publishers,2006.

5. Kumarappa J C Economy of Permanence, Sarva Seva Sangh Prakashan, 2017.

v. COURSE PLAN

Module	Contents	No. of hours
I	Understanding Value Education Self-Exploration as the process for Value Education Sharing about oneself Understanding Happiness and Prosperity-the Basic Human Aspirations Right Understanding, Relationship, Physical Facility Exploring Human Consciousness Happiness and Prosperity- Current Scenario Method to Fulfil the Basic Human Aspirations Exploring Natural Acceptance	9
II	Understanding Human Being as the Co-existence of the Self and Body Distinguishing between the needs of the Self and the Body Exploring the difference of needs of the Self and the Body The Body as an Instrument of the Self Understanding Harmony in the Self Exploring Sources of Imagination in the Self Harmony of the Self with the Body Programme to ensure Self Regulation and Health Exploring Harmony of Self with the Body	9
III	Harmony in the Family-the Basic unit of Human Interaction Values in the Human-to-Human Relationship 'Trust' –the foundation Value in Relationship Exploring the feeling of Trust 'Respect'- as the Right Evaluation Exploring the feeling of Respect Understanding Harmony in the Society Vision for the Universal Human Order Exploring Systems to fulfil Human Goal	9

IV	Understanding Harmony in the Nature Interconnectedness, self regulation and Mutual Fulfilment among the four orders of Nature Exploring the four orders of Nature Realizing Existence as Co-Existence at all Levels The Holistic Perception of Harmony in Existence Exploring Co-Existence in Existence	**9**
V	Natural Acceptance of Human Values Definitiveness of (Ethical) Human Conduct Exploring Ethical Human Conduct A Basis for Humanistic Education,Humanistic Constitution and Universal Human Order Competence in Professional Ethics Exploring Humanistic Models in Education Holistic Technologies, Production Systems and Management-Models- Typical Case Studies Strategies for Transition towards Value –based Life and Profession Exploring Steps of Transition towards Universal Human Order	**9**
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment Test (1 No) : 10 marks

Assignment/Project/Case study etc. : 20 marks

Self-Assessment: 5 marks

Peer Assessment: 5 marks

Peer Assessment can be done on group-wise basis by dividing the class into suitable groups.

Total : 40 marks

Assessment Pattern can be modified (if needed), subject to the approval of the Committees Concerned

vii. END SEMESTER EXAMINATION

The End semester examination will be conducted by the faculty. The examination will be for three hours and 60 marks.

viii. MODE OF CONDUCT OF COURSE (L-T- P: 2 – 1 - 0)

Lecture hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection and self-exploration. Scenarios may be used to initiate discussion. Depending on the nature of topics, worksheets, home assignment and/or activity are included.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8-day FDP on Universal Human Values is deemed essential.

Course Code	Course Name	Category	L	T	P	J	Credit	Year of introduction
23ESL2NC	**INDUSTRIAL SAFETY ENGINEERING**	**ESC**	**2**	**1**	**0**	**0**	**1**	**2023**

i. COURSE OVERVIEW

Goal of this course is to expose the students to the concepts of safety engineering and identify possible safety requirements. It introduces students to the various safety equipment and precautions. After this course, students will be able to recognize similar safety problems in real-world situations and respond accordingly

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

CO1	Explain the theories of accident causation and preventive measures of industrial accidents	Understand
CO2	Explain personal protective equipment, its selection, safety performance & indicators and importance of housekeeping.	Understand
CO3	Explain the various hazards and associated safety measures in construction industries.	Understand
CO4	Explain various hazards associated with different machines and mechanical.	Understand
CO5	Explain different hazard identification tools in different industries with the knowledge of different types of chemical hazards	Understand

iii. SYLLABUS

Need for safety. Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation. Safety organization- objectives, types, functions, Role of management.

Personal protection in the work environment, Types of PPEs, Personal protective equipment- respiratory and non-respiratory equipment. Performance: Frequency rate, severity rate, incidence rate, activity rate. Housekeeping: Responsibility of management and employees. Typical industrial models and methodology.

Introduction to construction industry and safety issues in construction Safety in various construction operations – Excavation and filling – Under-water works – Under-pinning & Shoring – Ladders & Scaffolds – Tunneling – Blasting – Demolition – Confined space – Temporary Structures. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.

Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding, Material Handling equipment-operation & maintenance. . Hearing Conservation Program in Production industries.

Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - Hazard and Operability study (HAZOP)) –Hazardous properties of chemicals, Material Safety Data Sheets

iv a) TEXTBOOKS

1. **R.K Jain,** Industrial Safety, Health and Environment management systems, Khanna Publications, 2000.
2. **Paul S V,** Safety management System and Documentation training Programme handbook, CBS Publication, 2000.
3. **Krishnan, N.V.** Safety management in Industry. Jaico Publishing House, New Delhi, 1997.

b) REFERENCES

1. Guidelines for Process Hazards Analysis (PHA, HAZOP), Hazards Identification, and Risk Analysis, CRC Press 2018.
2. Safety Management System And Documentation Training Programme Handbook, CBS Publishers & Distributors, 2019
3. Hazards and Safety in Process Industries - Case Studies, CRC Press, 2021

v. COURSE PLAN

Module	Contents	No. of hour

		s
I	Need for safety- Safety and productivity. Definitions: Accident, Injury, Unsafe act, Unsafe Condition, Dangerous Occurrence, Reportable accidents. Theories of accident causation - Safety, organization- objectives, types, functions, Role of management - supervisors, workers, unions, government and voluntary agencies in safety. Safety policy- Safety Officer-responsibilities, authority. Safety committee- need, types, advantages.	**9**

II	Personal protection in the work environment -Types of PPEs, Personal protective equipment-respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance - Frequency rate, severity rate, incidence rate, activity rate. Housekeeping- Responsibility of management and employees. Advantages of good housekeeping. 5 s of housekeeping. Work permit system- objectives, hot work and cold work permits.	**9**
III	Introduction to construction - industry and safety issues in construction. Safety in various construction operations – Excavation and filling – Under- water works – Under-pinning & Shoring – Ladders & Scaffolds. Tunneling – Blasting , Demolition – Confined space –Temporary Structures. Familiarization with relevant Indian Standards and the National Building Code provisions on construction safety. Relevance of ergonomics in construction safety. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.	**9**
IV	Machinery safeguard-Point-of-Operation, Principle of machine guarding -types of guards and devices. Safety in turning, and grinding. Welding and Cutting-Safety Precautions of Gas welding and Arc Welding. Material Handling-Classification-safety consideration- manual and mechanical handling. Handling assessments and techniques- lifting, carrying, pulling, pushing, palletizing and stocking. Material Handling equipment-operation & maintenance. Maintenance of common elements- wire rope, chains slings, hooks, clamps. Hearing Conservation Program in Production industries.	**9**
V	Hazard and risk, Types of hazards –Classification of Fire, Types of Fire extinguishers, fire explosion and toxic gas release, Structure of hazard identification and risk assessment. Identification of hazards: Inventory analysis, Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis. Hazard and Operability study (HAZOP)) – methodology, criticality analysis, corrective action and follow-up. Control of Chemical Hazards- Hazardous properties of chemicals, Material Safety Data Sheets	**9**
	Total	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination –
100: 0

Continuous Assessment		
Attendance	:	5 marks
Assignments	:	15 marks
Assessment through Tests	:	20 marks
Total Continuous Assessment	:	**40 marks**
Final Examination (Summative)	:	**60 marks**
TOTAL	:	**100rks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of tests: 02
- Maximum Marks: 30
- Test Duration: 1½ hours
- Topics: 2 ½ modules

viii. NO END SEMESTER EXAMINATION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSP20C	Operating Systems Lab	PCC	0	0	3	0	2	2023

PRE-REQUISITE: 23CSL20A Data Structures, 23ESB10E Programming in C

i. COURSE OVERVIEW

The course aims to offer students a hands-on experience on Operating System concepts using a constructivist approach and problem-oriented learning. Operating systems are the fundamental part of every computing device to run any type of software.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Make use of systems calls in Linux Operating Systems.	Apply
CO 2	Implement Process Creation and Inter Process Communication in Operating Systems.	Apply
CO 3	Implement algorithms related to process scheduling, page replacement and disk scheduling.	Apply
CO 4	Implement Banker's Algorithm for Deadlock Avoidance in Operating Systems.	Apply
CO 5	Demonstrate the fundamentals of Xv6 operating system.	Understand

iv (a) TEXT BOOKS

1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.
2. W. Richard Stevens, UNIX Network Programming-Interprocess Communication volume-2,2/e, Prentice Hall,1999
3. https://pdos.csail.mit.edu/6.828/2018/xv6/book-rev11.pdf

(b) REFERENCES

1. Abraham Silberschatz, Peter B Galvin, Greg Gagne, Operating System Concepts, 9/e, Wiley India, 2015.
2. Andrew S Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2015.
3. William Stallings, "Operating systems", 6th Edition, Pearson, Global Edition, 2015.

v. COURSE PLAN

Module	Contents	Hours
1	Getting started with Linux basic commands for directory operations, displaying directory structure in tree format, redirection, pipes, filters, job control, changing ownership/permissions of files/links/directory.	3
2	Introduction to Shell Scripting: Write a shell script to implement a menu driven calculator with following functions	3

	1. Addition 2. Subtraction 3. Multiplication 4. Division 5. Modulus	
3	Implement programs for Inter Process Communication using PIPE and Shared Memory.	**6**
4	Simulate the following non-pre-emptive CPU scheduling algorithms to find turnaround time and waiting time. a) FCFS b) SJF c) Round Robin (pre-emptive) d) Priority.	**6**
5	Implement the producer-consumer problem using semaphores.	**3**
6	Write a program to simulate the working of the dining philosopher's problem.	**3**
7	Implement the banker's algorithm for deadlock avoidance.	**6**
8	Simulate the following page replacement algorithms a) FIFO b) LRU c) LFU	**6**
9	Simulate the following disk scheduling algorithms. a) FCFS b) SSTF c) SCAN d) C-SCAN	**6**
10	Case study-Xv6	**3**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment

Attendance : 5 marks

Continuous Assessment : 55 marks

Final Assessment : 40 marks

Total : 100 marks

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSP20D	Database Lab	PCC	0	0	3	0	2	2023

i. COURSE OVERVIEW

The Database Management Systems course is intended to impart the elementary concepts of a database management system to students and equip them to design and implement a database application based on those concepts. This course helps the learners to get practical exposure on database creation, SQL queries creation, transaction processing and NoSQL & MongoDB based operations. The course enables the students to create, manage and administer the databases, develop necessary tools for the design and development of the databases, and to understand emerging technologies to handle Big Data.

ii. COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Design database schema for a given real world problem-domain using standard design and modeling approaches.	Apply
CO2	Construct queries using SQL for database creation, interaction, modification, and updation.	Apply
C03	Design and implement triggers and cursors.	Apply
C04	Implement procedures, functions, and control structures using PL/SQL.	Apply
CO5	Implement CRUD operations in NoSQL Databases.	Apply
C06	Develop database applications using front-end tools and back-end DBMS.	Apply

iii. LIST OF EXPERIMENTS

1. Design a database schema for an application with ER diagram from a problem description.
2. Creation, modification, configuration, and deletion of databases using UI and SQL Commands.
3. Creation of database schema - DDL (create tables, set constraints, enforce relationships, create indices, delete and modify tables). Export ER diagram from the database and verify relationships using SQL workbench(with the ER diagram designed in step 1).
4. Database initialization - Data insert, Data import to a database (bulk import using UI and SQL Commands).
5. Practice SQL commands for DML (insertion, updating, altering, deletion of data, and viewing/querying records based on condition in databases).
6. Implementation of built-in functions in RDBMS.
7. Implementation of various aggregate functions in SQL.
8. Implementation of Order By, Group By & Having clause.

9. Implementation of set operators nested queries, and join queries.
10. Practice of SQL commands for creation of views and assertions.
11. Implementation of various control structures like IF-THEN, IF-THEN-ELSE, IF-THEN- ELSIF, CASE, WHILE.
12. Creation of Procedures, Triggers and Functions.
13. Creation of Packages.
14. Creation of Cursors.
15. Creation of PL/SQL blocks for exception handling.
16. Familiarization of NoSQL Databases .
17. Implement CRUD operations on NoSQL Databases.
18. Implement NoSQL Databases Collections.
19. Design a database application using any front end tool for any problem selected. The application constructed should have five or more tables.

iv. (a) TEXT BOOKS

1. Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education, 7/e, 2017.

2. Sliberschatz A., H. F. Korth and S. Sudarshan, Database System Concepts, 6/e, McGraw Hill, 2011.

(b) REFERENCE MATERIALS

1. Adam Fowler, NoSQL for Dummies, John Wiley & Sons, 2015.
2. NoSQL Data Models: Trends and Challenges (Computer Engineering: Databases and Big Data), Wiley, 2018.

v. Assessment Pattern

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment	:	55 marks
Final Assessment	:	40 marks
Total	**:**	**100 marks**

MINOR

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MB	**Programming Methodologies**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

The course deals with the various systems of ideas that have been used to guide the design of programming languages. It focuses on data types, variables, control flow structures, computational problems, characteristics of object oriented programming languages and concurrency constructs in different programming languages. The course provides the learners a clear understanding of the main constructs of contemporary programming languages.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the criteria for evaluating programming languages and compare Imperative, Functional and Logic programming languages.	Understand
CO 2	Explain the characteristics of data types and variables.	Understand
CO 3	Illustrate how control flow structures and subprograms help in developing the structure of a program to solve a computational problem.	Understand
CO 4	Explain the characteristics of Object Oriented Programming Languages.	Understand
CO 5	Compare concurrency constructs in different programming languages.	Understand

iii. SYLLABUS

Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.

Data Type Checking, Strong Typing, Type Equivalence. **Expressions** – Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. **Assignment** - Assignment Statements, Mixed-mode Assignment.

Statement-Level Control Structures, Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Closures, Co-routines.

Support for Object Oriented Programming, **Exception Handling** – Basic Concepts, Design Issues. **Event Handling** - Introduction to Event Handling.

Concurrency – Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages. **Logic Programming Languages –** Basic Elements of Prolog, Applications of Logic Programming.

iv (a) TEXT BOOKS

1. Robert W. Sebesta, Concepts of Programming Languages, 10th Edition, Pearson.
2. Scott M. L., Programming Language Pragmatics, 3rd Edn., Morgan Kaufmann Publishers.

(b) REFERENCES

1. Kenneth C. Louden, Programming Languages: Principles and Practice, 2nd Edn., Cengage Learning.
2. Tucker A. B. and R. E. Noonan, Programming Languages: Principles and Paradigms, 2nd Edn. –TMH.
3. Ravi Sethi, Programming Languages: Concepts & Constructs, 2nd Edn., Pearson Education.
4. David A. Watt, Programming Language Design Concepts, Wiley Dreamtech.

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction** – Role of Programming Languages, Programming Domains, Language Evaluation Criteria, Influence on Language Design, Language Design Trade-offs, Implementation Methods. Names, Bindings & Scope – Names, Variables, Concept of Binding, Scope and Lifetime, Referencing Environments.	**8**
II	**Data Types**- Primitive Data Types, Character String Types, User-Defined Ordinal Types, Array Types, Record Types, List Types, Pointer & Reference Types, Type Checking, Strong Typing, Type Equivalence. Expressions- Arithmetic Expressions, Overloaded Operators, Type Conversions, Relational and Boolean Expressions, Short-Circuit Evaluation. Assignment-Assignment Statements, Mixed-mode Assignment.	**10**
III	**Statement-Level Control Structures** – Selection Statements, Iterative Statements, Unconditional Branching, Guarded Commands. Subprograms – Design Issues of Subprograms, Local Referencing Environments, Parameter Passing Methods, Subprograms as Parameters, Overloaded Subprograms, Closures, Co-routines.	**8**
IV	**Support for Object Oriented Programming** – Inheritance, Dynamic Binding, Design Issues for Object Oriented Languages, Support for Object Oriented Programming in C++, Implementation of Object Oriented Constructs. Exception Handling – Basic Concepts, Design Issues. Event Handling - Introduction to Event Handling.	**10**
V	**Concurrency** – Subprogram Level Concurrency, Semaphores, Monitors, Message Passing. Functional Programming Languages – Introduction to LISP and Scheme, Comparison of Functional and Imperative Languages. **Logic Programming Languages** – Basic Elements of Prolog, Applications of Logic Programming.	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MD	CONCEPTS IN MACHINE LEARNING	VAC	3	0	0	0	3	2023

PRE-REQUISITE: 23CSL2MB Mathematics for Machine Learning

i. COURSE OVERVIEW

This course enables the learners to understand the fundamental concepts and algorithms in machine learning. The course covers the standard and most popular supervised learning algorithms such as linear regression, logistic regression, decision trees, Bayesian learning & the naive Bayes algorithm, support vector machines& kernels, basic clustering algorithms and dimensionality reduction methods. This course helps the students to provide machine learning based solutions to real world problems.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Illustrate Machine Learning concepts and demonstrate the Discriminative models.	Understand
CO 2	Explain Gaussian models and model evaluation metrices.	Understand
CO 3	Illustrate the concept of Generative Models and Ensemble models.	Understand
CO 4	Explain clustering algorithms and the Dimensionality Reduction methods.	Understand
CO 5	Apply the mathematical concepts behind Artificial Neural network in solving real time problems.	Apply

iii. SYLLABUS

Discriminative Models – Introduction, Types of machine learning, Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Logistic regression, multi class classification, Decision Tree, Support Vector Machines- Large margin classifiers, Nonlinear SVM, kernel functions.

Model Evaluation Metrices and Gaussian Models – Precision, Recall, Accuracy, F1-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC), Regularization, Bias Variance, Cross Validation. Gaussian models: Multivariate Gaussian distributions, Maximum Likelihood Estimate, Inferring parameters, Linear and Quadratic Discriminant Analysis, Mixture models.

Generative Models– Bayesian concept learning, Likelihood, Posterior predictive distribution, Naive Bayes classifiers, Hidden Markov Models. Ensemble models – Bagging and Boosting.

Clustering - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering. Dimensionality reduction–Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.

Neural Network Basics - Binary Classification, Logistic Regression, Gradient Descent, Derivatives, Multilayer feed forward network – Shallow neural networks: Activation functions, Backpropagation algorithm.

Case Study: Develop a predictive model using traditional Machine Learning Classifiers.

iv (a) TEXT BOOKS

1. EthemAlpaydin, Introduction to Machine Learning, 2nd edition, MIT Press 2010.
2. Mohammed J Zaki and Wagner Meria, Data Mining and Analysis: Fundamental Concept and Algorithms, Cambridge University Press, first South Asia edition, 2016.
3. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016.
Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

(b) REFERENCES

1. Christopher Bishop. Neural Networks for Pattern Recognition, Oxford University Press, 1995.
2. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective, MIT Press 2012.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements Of Statistical Learning, Second edition Springer 2007.
P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.
4. Davy Cielen, Arno DB Meysman and Mohamed Ali. Introducing Data Science: Big Data, Machine Learning, and More, Using Python Tools, Dreamtech Press 2016.

v. COURSE PLAN

Module	Contents	Hours
I	**Introduction**: Machine learning, Terminologies in machine learning, Types of machine learning: supervised, unsupervised, semi-supervised learning. Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Univariate and Multivariate Linear Regression, Logistic regression, Decision Tree, Support Vector Machines- Large margin classifiers.	**10**
II	**Model Evaluation Metrices**: Precision, Recall, Accuracy, F1-Measure, Receiver Operating Characteristic Curve(ROC), Area Under Curve (AUC), Regularization, Bias Variance,Cross Validation. Multivariate Gaussian distributions, Maximum Likelihood Estimate Linear and Quadratic Discriminant Analysis, Gaussian models: GMM.	**10**
III	**Generative models**: Bayesian concept learning, Likelihood, Posterior predictive distribution, Naive Bayes classifiers, Hidden Markov Models. Ensemble models – Bagging and Boosting.	**8**
IV	**Clustering** - Similarity measures, Hierarchical Agglomerative Clustering, K-means partitional clustering. Dimensionality reduction – Principal Component Analysis, factor Analysis, Multidimensional scaling, Linear Discriminant Analysis.	**10**
V	Neural Network Basics: Binary Classification, Logistic Regression, Gradient Descent, Derivatives, Multilayer feed forward network – Shallow neural networks: Activation functions, Backpropagation algorithm. Case Study: Identify an efficient traditional machine learning model for face detection task.	**7**
		Total Hours **45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment		
Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40 marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MF	**Introduction to Computer Networks**	**VAC**	**3**	**0**	**0**	**0**	**3**	**2023**

i. COURSE OVERVIEW

The aim of this course is to build an understanding of the fundamental concepts of computer networking. The course covers the main features of computer networks, various protocols, routing algorithms and its functions. The learner will be able to familiarize the basic protocols of computer networks, and how they can be used to assist in computer design and implementation.

ii. COURSE OUTCOMES

After the completion of the course, the student will be able to:

Course Outcomes	Description	Level
CO 1	Explain the features of computer networks, protocols and network design models.	Understand
CO 2	Summarize the design issues of data link layer, data link layer protocols, bridges and switches.	Understand
CO 3	Illustrate wired LAN protocols (IEEE 802.3/4/5) and wireless LAN protocols (IEEE 802.11a/b/g/n, 802.15).	Understand
CO 4	Choose appropriate routing algorithms, congestion control techniques and Quality of Service parameters for a network.	Apply
CO 5	Illustrate the functions and protocols of network, transport and application layer in inter-networking.	Understand

iii. SYLLABUS

Introduction-Uses of Computer Networks, Network Hardware, Network Software, Reference Models.

The Data Link Layer - Data Link layer Design Issues, E Elementary Data Link Protocols. The Medium Access Control (MAC) Sub layer Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.

Network Layer Design Issues. Routing Algorithms, Routing for Mobile Hosts, Congestion Control Algorithms, Quality of Service (QoS).

Network Layer in Internet-ICMP, IP, ARP, RARP, BOOTP, DHCP, OSPF, IPV6.

Transport Layer – The Transport Service Service Primitives, The User Datagram Protocol (UDP), Transmission Control Protocol (TCP), Application Layer protocols.

iv (a) TEXT BOOKS

1. Andrew S. Tanenbaum, Computer Networks, 6/e, Pearson

(b) REFERENCES

1. Behrouz A Forouzan, Data Communication and Networking, 4/e, Tata McGraw Hill ..
2. William Stallings, Computer Networking with Internet Protocols, Prentice -Hall, 2004.
3. James F. Kurose, Keith W. Ross, Computer Networking: A Top-Down Approach, 6/e

v. COURSE PLAN

Module	Contents	Hours
I	Introduction – Uses of Computer Networks, Network Hardware, Network Software, Reference Models – The OSI Reference Model, The TCP/IP Reference Model, Comparison of OSI and TCP/IP Reference models.	**7**
II	The Data Link Layer - Data Link layer Design Issues, Error Detection and Correction, Elementary Data Link Protocols, Sliding Window Protocols, HDLC (High-Level Data Link Control) Protocol. The Medium Access Control (MAC) Sub layer – The Channel Allocation Problem, Multiple Access Protocols, Ethernet, Wireless LANs - 802.11 a/b/g/n, Bridges & Switches.	**9**
III	Network Layer Design Issues. Routing Algorithms - The Optimality Principle, Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, Multicast Routing, Routing for Mobile Hosts. Congestion Control Algorithms, Quality of Service (QoS) - Requirements, Techniques for Achieving Good QoS.	**9**
IV	Network Layer in Internet – The IP Protocol, IP Addresses, Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Bootstrap Protocol (BOOTP), Dynamic Host Configuration Protocol (DHCP). Open Shortest Path First (OSPF) Protocol, Border Gateway Protocol (BGP), Internet Multicasting, IPv6, ICMPv6.	**10**
V	Transport Layer – The Transport Service – Services Provided to the Upper Layers, Transport Service Primitives. The User Datagram Protocol (UDP), Transmission Control Protocol (TCP) – Overview of TCP, TCP Segment Header, Connection Establishment & Release, Connection Management Modeling, TCP Retransmission Policy, TCP Congestion Control. Application Layer – File Transfer Protocol (FTP), Domain Name System (DNS), Electronic mail, MIME, Simple Network Management Protocol (SNMP), Dynamic Host Configuration Protocol (DHCP), World Wide Web – Architectural Overview.	**10**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment: End Semester Examination – 40: 60

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 40
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

viii. END SEMESTER EXAMINATION

- Maximum Marks: 60
- Exam Duration: 3 hours

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MH	Data Visualization& Machine Learning	VAC	3	0	0	0	3	2023

i. COURSE OVERVIEW:

This course offers a comprehensive exploration of Python for data visualization and machine learning. It covers fundamental principles of data visualization using Matplotlib and Seaborn, advances into sophisticated plotting techniques, delves into geospatial and network visualization, and finally introduces machine learning concepts using Scikit-learn. Students will gain a strong foundation in both data visualization and machine learning techniques through hands-on exercises and projects.

ii. COURSE OUTCOMES

After the completion of the course the student will be able to:

CO1	Explain the key techniques and packages for data visualization.	Understand
CO2	Make use of visualization Packages Matplotlib and seaborn	Apply
CO3	Summarize the importance of Geographic data visualization and network visualization.	Understand
CO4	Explain various machine learning algorithms using Scikit-learn.	Understand
CO5	Apply various machine learning algorithms for different applications	Apply

iii. SYLLABUS

Introduction to Python visualization: Data Visualization with Matplotlib: Data Visualization with Seaborn: Advanced Plotting Techniques, Geographic Data Visualization, Network Visualization, Introduction to Machine Learning with Scikit-learn: Understanding Machine-Learning Regression Techniques, Classification Techniques, Advanced Machine Learning Techniques: Ensemble Methods -Bagging, Boosting Unsupervised Learning Hyperparameter Tuning

iv. (a)TEXT BOOKS

1. Tamara Munzner, Visualization Analysis and Design, A K Peters Visualization Series, CRC Press, 2014.
2. Scott Murray, Interactive Data Visualization for the Web, O'Reilly, 2013.
3. "Introduction to Machine Learning with Python: A Guide for Data Scientists",Andreas C. Müller and Sarah Guido

(b) REFERENCES

1. Alberto Cairo, The Functional Art: An Introduction to Information Graphics and Visualization, New Riders, 2012

2. Nathan Yau, Visualize This: The Flowing Data Guide to Design, Visualization and Statistics, John Wiley & Sons, 2011.

v. COURSE PLAN

Module	Contents	No. of hours
I	**Introduction to Python visualization**: libraries (Matplotlib, Seaborn) Basic plotting with Matplotlib, Customizing plots: labels, colors, markers, and styles **Data Visualization with Matplotlib**: Line plots, scatter plots, and bar charts, Histograms and density plots, Box plots and violin plots Subplots and multiple axes	10
II	**Data Visualization with Seaborn:** Introduction to Seaborn library Statistical visualization with Seaborn, Pair plots and heatmap Customizing Seaborn plots **Advanced Plotting Techniques :**3D plotting with Matplotlib, Interactive plotting with Plotly, Animations in data visualization	7
III	**Geographic Data Visualization:** Introduction to geospatial data visualization, Plotting geographic data with GeoPandas, Creating interactive maps with Folium. **Network Visualization**: Introduction to network visualization, Graph plotting with NetworkX, Visualizing complex networks	8
IV	**Introduction to Machine Learning with Scikit-learn:** Understanding Machine-Learning Regression Techniques, Classification Techniques, Model Evaluation, Case study with python implementation	10
V	**Advanced Machine Learning Techniques**: Ensemble Methods - Bagging, Boosting Unsupervised Learning -clustering techniques, Hyper parameter Tuning-Grid search.	10
	Total hours (Approx.)	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2MJ	Cyber Security	VAC	3	0	0	0	3	2023

i. **COURSE OVERVIEW**:

This course provides an insight into various information security aspects and vulnerabilities. It also provides students basic knowledge and skills in detecting and defending threat to web Applications and network vulnerability.

ii. COURSE OUTCOMES

After the completion of the course the student will be able to

Course Outcomes	Description	Level
CO1	Explain the set of technical, social & political aspects of Cyber Security	Understand
CO2	Summarize various attacker techniques and motivations.	Understand
CO3	Differentiate various malicious codes	Understand
CO4	Interpret the various ways for securing devices	Apply
CO5	Compare various defense and analysis techniques	Understand

iii. SYLLABUS

Cyber Security Fundamentals- Symmetric Encryption, Attacker Techniques and Motivations- Malicious Code- DLL Injection - Securing Devices- Securing Host Devices - Securing Outer Perimeter Portals Defense and Analysis Techniques- Malicious Code Naming - Automated Malicious Code Analysis Systems – IDS

iv. TEXT BOOKS

1. Cybersecurity Essentials James Graham, Richard Howard, Ryan Olson, CRC Press
2. Cybersecurity Essentials Charles J. Brooks, ChristopherGrow, Philip Craig, Donald Short ISBN: 978-1-119-36239-5 November 2018
Cryptography and Network security-Behrouz A forouzan

v. COURSE PLAN

Module	Contents	No. of hours
I	Cyber Security Fundamentals – network and Security concepts - Information Assurance Fundamentals - Basic Cryptography – Symmetric encryption,public key encryption – Block vs Stream ciphers, Block cipher components, Data Encryption Standard (DES)– Structure, Key generation, Design criteria, Weaknesses, ,Advanced Encryption Standard (AES) .	**9**
II	Hash functions – Security requirements, Secure Hash Algorithm (SHA-512),Message Authentication Code (MAC) – Requirements, Uses Digital signatures , Direct Vs Arbitrated digital signatures,	**9**
III	Key management – Distribution of secret keys using symmetric and asymmetric encryption, Distribution of public keys, Kerberos	**8**
IV	Malicious software – Viruses, Related threats, Virus countermeasures, Distributed Denial of Service (DDoS),attacks – Types, Countermeasures-Attacker Techniques and Motivations - How hackers cover their tracks - Tunneling Techniques – HTTPS,DNS- Fraud Techniques - Threat Infrastructure,	**10**
V	System security – Intruders, Intrusion detection techniques, Types of IDS, usages of IDS, IPS, Password management, Firewalls,Types of Firewalls .	**9**
	Total Hours	**45**

vi. ASSESSMENT PATTERN

Continuous Assessment

Attendance	: 5 marks
Continuous Assessment Tests	: 20 marks
Assignment	: 15 marks
Total	**: 40marks**
End Semester Examination	: **60 marks**

vii. CONTINUOUS ASSESSMENT TEST

- No. of Tests: 02
- Maximum Marks: 30
- Test Duration: 1 ½ hours
- Topics: 2 ½ modules

HONOURS

Honours Basket 1: Security in Computing

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CSL2HA	NUMBER THEORY	Honours	3	0	0	**0**	**3**	**2023**

C**OURSE OVERVIEW**: The aim of this course is to create awareness among learners about theimportant areas of number theory used in computer science. The course covers modular arithmetic operations, methods to verify correctness of mathematical assertions, theorems for ensuring security in computing systems and applications of arithmetic functions. The goalof the course is to help the learners to apply the concepts in practical applications of Computer organization and Security, Coding and Cryptography, Random number generation,Hash functions and Graphics.

COURSE OUTCOMES

After the completion of the course the student will be able to:

CO 1	Illustrate modular arithmetic operations, methods and techniques	Understand
CO 2	Use the methods - Induction, Contraposition or Contradiction to verifythe correctness of mathematical assertions	Apply
CO 3	Utilize theorems and results about prime numbers, congruences, quadratic residues and integer factorization for ensuring security in computing systems.	Analyse
CO 4	Illustrate uses of Chinese Remainder Theorem & Euclidean algorithmin Cryptography and Security	Apply
CO 5	Explain applications of arithmetic functions in Computer Science	Understand
CO 6	Implement Number Theoretic Algorithms using a programming language	Apply

SYLLABUS

Divisibility and Modular Arithmetic, Finite Fields, Divisibility and Division Algorithms, Primes and Congruence, Methods to find prime numbers, Primality testing and factorization,Congruence, Congruences with a Prime-Power Modulus, Pseudo-primes and Carmichael numbers, Euler's Function, Euler's Totient function.Quadratic Residues, Quadratic Congruences, Legendre symbol, Jacobi Symbol, Quadratic reciprocity. Arithmetic Sum of Squares, The Gaussian Integers, Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.

TEXT BOOKS

1. G.A. Jones & J.M. Jones, Elementary Number Theory, Springer UTM, 2007.
2. Joseph Silverman, A Friendly introduction to Number Theory, Pearson Ed. 2009.

REFERENCES

1. William Stallings, Cryptography and Network Security Principles and Practice,PearsonEd.
2. Tom M.Apostol, 'Introduction to Analytic Number Theory', Narosa PublishingHouse Pvt. Ltd, New Delhi, (1996).
3. Neal Koblitz, A course in Number Theory and Cryptography, 2nd Edition, Springer 2004.

COURSE PLAN

Module	Contents	No. of hours
I	**Divisibility and Modular Arithmetic:** Finite Fields – Groups, Rings and Fields. Divisibility - Divisibility and Division Algorithms, Well ordering Principle, Bezout's Identity. Modular Arithmetic- Properties, Euclid's algorithm for the greatest common divisor, Extended Euclid's Algorithm, Least Common multiple, Solving Linear Diophantine Equations, Modular Division.	8
II	**Primes and Congruence:** Prime Numbers-Prime Numbers and prime – power factorization, Fermat and Mersenne primes, Primality testing and factorization. Congruences- Linear congruences, Simultaneous linear congruences, Chinese Remainder Theorem, Fermat's little theorem, Wilson's theorem.	8

III	**Congruences with a Prime-Power Modulus & Euler's Function:** Congruences with a Prime-Power Modulus-Arithmetic modulo p, Pseudo-primes and Carmichael numbers, Solving congruences modulo prime powers. Euler's Function-Euler's Totient function, Applications of Euler's Totient function, Traditional Cryptosystem, Limitations. The Group of units- The group U_n, primitive roots, Existence of primitive roots, Applications of primitive roots.	8
IV	**Quadratic Residues & Arithmetic Functions:** Quadratic Residues- Quadratic Congruences, The group of Quadratic residues, Legendre symbol, Jacobi Symbol, Quadratic reciprocity. Arithmetic Functions- Definition and examples, Perfect numbers, Mobius function and its properties, Mobius inversion formula, The Dirichlet Products.	9
V	**Sum of Squares and Continued Fractions:** Sum of Squares- Sum of two squares, The Gaussian Integers, Sum of three squares, Sum of four squares. Continued Fractions -Finite continued fractions, Infinite continued fractions, Pell's Equation, Solution of Pell's equation by continued fractions.	12
	Total hours (Approx.)	**45**

vi)ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

Honor Basket 2: COMPUTATIONAL BIOLOGY

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL2HA	Computational Fundamentals for Bioinformatics	Honours	3	0	0	**0**	**3**	**2023**

i) COURSE OVERVIEW: Bioinformatics is an interdisciplinary area that combines Computer Science, Molecular Biology, and Mathematics and allied areas of Science. This course covers computational fundamentals of Bioinformatics and Computational Biology such as DNA, genes and proteins, transcription, translation, sequence alignment, representation and basic Python programming required for handling bioinformatics data. The learners will be able to solve basic bioinformatics problems using python programming.

ii) COURSE OUTCOMES

CO 1	Describe the basic concepts of Bioinformatics with an emphasis on biological macromolecules-DNA, RNA and Protein and synthesis of biomolecules	Understand
CO 2	Identify biological data formats and databases, retrieve bio-sequences, and align bio- sequences to identify similarity, dynamic programming.	Apply
CO 3	Illustrate nucleotide attributes and transcription using programming tools	Apply
CO 4	Demonstrate the concepts of Parsing FASTA and Sequences Analysis	Apply
CO 5	Compute k-mers, translation of DNA subsequences and Open reading frame.	Apply

iii) SYLLABUS

Introduction to bioinformatics, Nature & Scope of Bioinformatics, animal vs plants, Eukaryote vs prokaryote, Nucleus. Chromosome, gene DNA, RNA, amino acids, and

Protein, The Central Dogma, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure, Transcription,translation.

Introduction to Biological Databases and data storage, NCBI, Genbank, Bio sequence formats- Database Similarity Searching, BLAST, Sequence alignment, Scoring Matrices, Multiple- Sequence Alignment, Dynamic programming

Tetranucleotide Frequency, Counting the Nucleotides, Writing and Verifying a Solution, Transcribing DNA into mRNA: Mutating Strings, Reading and Writing Files, Reverse Complement of DNA, String Manipulation, Iterating Over a Reversed String.

Creating the Fibonacci Sequence, Writing, Testing, and Benchmarking Algorithms, retrieving FASTA Using Bio python, Iterating the Sequences Using a for Loop, Parsing FASTA and Analyzing Sequences, Computing GC Content, Finding the Hamming Distance, Counting Point Mutations

K-mers and Codons, Translating Codons, Translating mRNA into Protein, Finding Subsequences of DNA, Find a Motif in DNA, Finding Overlapping Patterns Using Regular Expressions, Sequence Similarity, Finding the Shortest Sequence in a FASTA File, Extracting K-mers from a Sequence, Counting Frequencies of K-mers, Finding Open Reading Frames

iv) TEXT BOOKS

1. Mount, D. W.. Bioinformatics: Sequence and Genome Analysis. India, CBS Publishers& Distributors, 2005.
2. Youens-Clark, Ken. *Mastering Python for Bioinformatics*. UnitedStates: O'ReillyMedia, 2021.

REFERENCES

1. Kelley, S.T. and Didulo, D, *Computational Biology: A Hypertextbook*. John Wiley & Sons,2020
2. Baxevanis, Andreas D., Gary D. Bader, and David S. Wishart, eds. *Bioinformatics*. JohnWiley & Sons, 2020.
3. Shaik, Noor Ahmad, et al. *Essentials of Bioinformatics, Volume I.* Springer, 2019
4. Selzer, Paul M., Richard J. Marhöfer, and Andreas Rohwer, *Applied bioinformatics*. *Anintroduction–Springer, Verlag,*, 2008.
5. S C Rastogi, N Mendiratta and P Rastogi, *Bioinformatics: Methods and Applications,* PHILearning Private Limited, New Delhi, 2015.
6. D E Krane and M L Raymer, *Fundamental Concepts of Bioinformatics*, Pearson Education,2006.
7. Bassi, Sebastian. *Python for Bioinformatics*. United Kingdom: CRC Press, 2017.
8. Model, Mitchell L. Bioinformatics Programming Using Python. United States: O'Reilly

Media, 2010.

9. Antao, Tiago. *Bioinformatics with Python Cookbook*. United Kingdom: Packt Publishing, 2015.Antao, Tiago. Bioinformatics with Python Cookbook: Learn how to UseModern Python Bioinformatics Libraries and Applications to Do Cutting-edge Research in Computational Biology, 2nd Edition. United Kingdom: Packt Publishing, 2018.

v)COURSE PLAN

Module	Contents	No. of hours
I	Introduction to bioinformatics, Nature & Scope of Bioinformatics, Animal vs plants, Eukaryote vs prokaryote, Nucleus. Chromosome, gene, DNA, RNA, and Protein,The Central Dogma introduction, Messenger RNA, tRNA, rRNA, Genetic code, Gene Structure and Control, Transcription, Translation,	10
II	Introduction to Biological Databases and data storage, NCBI, Genbank, NCBI, Genbank Sequence retrieval, Bio sequence formats, Database Similarity Searching, BLAST, BLAST Exercises, Sequence alignment, Scoring Matrices, Multiple-Sequence Alignment, Introduction to Dynamic programming in MSA.	10
III	Counting the Nucleotides, Writing and Verifying a Solution, Transcribing DNA into mRNA, Iterating the Input Files, Mutating Strings, Writing and Reading Output Sequences, Reverse Complement of DNA, String Manipulation, Iterating Over a Reversed String	10
IV	Creating the Fibonacci Sequence, Writing, Testing, and Benchmarking Algorithms, Retrieving FASTA Using Biopython, Parsing FASTA and Analysing Sequences, Computing GC Content, Finding the Hamming Distance, Iterating the Characters of Two Strings, Counting Point Mutations	8
V	K-mers and Codons, Translating mRNA into Protein, Finding Subsequence of DNA, Find a Motif in DNA, Finding Overlapping Patterns Using Regular Expressions, Sequence Similarity, Finding the Shortest Sequence in a FASTA File , Extracting K-mers from a Sequence, Counting Frequencies of K-mers, Finding Open Reading Frames	9

vi)ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**

Honour Bucket 3: COMPUTER VISION

Course Code	Course Name	Category	L	T	P	J	Credit	Year of Introduction
23CTL2HB	ADVANCED TOPICS IN COMPUTER GRAPHICS	Honours	3	0	0	**0**	**3**	**2023**

PREREQUISITE: A sound knowledge of Mathematics and concepts of any programming language.

i) COURSE OVERVIEW: This course helps the learners to make awareness about strong theoretical concept in computer graphics. It covers the three-dimensional environment representation in a computer, transformation of 2D/3D objects, basic mathematical techniques and algorithms used to build useful applications. This course enables the learners to develop the ability to create image processing frameworks for different domains and develops algorithms for emerging displaytechnologies.

ii) COURSE OUTCOMES: After the completion of the course the student will be able to

CO 1	Describe the working principles of graphics devices	Understand
CO 2	Illustrate line drawing, circle drawing and polygon filling algorithms	Understand
CO 3	Make Use of geometric representations and transformations on 2D & 3D objects.	Apply
CO 4	Apply the working of various clipping algorithms and projection algorithms.	Apply
CO 5	Summarize visible surface detection methods	Understand
CO6	Explain the concept of realism in a scene and its performance preservation	Understand

iii) SYLLABUS

Basics of Computer Graphics and its applications. Video Display devices - Refresh Cathode Ray Tubes, Random Scan Displays and systems, Raster scan displays and systems, Color CRT displays,Flat panel display and its categories. Line drawing algorithms - DDA, Bresenham's algorithm. Circle drawing algorithms - Midpoint Circle generation algorithm, Bresenham's algorithm.

Filled Area Primitives- Scan line polygon filling, Boundary filling and flood filling. Two dimensional transformations-Translation, Rotation, Scaling, Reflection and Shearing, Composite transformations, Matrix representations and homogeneous coordinates.

Window to viewport transformation. Cohen Sutherland and Midpoint subdivision line clipping algorithms, Sutherland Hodgeman and Weiler Atherton Polygon clipping algorithms. Three dimensional viewing pipeline. Basic 3D transformations.

Projections- Parallel and Perspective projections. Visible surface detection algorithms- Back face detection, Depth buffer algorithm, Scan line algorithm, A buffer algorithm

Realism - Illumination Shading, Shadows, Texture mapping, Bump mapping, Environment mapping, Transparency, Accumulation Buffer, Back face Culling, Visibility Culling.

iv)TEXT BOOKS

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 2e, 1996
2. Aditi Majumder and M.Gopi , Introduction to VISUAL COMPUTING Core Concepts inComputer Vision, Graphics, and Image Processing, 2018

REFERENCES

1) William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics.McGraw Hill, 2001
2) Zhigang Xiang and Roy Plastock, Computer Graphics (Schaum's outline Series), McGrawHill, 2019.
3) David F. Rogers , Procedural Elements for Computer Graphics, Tata McGraw Hill,2001.
4) Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with OpenGL,PHI, 4e, 2013.

v) COURSE PLAN

Module	Contents	No. of hours
I	Basics of Computer Graphics and applications, Refresh Cathode Ray Tubes, Random and Raster Scan Displays and systems, Color CRT displays, Flat panel display and its categories, DDA Line drawing Algorithm, Bresenham's line drawing algorithm, Midpoint Circle generation algorithm, Bresenham's Circle generation algorithm, Illustration of line and circle drawing algorithms	10
II	Scan line polygon filling, Boundary filling and flood filling, Basic 2D transformations-Translation, Basic 2D transformations- Rotation, Basic 2D transformations- Scaling, Reflection and Shearing,	9

	Illustration of Basic 2D Transformations, Composite transformations, Matrix representations and homogeneous coordinates	
III	Window to viewport transformation, Cohen Sutherland Line clipping algorithm, Midpoint subdivision Line clipping algorithm, Sutherland Hodgeman Polygon clipping algorithm, Weiler Atherton Polygon clipping algorithm, Three-dimensional viewing pipeline, Basic 3D transformation-Translation and scaling, Basic 3D transformation-Rotation	8
IV	Projections-Parallel projections, Projections- Perspective projections, Illustration of projection methods, Visible surface detection algorithms-Back face detection, Depth buffer algorithm, Scan line visible surface detection algorithm, *A buffer* algorithm,	7
V	Illumination, Shading and Shadows, Texture mapping-Texture to object space mapping, Texture mapping-Object to screen space mapping and Mip Mapping, Bump mapping, Bump mapping-Illustration, Environment mapping and Transparency, Accumulation Buffer and Back face Culling, Visibility Culling, Visibility Culling	10

vi)ASSESSMENT PATTERN

Continuous Assessment

Attendance	:	5 marks
Continuous Assessment Tests	:	20 marks
Assignment	:	15 marks
Total	:	**40marks**
End Semester Examination	:	**60 marks**