DIVISION OF DATA SCIENCE AND CYBER SECURITY

LIST OF NEW COURSES

Sl. No.	Course Code	Course Title	L	T	P	Credits
1	23DC1001	Digital System Design	3	0	0	3
2	23DC1002	Digital System Design Laboratory	0	0	2	1
3	23DC1003	Digital Principles and Computer Organization	3	0	0	3
4	23DC1004	Digital Principles and Computer Organization Laboratory	0	0	2	1
5	23DC1005	Programming for Problem Solving	3	0	0	3
6	23DC1006	Programming for Problem Solving Laboratory	0	0	3	1.5
7	23DC1007	Introduction to Artificial Intelligence	2	0	0	2
8	23DC1008	Python Programming	3	0	0	3
9	23DC1009	Python Programming Laboratory	0	0	3	1.5
10	23DC1010	Ethics in Information Technology	2	0	0	2
11	23DC1011	Microprocessor and Microcontroller	2	0	0	2
12	23DC1012	Microprocessor and Microcontroller Laboratory	0	0	2	1
13	23DC1013	Computer Organization and Architecture	3	0	0	3
14	23DC2001	Object Oriented Programming	3	0	0	3
15	23DC2002	Object Oriented Programming Laboratory	0	0	3	1.5
16	23DC2003	Data Structures and Algorithms	3	0	0	3
17	23DC2004	Data Structures and Algorithms Laboratory	0	0	3	1.5
18	23DC2005	Cyber Physical System	3	0	0	3
19	23DC2006	IoT and its Applications	3	0	0	3
20	23DC2007	IoT and its Applications Laboratory	0	0	2	1
21	23DC2008	Computer Networks	3	0	0	3
22	23DC2009	Computer Networks Laboratory	0	0	3	1.5
23	23DC2010	Database Management Systems	3	0	0	3
24	23DC2011	Database Management Systems Laboratory	0	0	3	1.5
25	23DC2012	Design and Analysis of Algorithm	3	0	0	3
26	23DC2013	Communication for Cyber Physical Systems	3	0	0	3
27	23DC2014	Operating Systems	3	0	0	3
28	23DC2015	Machine Learning Techniques	3	0	0	3
29	23DC2016	Machine Learning Techniques Laboratory	0	0	3	1.5
30	23DC2017	Data Engineering	3	0	0	3
31	23DC2018	Quantum Machine Learning	3	0	0	3
32	23DC2019	Federated Learning	3	0	0	3
33	23DC2020	Data Science Ecosystem	3	0	0	3
34	23DC2021	Data Science Ecosystem Laboratory	0	0	3	1.5
35	23DC2022	Explainable AI	3	0	0	3
36	23DC2023	Zero Trust Architecture	3	0	0	3
37	23DC2024	Modern Cryptography	3	0	0	3
38	23DC2025	Biometrics and Security	3	0	0	3
39	23DC2026	Social Network Security	3	0	0	3
40	23DC2027	Healthcare System Data Analytics	3	0	0	3
41	23DC2028	Data Exploration and Visualization	2	0	0	2
42	23DC2029	Data Science in Robotics	3	0	0	3
43	23DC2030	Foundations of Data Analytics	3	0	0	3
44	23DC2031	Generative AI	3	0	0	3
45	23DC2032	Full Stack Development	3	0	0	3
46	23DC2033	Full Stack Development Laboratory	0	0	3	1.5
47	23DC2034	Robotic Process Automation	3	0	0	3
48	23DC2035	Robotic Process Automation Laboratory	0	0	2	1
49	23DC2036	Augmented Reality and Virtual Reality	3	0	0	3
50	23DC2037	Cognitive Computing	3	0	0	3

51	23DC2038	Nature Inspired Optimization	3	0	0	3
52	23DC2039	Cloud Security Foundation Laboratory	0	0	3	1.5
53	23DC2040	Deep Learning	3	0	0	3
54	23DC2041	Deep Learning Laboratory	0	0	3	1.5
55	23DC2042	Theory of Computation	3	0	0	3
56	23DC2043	Cloud Computing for Data Analytics	3	0	0	3

		SKILL BASED COURSES				
Sl. No.	Course Code	Course Title	L	T	P	Credits
1	23DC2501	Exploratory Data analysis using Tableau	0	0	2	1
2	23DC2502	Docker and Kubernetes Laboratory	0	0	2	1
3	23DC2503	Cloud Foundations	0	0	2	1
4	23DC2504	Data Engineering Processes and Tools	0	0	2	1
5	23DC2505	AI Practitioner Laboratory	0	0	2	1

Course Code	Digital System Design	L	T	P	C
23DC1001		3	0	0	3

Course Objectives:

Enable the students to:
1. Examine the foundational postulates of Boolean algebra and analyze combinational and sequential circuits.
2. Distinguish various logic families, semiconductor memories, and programmable logic devices.
3. Apply HDL to design and validate combinational and sequential circuits.

Course Outcomes:

The students will be able to:
1. Illustrate the basic postulates of Boolean algebra and operate logic gates.
2. Implement an optimal method for simplification of Boolean expressions
3. Distinguish among various combinational logic circuits.
4. Design and compare various types of sequential logic circuits.
5. Examine different logic families, classify memory devices, and identify methods for implementing logic circuits.
6. Construct combinational and sequential circuits.

Module: 1	Minimization Techniques and Logic Gates	6 Hours

Boolean postulates and laws - DeMorgan's Theorem - Boolean expression minimization - Karnaugh maps - Logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR - Implementations of logic functions using gates.

Module: 2	Combinational Circuits	7 Hours

Design procedure - Adders and subtractors - Multiplexers and demultiplexers - Encoders and decoders – Comparators - Arithmetic Logic Unit (ALU).

Module: 3	Sequential Circuits	8 Hours

Latches and flip-flops: SR, JK, D, T, and Master-Slave - Clock generation and parameters - Counters: asynchronous and synchronous - Shift registers - Sequence generators - Synchronous and asynchronous sequential circuits.

Module: 4	Logic Families	8 Hours

Introduction to TTL, ECL, and CMOS families - Specifications, noise margin, propagation delay - Interfacing techniques.

Module: 5	Memory Devices	8 Hours

Classification of memories: ROM, PROM, EPROM, EEPROM, RAM - Memory organization and operation - Programmable Logic Devices: PLA, PAL, FPGA.

Module: 6	HDL		8 Hours

Introduction to Verilog - Verilog modules, ports, operators, and data types - Modeling techniques: dataflow, behavioural, structural, switch-level - Designing combinational and sequential circuits using Verilog.

Total Lectures	45 Hours

Text Books

1	M. Morris Mano. (2018). *Digital Design. (5th Edition).* Pearson Education. ISBN: 978-9353062019.
2	Michael D. Ciletti. (2018). *Advanced Digital Design with the Verilog HDL. (3rd Edition).* Pearson. ISBN: 978-0136019282.

Reference Books

1	John F. Wakerly. (2018). *Digital Design: Principles and Practices. (5th Edition).* Pearson. ISBN: 978-0134460093.
2	Charles H. Roth Jr. (2019). *Fundamentals of Logic Design. (7th Edition).* Cengage Learning. ISBN: 978-8131526156.
3	Rabaey. Chandrakasan. and Nikolic. (2019). *Digital Integrated Circuits: A Design Perspective* (2nd Edition). Pearson. ISBN: 978-9332573925.
4	Giuliano Donzellini. Luca Oneto. (2018). *Introduction to Digital Systems Design. (1st Edition).* Springer International Publishing. ISBN:978-3319928043
5	Charles H. Roth. Lizy Kurian John. (2018). *Digital Systems Design Using VHDL (1st Edition).* Cengage Learning. ISBN: 978-1305638921

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Digital System Design Laboratory	L	T	P	C
23DC1002		0	0	2	1

Course Objectives:

Enable the students to:
1. Demonstrate the characteristics of all logic gates
2. Design combinational and sequential circuits
3. Develop and simulate digital circuits using HDL

Course Outcomes:

The students will be able to:
1. Demonstrate the basic characteristics of all logic gates.
2. Illustrate different methods for realizing logic gates using universal gates.
3. Design and verify combinational logic circuits.
4. Perform and inspect sequential logic circuits.
5. Develop digital circuits for practical applications
6. Implement and test digital circuits using HDL for real time applications

List of Exercises:

1. Realization of logic gates using universal gate.
2. Design, implementation, and verification of full adder and full subtractor.
3. Design, implementation, and verification of multiplexer and demultiplexer
4. Design, implementation, and verification of encoder and decoder.
5. Design, implementation, and verification of flip-flop.
6. Design, implementation, and verification of magnitude comparator using HDL.
7. Design, implementation, and verification of counters using HDL.

Course Code	Digital Principles and Computer Organization	L	T	P	C
23DC1003		3	0	0	3

Course Objectives:

Enable the students to:
1. Examine the knowledge on fundamental principles of digital logic and computer organization.
2. Develop skills to design and analysing combinational and sequential circuits.
3. Analyse computer architecture, including processor design, memory management, and I/O operations.

Course Outcomes:

The students will be able to:

1. Illustrate a variety of combinational circuits, such as binary adders, subtractors, encoders, decoders.
2. Demonstrate the concepts of sequential logic, including flip-flops, clocked sequential circuits, and state machines.
3. Examine the fundamental principles of computer architecture and organization, following the Von Neumann architecture model.
4. Apply critical thinking to assess the impact of different architectural choices on system performance and functionality.
5. Develop design skills by creating and optimizing digital circuits to meet specified design requirements and constraints.
6. Organize and plan team efforts to solve complex design projects and assignments, fostering teamwork and peer learning.

Module: 1	Combinational Logic	8 Hours

Combinational Circuits - Karnaugh Map - Analysis and Design Procedures - Binary Adder - Subtractor - Decimal Adder - Magnitude Comparator - Decoder - Encoder.

Module: 2	Synchronous Sequential Logic	8 Hours

Introduction to Sequential Circuits - Flip - Flops - operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits - Design - Moore/Mealy models, state minimization, state assignment, circuit implementation - Registers - Counters.

Module: 3	Computer Fundamentals	7 Hours

Functional Units of a Digital Computer: Von Neumann Architecture - Operation and Operands of Computer Hardware Instruction - Instruction Set Architecture (ISA): Memory Location, Address and Operation - Instruction and Instruction Sequencing - Addressing Modes, Encoding of Machine Instruction - Interaction between Assembly and High Level Language.

Module: 4	Processor	7 Hours

Instruction Execution - Building a Data Path - Designing a Control Unit - Hardwired Control, Microprogrammed Control - Pipelining - Data Hazard - Control Hazards.

Module: 5	Memory and I/O	8 Hours

Memory Concepts and Hierarchy - Memory Management - Cache Memories: Mapping and Replacement Techniques - Virtual Memory - DMA - I/O - Accessing I/O: Parallel and Serial Interface - Interrupt I/O - Interconnection Standards: USB, SATA.

Module: 6	Advanced Processor Design	7 Hours

Superscalar and VLIW Architectures - Branch Prediction and Speculative Execution - Out-of-order Execution - Multithreading and Multiprocessing - Advanced Memory Hierarchy - Cache Coherency.

Total Lectures		45 Hours

Text Books

1	M. Morris Mano and Michael D. Ciletti. (2018). *Digital Design: With an Introduction to the Verilog HDL. VHDL. and System Verilog. (6th Edition).* Pearson Education. ISBN: 978-9353062019.
2	David A. Patterson and John L. Hennessy. (2020). *Computer Organization and Design: The Hardware/Software Interface. (6th Edition).* Morgan Kaufmann/Elsevier. ISBN: 978-0128201091.

Reference Books

1	Carl Hamacher. Zvonko Vranesic. Safwat Zaky. Naraig Manjikian. (2012). *Computer Organization and Embedded Systems. (6th Edition).* Tata McGraw-Hill. ISBN: 978-9355323729.
2	William Stallings. (2016). *Computer Organization and Architecture – Designing for Performance.* (10th Edition). Pearson Education. ISBN: 978-9332570405.
3	M. Morris Mano. (2016). *Digital Logic and Computer Design. (2nd Edition).* Pearson Education. ISBN: 978-9332542525.

4	Yamin Li. (2015). *Computer Principles and Design in Verilog HDL*. (1st *Edition*). Tsinghua University Press. ISBN:978-1118841129
5	David A. Patterson. (2017). *Computer Organization and Design RISC-V*. (1st *Edition*). Morgan Kaufmann publisher. ISBN:978-0128122761.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Digital Principles and Computer Organization Laboratory	L	T	P	C
23DC1004		0	0	2	1

Course Objectives:

Enable the students to:
1. Adapt fundamental principles of digital logic and Boolean algebra
2. Develop skills in designing and implementing combinational and sequential circuits using logic gates.
3. Demonstrate the application of theoretical concepts to practical scenarios through simulation and hardware implementation.

Course Outcomes:

The students will be able to:
1. Apply Boolean algebra principles to verify Boolean theorems using logic gates effectively.
2. Demonstrate competence in designing and implementing combinational circuits for arbitrary functions using logic gates.
3. Construct 4-bit binary adder/subtractor circuits, showcasing proficiency in binary arithmetic and circuit synthesis.
4. Develop proficiency in implementing code converters and BCD adder, encoder, and decoder circuits, enabling efficient data conversion and manipulation.
5. Demonstrate knowledge and skills in designing and implementing synchronous counters, illustrating an understanding of sequential circuit design and timing considerations.
6. Design and simulate a simple CPU architecture with an instruction set capable of basic arithmetic and logical operations, showcasing comprehension of CPU operation and data processing.

List of Exercises:

1. Verification of Boolean theorems using logic gates.
2. Design and implementation of combinational circuits using gates for arbitrary functions.
3. Implementation of 4-bit binary adder/subtractor circuits.
4. Implementation of code converters.
5. Implementation of BCD adder, encoder and decoder circuits.
6. Implementations of the Synchronous counters.
7. Implementation of a Universal shift register.
8. Design a simple ALU capable of performing addition, subtraction, AND, OR operations.
9. Simulate UART communication between two devices using start and stop bits.
10. Simulate a simple CPU architecture with an instruction set capable of basic arithmetic and logical operations.

Course Code	Programming for Problem Solving	L	T	P	C
23DC1005		3	0	0	3

Course Objectives:

Enable the students to:
1. Analyze various components in problem solving.
2. Identify syntax and semantics of programming language.
3. Apply basic algorithms in the programming language.

Course Outcomes:

The students will be able to:
1. Demonstrate the components of computers and to prepare algorithms/flowcharts for programs.
2. Analyze the concept of data types, variables, operators and expressions in programming language.
3. Illustrate branching and iterative statement for solving problems.

4. Apply programming solutions for searching and sorting problems.
5. Demonstrate the concept of functions and its components.
6. Implement the concept of recursion and memory allocation.

Module: 1	Introduction to Computers and Algorithms	7 Hours

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - Flowchart / Pseudocode with examples - From algorithms to programs - source code - Syntax and Logical Errors in compilation - object and executable code.

Module: 2	Introduction to Programming	7 Hours

Datatypes: user defined and derived datatypes – variables – operators - expressions and precedence - Arrays: Arrays (1-D, 2-D), Character arrays and Strings.

Module: 3	Control Structures	7 Hours

Conditional Branching and Loops - Writing and evaluation of conditionals and consequent branching.

Module: 4	Basic Algorithms	8 Hours

Searching: Linear and Binary - Basic Sorting Algorithms: Bubble, Insertion, Selection, Quick, Finding roots of Equations.

Module: 5	Functions	8 Hours

Functions: Functions (including using built in libraries), Parameter passing in functions, call by value - Passing arrays to functions: idea of call by reference - Inline functions.

Module: 6	Recursion and Pointers	8 Hours

Recursion - Example programs, such as Finding Factorial, Fibonacci series - Introduction to pointers and memory allocation.

Total Lectures	45 Hours

Text Books

1.	Sumitabha Das. (2021). *Programming for Problem Solving with C. (1st edition).* McGraw Hill Education. ISBN: 9789390385782.
2.	E. Balagurusamy. 2019. *Programming in ANSI C*. McGraw Hill Education. *(8th Edition)*. ISBN: 9789351343202.

Reference Books

1.	G Venkatesh and Madhavan Mukund. (2021). *Computational Thinking: A Primer for Programmers and Data Scientists. (1st Edition).* Notion Press. ISBN: 9781685234812.
2	Yashavant Kanetkar. (2021). *Let Us C: Authentic guide to C programming language.* (18th Edition). ISBN: 9789391392994.
3	Paul Deitel and Harvey Deitel. (2013). *C How to Program. (7th Edition).* Pearson Publication. ISBN-10: 0-13-299044-X ISBN-13: 978-0-13-299044-8.
4	Robert C. Seacord. (2020). *Effective C An Introduction to Professional C Programming*. No Starch Press. *(1st Edition)*. ISBN:978-1718501058.
5	Brian W. Kernighan. (2017). *C Programming Language*. CreateSpace Independent Publishing Platform. *(1st Edition)*. ISBN:978-1548817701

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Programming for Problem Solving Laboratory	L	T	P	C
23DC1006		0	0	3	1.5

Course Objectives:

Enable the students to:
1. Explore various problem-solving approaches.
2. Identify the basic programming constructs in C.
3. Experiment various computing strategies for C based solutions to real world problems.

Course Outcomes:

The students will be able to:

1. Formulate algorithmic solutions to simple computational problems.
2. Demonstrate programming solutions for real world problems.
3. Execute programs using conditionals and loops for solving problems.
4. Implement functions to decompose a program.
5. Carryout inline functions to solve real world problems.
6. Develop programming solutions for recursion.

List of Experiments

1. C programming using simple statements and expressions. (simple interest, distance between two points, swapping values)
2. Implementing programs using Strings. (reverse, palindrome, replacing characters)
3. Implementing program using Conditional statements (voter's age validity, student mark range validation, avoiding divide by zero error)
4. Implementing programs using Iterative loops. (sum of 'n' natural numbers, multiplication table)
5. Implementing programs using Conditionals and Iterative statements. (Number series, Number Patterns, pyramid pattern)
6. Implementing programs using do-while loop (calculate the compound interest for a given principal amount, interest rate, and time period also allow the user to input values multiple times).
7. Implementing programs using arrays (read 'n' number of values in an array and display them in reverse order).
8. Implementing programs using Functions. (area of shape, Grade Computation)
9. Implementing programs using Inline functions (count the number of vowels in a given string, prime number checking)
10. Implementing real-time/technical applications using recursion. (factorial, fibonacci series, LCM and GCD).

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Introduction to Artificial Intelligence	L	T	P	C
23DC1007		**2**	**0**	**0**	**2**

Course Objectives:

Enable the students to:
1. Analyze fundamental concepts of artificial intelligence and intelligent agents.
2. Illustrate the problem-solving paradigms, search methodologies and learning algorithms.
3. Apply the applications of AI agents in various fields.

Course Outcomes:

The students will be able to:
1. Illustrate AI as intelligent agent that receive precepts from the environment
2. Analyze different search algorithms to reach the goal in state-space problems.
3. Apply learning strategies to intelligent agent to acquire knowledge from the environment.
4. Develop the planning methods with certainty factors for problem solving in AI.
5. Demonstrate the communicating and perceiving agents in the AI field.
6. Develop the real-time applications of intelligent agents in various fields.

Module: 1	Artificial Intelligence and Agents	5 Hours

Foundations of AI - Artificial and Natural Intelligence - History and State of Art - Intelligent Agents - Agents Situated in Environments - Expert systems- Applications.

Module: 2	Problem solving by search	5 Hours

Problem-solving by Search - Defining the problem as a state space search - Problem characteristics - Graph searching - Generic search algorithm - Informed and Uninformed search - Depth - first Search, Breadth first Search - Best first search - Issues in the design of Search.

Module: 3	Learning	5 Hours

Learning Issues - Basic Models - Rote Learning - learning by Taking Advice - Learning in Problem-solving - Learning from examples - Analogy based learning - Neural Net Learning - Genetic Learning - Clustering - Reinforcement Learning.

Module: 4	Planning	5 Hours

Components of a Planning System - Goal Stack Planning- Forward Planning - Regression Planning - Planning as a Constraint Satisfaction Problem - Hierarchical Planning - Other Planning Techniques.

Module: 5	Language Processing	5 Hours

Language Models - Syntactic and Semantic Analysis - Discourse and Pragmatic processing - Statistical Natural Language Processing - Spell Checking - Text Classification - Information Retrieval and extraction - Image Formation - Basic Image Processing Operations - Object recognition by appearance.

Module: 6	AI Agents in Real time	5 Hours

Diagnostic agent - Tutoring agent - Trading agent - Smart Home - ChatGPT - Driverless cars - Virtual assistant - An autonomous delivery and helping robot.

Total Lectures	30 Hours

Text Books

1	Stuart Russell and Peter Norvig. (2021). *Artificial Intelligence - A Modern Approach.* (4th Edition). Prentice Hall. ISBN: 1292401176. 9781292401171.
2	David L. Poole. Alan K. Mackworth. (2017). *Artificial Intelligence: Foundations of Computational* Agents. *(2nd Edition).* Cambridge University Press. ISBN: 9781107195394.

Reference Books

1	Elaine Rich and Kevin Knight. (2019). *Artificial Intelligence. (3rd Edition).* Tata McGraw-Hill Publication. ISBN: 9780070087709.
2	Eugene Charniak and Drew V. McDermott. (2019). *Introduction to Artificial* Intelligence. *(3rd Edition).* Pearson Education. ISBN: 0201119455. 9780201119459.
3	M. Tim Jones. (2015 Reprint). *Artificial Intelligence: A Systems Approach (Computer Science).* (1st Edition). Jones and Bartlett Publishers. ISBN-13: 978-9380298139.
4	Luger, George F. (2008). *Artificial Intelligence: Structures and Strategies for Complex Problem Solving (6th Edition).* Pearson. ISBN: 978-0321545893.
5	Goodfellow, Ian, Bengio, Yoshua, & Courville, Aaron. (2016). *Deep Learning.* MIT Press. ISBN: 978-0262035613.

Course Code	Python Programming	L	T	P	C
23DC1008		3	0	0	3

Course Objectives:

Enable the students to:
1. Analyze the fundamental principles of Object-Oriented Programming, as well as data and information processing techniques.
2. Demonstrate real-world software development challenges.
3. Develop practical and contemporary applications.

Course Outcomes:

The students will be able to:
1. Illustrate the basic programming constructs of Python suitably.
2. Analyze the concepts of string processing, Encryption, file I/O, lists and dictionary.
3. Apply modules for reusability and the object-oriented principles for modeling and developing software systems.
4. Develop applications with graphical user interface.
5. Demonstrate data handling using Numpy arrays and Pandas.
6. Demonstrate visualization techniques using Pandas and matplot libraries.

Module: 1	Variables, Expressions, and Conditional Statements	7 Hours

Introduction to Python, Variables, and Comments - Numeric Data Types and Character Sets - Operators - Type Conversion - Expressions - Functions and Modules - Formatting text for output - Loop and Selection Statements - if and if-else statements, while loop, for loop, control statements break, continue, pass - Simulate a guessing the number game.

Module: 2	Strings, Text Files, Lists, and Dictionaries	7 Hours

Strings - Accessing characters and substrings in strings, String Methods, Basic string operations, String slicing, Searching, comparing, and manipulating Strings - Data Encryption - Text Files - Lists - List operations, searching and sorting a list, Tuple - Sets – Dictionaries - Simulate a password generator.

Module: 3	Functions and Classes	7 Hours

Defining simple function - Design with Recursive functions - Higher order functions - Arithmetic and operator overloading - comparison methods - Using pickle for permanent storage of objects - Objects and classes - Structuring classes with Inheritance and Polymorphism-Exception handling - Simulate a personal expenditure tracker, Simulate a currency calculator.

Module: 4	Graphical User Interfaces	8 Hours

GUI-Based Programs - Terminal-Based Version, GUI-Based Version and Event - Driven Programming, Windows and Window Components, Displaying Images, Command Buttons and Responding to Events and Viewing the Images, Label, and Entry Fields for the Input and Output of Text, Pop-up Dialog Boxes and Other Useful GUI Resources - Accessing Database - Storing and Retrieving data - updation - Simulate a calculator, simulate a Course credits management system. Simple Graphics - Overview of Turtle Graphics, Turtle Operations, Object Instantiation, and the turtle graphics Module, Drawing Two - Dimensional Shapes, Colors and the RGB System - Simulate an application to draw appealing modern art

Module: 5	Introduction to Python Libraries	8 Hours

Introduction to Python Libraries: NumPy, Pandas, Matplotlib, NumPy array: Creating NumPy arrays, various data types of NumPy arrays, indexing and slicing, swapping axes, transposing arrays, data processing using NumPy arrays series, Data Frame, Index objects, loading data into Pandas data frame, Working with Data Frames, Data wrangling.

Module: 6	Plotting and Visualization	8 Hours

Using matplotlib to plot data: figures, subplots, markings, color and line styles, labels and legends, Plotting functions in Pandas: Line, Bar, Scatter plots, Histograms, stacked bars, Heat – map.

Total Lectures	45 Hours

Text Books	
1	Nayak. R. & Gupta. N. (2022). *Python for Engineers and Scientists: Concepts and Applications. (1st Edition).* CRC Press. ISBN: 978-9332542525.
2	Rick van Hattem. (2016). *Mastering Python. Packt* Publishing *(2nd Edition).* ISBN: 139781786463746.

Reference Books	
1	Wes McKinney. (2022). *Python for Data Analysis: Data Wrangling with pandas. NumPy. and Jupiter. (3rd Edition).* O'Reilly Media. ISBN: 978-1098104030.
2	Gupta S.C. Kapoor V.K. (2020). *Fundamentals of Mathematical Statistics.* Sultan Chand & Sons. ISBN: 978-9351611738.
3	Michal Jaworski. TarekZiade. (2016). *Expert Python* Programming. *(2nd Edition).* Packt Publishing. ISBN-13: 978-1785886850.
4	Zelle, John M. (2017). *Python Programming: An Introduction to Computer Science* (3rd Edition). Franklin, Beedle & Associates Inc. ISBN: 978-1590282755.
5	Severance, Charles R. (2016). *Python for Everybody: Exploring Data in Python 3.* CreateSpace Independent Publishing Platform. ISBN: 978-1530051120.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Python Programming Laboratory	L	T	P	C
23DC1009		0	0	3	1.5

Course Objectives:

Enable the students to:

1. Analyze basics of python programming concepts
2. Apply the concepts of conditional statements, looping, control Statements, List, and dictionaries.

3. Develop programs using object-oriented features, graphical user interfaces and image Processing

Course Outcomes:

The students will be able to:

1. Illustrate the procedure and to write, test, and debug python programs.
2. Implement conditional and looping statements for python programs
3. Apply functions and represent data using lists, set, tuples, and dictionaries.
4. Illustrate file I/O Operations in python program.
5. Demonstrate applications with graphical user interface.
6. Develop design code and visualize the results with matplotlib and Pandas.

List of Exercises:

1. Use of Control Statements in Python
2. List, Set & Tuple Manipulation
3. Dictionary Manipulation
4. Creating User Defined Functions
5. File Handling based Applications
6. Text processing using string functions
7. Design applications using classes and Objects
8. Creating applications using Inheritance
9. Implement Graphical User Interface (GUI) application development and Graphics design using turtle.
10. Import iris data using sklearn library and compute mean, mode, median, standard deviation, confidence interval and standard error for each feature. (Download IRIS data from https://archive.ics.uci.edu/ml/datasets/iris or import it from sklearn.datasets)
11. Load a Pandas data frame with a selected dataset. Identify and count the missing values in a data frame.
    a. Drop duplicate rows.
    b. Detect the outliers and remove the rows that have outliers.
    c. Identify the most correlated positively correlated attributes and negatively correlated attributes.
12. Load Titanic data from sklearn library, plot the following with proper legend and axis labels:
    a. Plot bar chart to show the frequency of survivors and non-survivors for male. and female passengers separately.
    b. Draw a scatter plot for any two selected features.
    c. Compare density distribution for features age and passenger fare.
    d. Use a pair plot to show pairwise bivariate distribution.

Exercises from the above list will be approved by the HoD during the start of the semester.

Recommended by Board of Studies	24.04.2024
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Course Code	Ethics in Information Technology	L	T	P	C
23DC1010		**2**	**0**	**0**	**2**

Course Objectives:

Enable the students to:

1. Analyze the basic concepts of professional ethics, organizational culture and climate.
2. Examine the impact of the IT profession, software development, cyber laws and regulations in society.
3. Develop the standards, policies, procedures and controls for Information Security Management Systems.

Course Outcomes:

The students will be able to:

1. Illustrate professional ethics, leadership theories, and management styles relevant to engineering practice.
2. Demonstrate cyberattacks, cybersecurity measures, and legal frameworks governing IT ethics and privacy.
3. Apply intellectual property rights, patent procedures, and essential considerations regarding software copyrights.

4. Apply strategies for engineering quality software and understand the impact of IT on productivity and standards of living.
5. Design social networking platforms, ethical dilemmas, industry codes of conduct, and incorporate green computing practices.
6. Demonstrate the implementation of ISO 27001 information security management systems, along with understanding auditing procedures and incident response protocols.

Module: 1	Overview of Professional Ethics	5 Hours

Professional Ethics - Organizational Culture and Climate - Engineering Ethics - Ethical Problem Solving Techniques - Ethical Issues in Engineering Practice - Leadership theories: Transactional, Transformational, Charismatic leadership, Situational leadership - Participative style of management- Engineers as Managers - Concept of Continuous improvement - PDCA Cycle - Quality circles.

Module: 2	Cyber Attacks and Cyber Laws	5 Hours

Ethics for IT Workers and IT Users - Cyberattacks and Cybersecurity - Confidentiality, Integrity and Authenticity (CIA) - The CIA Security Triad - Response to Cyberattack. - Privacy - IT Act cyber laws - Information Technology Act, 2000 ("IT Act") - Digital Signature.

Module: 3	Intellectual Property Rights	5 Hours

Intellectual Property , Software Copyrights , Patents , Trade Secrets, Key Intellectual Property **Issues**, Patentable Software related Products , IPR Procedures , Patent Application, Publication, examination, awarding.

Module: 4	Software Development and Information Technology	5 Hours

Strategies to Engineer Quality Software, Software Product Liability, Key Issues in Software Development- The impact of IT on the Standard of Living and Productivity - Industry 4.0 standards and applications in areas like Food, Water, Energy and Health care.

Module: 5	Social Networking and Ethical Issues	5 Hours

Social Networking Web Site, Business Applications of Online Social Networking, Social Networking Ethical Issues, Online Virtual Worlds, Key ethical issues for Organizations, Contingent Workers, Outsourcing, Whistle Blowing, Green Computing, ICT Industry Code for Conduct.

Module: 6	Standards for Information Security Management	5 Hours

Information Security Management Systems (ISMS) - ISO 27001 - Framing Security Policy of Organization - Committees - Security Forum, Core Committee, Custodian and Users, Business Continuity Process Team & Procedure - Information Security Auditing Process, IT Security Incidents.

Total Lectures	30 Hours

Text Books	
1	George Reynolds. (2018). *Ethics in Information Technology. (6th Edition).* CENGAGE Learning. ISBN: 978-1337405874.
2	Sara Baase. Timothy Henry. (4th Edition). *A Gift of Fire: social. legal. and ethical issues for computing and the Internet.* Prentice Hall. 2012. ISBN: 978-0132492676.

Reference Books	
1	Charles Byrns Fleddermann. (2012). *Engineering Ethics. (4th Edition).* Pearson. ISBN: 978-0132145213.
2	Richard A. Spinello. (2003). *Case Studies in Information Technology* Ethics. (*2nd Edition).* Prentice Hall. ISBN: 978-0130991508.
3	Neeraj Pandey. Kushdeep Dharni. (2014). *Intellectual Property Rights.* PHI Learning Pvt. Ltd. ISBN: 978-8120349896.
4	Quinn, Michael J. (2020). *Ethics for the Information Age* (8th Edition). Pearson. ISBN: 978-0135217726.
5	Tavani, Herman T. (2016). *Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing* (5th Edition). Wiley. ISBN: 978-1119239754.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Microprocessor and Microcontroller	L	T	P	C
23DC1011		**2**	**0**	**0**	**2**

Course Objectives:

Enable the students to:
1. Analyze the architectures of Intel microprocessors, microcontroller and ARM processors.
2. Develop assembly language programming in 8051 microcontroller and ARM processor.
3. Illustrate the peripheral I/O devices with the 8051 microcontroller.

Course Outcomes:

The students will be able to:
1. Demonstrate various microprocessors including Intel Pentium Processors
2. Analyze the architecture and the program of Intel 8086 Microprocessor.
3. Develop assembly language programming using 8051 microcontroller.
4. Demonstrate interfacing of various peripherals such as general purpose input/ output, timers, serial communication, LCD, keypad and ADC with 8051 microcontroller
5. Develop simple applications using ARM processor
6. Demonstrate the concepts of advanced microprocessors and microcontrollers

Module: 1	8086 Microprocessor Architecture and Interfacing	6 Hours

Introduction to Microprocessors, 8086 - Architecture and Addressing modes, Memory Segmentation, Instruction Set, Assembly Language Processing, minimum and maximum mode configuration, Programmable Peripheral Interface (8255), Programmable Timer Controller (8254), Memory Interface to 8086.

Module: 2	8051 Microcontroller	5 Hours

Architecture of 8051 - Special Function Registers (SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Assembly language programming.

Module: 3	Microcontroller 8051 Peripherals	4 Hours

I/O Ports, Timers-Counters, Serial Communication and Interrupts.

Module: 4	I/O Interfacing	6 Hours

LCD, LED, Keypad, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Sensor with Signal Conditioning Interface.

Module: 5	ARM Processor Architecture and Instruction set	5 Hours

Overview of ARM architecture, Registers, Modes, ARM Instruction - data processing instructions, branch instructions, load store instructions, SWI Instruction, Loading instructions, conditional Execution, Assembly Programming.

Module: 6	Advanced Microprocessor and Microcontroller	4 Hours

Overview of Intel Pentium, I (i3, i5, i7) Series Processors, - RISC Processors - RISC Vs CISC, RISC properties and evolution.

Total Lectures	30 Hours

Text Books

1	Douglas V. Hall. (2017). *Microprocessors & Interfacing. (3rd Edition).* Tata McGraw Hill. ISBN - 9781259006159.
2	Ramesh S. Gaonkar. (2013). *Microprocessor Architecture Programming and Application. (6th Edition).* Pen ram International. Mumbai. ISBN-13: 978-8187972884.
3	Mazidi. Muhammad Ali. Naimi. Sarmad. Naimi. Sepehr. Chen. Shujen. (2016). *ARM Assembly Language Programming & Architecture.* United States: Microdigitaled.com. ISBN: 978-0997925906.

Reference Books

1	A.K. Ray. K.M. Bhurchandi. (2012). *Advanced Microprocessors and Peripherals. (3rd Edition).* Tata McGrawHill. ISBN: 9780070140622.

2	A. Nagoor Kani. (2017). *Microprocessors and* Microcontrollers. *(2nd Edition)*. McGraw Hill Education. ISBN: 978-0071329743.
3	Pablo Mary. Panda Jeebananda. (2016). *Microprocessors and Microcontrollers*. PHI Learning Pvt. Ltd. ISBN: 978-8120352315.
4	Rafiquzzaman, Mohamed. (2018). *Microprocessor Theory and Applications with 68000/68020 and Pentium*. John Wiley & Sons. ISBN: 978-1119448415.
5	Peatman, John B. (1997). *Embedded Design with the PIC18F452 Microcontroller*. McGraw-Hill Education. ISBN: 978-0071427838.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Microprocessor and Microcontroller Laboratory	L	T	P	C
23DC1012		0	0	2	1

Course Objectives:

Enable the students to:
1. Illustrate the concepts of assembly language programs of Intel 8086 including arithmetic and logical, sorting, searching, and string manipulation operations.
2. Apply assembly language programs for interfacing Intel 8086 with peripheral devices.
3. Develop simple programs on ARM Processor.

Course Outcomes:

The students will be able to:
1. Illustrate the concepts of assembly language programming in 8086 Microprocessor.
2. Demonstrate the components and setup for interfacing 8255 PPI with the 8086 Microprocessor
3. Develop assembly language programming with 8051 Microcontroller.
4. Implement methods to generate output waveforms with DAC
5. Demonstrate different techniques for interfacing I/O devices with the 8051 microcontroller
6. Develop programming skills to design and optimize simple application on the ARM processor.

List of Exercises

1. Arithmetic and Logical operations using 8086.
2. Sorting/Searching of an element using 8086.
3. Generation of square wave by interfacing with 8255 PPI
4. 8259 programmable interrupt controller - Development of interrupt service routine.
5. 8279 Keyboard/display controller - Keyboard scan - blinking and rolling display.
6. Stepper motor controller interface.
7. Arithmetic, Logical and Bit Manipulation Instructions of 8051.
8. Program and verify Timer/Counter in 8051.
9. Program and verify Interrupt handling in 8051.
10. Interfacing LCD to 8051.
11. Interfacing matrix/keyboard to 8051.
12. Simple programs with ARM processor

Exercises from the above list will be approved by the HoD during the start of the semester

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Computer Organization and Architecture	L	T	P	C
23DC1013		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the fundamental principles of digital logic and computer organization.
2. Develop skills in designing and analysing combinational and sequential circuits.
3. Analyze computer architecture, including processor design, memory management, and I/O operations.

Course Outcomes:

The students will be able to:

1. Illustrate the fundamental principles of computer architecture fundamentals and the interactions among its components.
2. Demonstrate the memory technology principles to analyse performance modelling effectively
3. Demonstrate the concept of I/O operations and number systems proficiently, demonstrating mastery through practical application and conceptual comprehension.
4. Implement computer arithmetic principles and understand machine instructions.
5. Demonstrate processor structure, instruction pipelining, and RISC concepts to evaluate their effectiveness.
6. Apply control unit operation and parallel processing concepts succinctly.

Module: 1	Introduction	7 Hours

Introduction to Computer Architecture: Structure and function, IAS Computer, Computer Components, Computer function, Interconnection structure, Bus Interconnection, PCI Physical and Logical Architecture.

Module: 2	Introduction to Internal Memory Technology	8 Hours

Principle of Locality, Characteristics of Memory Systems, The memory hierarchy, Performance Modelling of a Multilevel Memory hierarchy, Introduction to cache memory, Elements of cache design, Cache Performance Models, Internal Memory: Semiconductor memory, Error correction, DDR DRAM, eDRAM, Flash Memory.

Module: 3	Input / Output Modules and Number Systems	8 Hours

Introduction to external devices, Input / Output modules, Programmed I/O, Interrupt driven I/O, Direct memory access, Direct cache access, I/O channels and processors, Number Systems.

Module: 4	Computer Arithmetic and Instruction Set	7 Hours

Computer arithmetic, Integer representation and arithmetic, Floating point representation and arithmetic, Machine Instruction Characteristics, types of operands and operations (Intel x86 and ARM processor), Addressing modes and Instruction formats.

Module: 5	Processor Structure and Reduced Instruction Set	8 Hours

Processor organization, Register organization, Instruction cycle, Instruction pipelining, Processor Organization for Pipelining, Instruction Execution Characteristics, The Use of a Large Register File, Compiler-Based Register Optimization, Reduced Instruction Set Architecture.

Module: 6	Control unit Operation and Parallel Processing	7 Hours

Micro operations, Control of the processor, Hardwired implementation, Microprogrammed control, Multiple Processors Organization, Symmetric Multiprocessor, Cache Coherence and the MESI Protocol.

Total Lectures		45 Hours

Text Books

1	William Stallings. (2019). *Computer Organization and Architecture: Designing for* Performance. (*11th Edition*). Pearson Education. ISBN: 978-0-13-499719-3.
2	John L. Hennessy. David A. Patterson. (2012). *Computer Architecture: A Quantitative Approach. (5th Edition).* Morgan Kaufmann. ISBN: 978-0-12-383872-8.

Reference Books

1	Andrew S. Tanenbaum. Todd Austin. (2013). *Structured Computer Organization. (6th Edition).* Prentice Hall. ISBN: 0132916525.
2	John P. Hayes. (2002). *Computer Organization and Architecture. (3rd Edition).* McGraw Hill. ISBN: 0070273553.
3	Carl Hamacher. Zvonko Vranesic. Safwat Zaky. Naraig Manjikian. (2012). *Computer Organization and Embedded Systems. (6th Edition)* Tata McGraw-Hill. ISBN: 9780077418809.
4	V.P. Heuring. H.F. Jordan. (2004). *Computer Systems Design and Architecture.* (*2nd Edition*). Pearson Education. ISBN: 9788177584837.
5	David Harris. Sarah L. Harris. (2021). *Digital Design and Computer Architecture, RISC. (5th Edition).* Morgan Kaufmann. ISBN: 978-0128200643

Recommended by Board of Studies	24.04.2024

Course Code	Object Oriented Programming	L	T	P	C
23DC2001		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the fundamentals of object-oriented programming constructs.
2. Analyze the multithreading and exception handling concepts to enhance software reliability.
3. Develop interactive GUIs with swing and manage events.

Course Outcomes:

The students will be able to:
1. Analyze Java fundamentals and object-oriented principles.
2. Develop object-oriented features and interfaces to enhance software functionality and user interaction.
3. Analyze the mechanisms of multithreading and exception handling to optimize performance and reliability.
4. Apply file I/O and string manipulation techniques for improved data handling.
5. Demonstrate Java generics and collections for enhanced code efficiency.
6. Apply Java Swing to develop desktop applications that solve real-time problems.

Module: 1	Introduction to Java and Object-Oriented Programming	7 Hours

Overview of Java: History, Evolution, Features - JVM, JDK, JRE, Byte Code - OOP Concepts: Classes, Objects, Data Abstraction, Encapsulation - Java Data Types, Variables, Arrays, Operators, Type Conversion, Control Statements.

Module: 2	Inheritance, Polymorphism, and Interfaces	7 Hours

Inheritance: Super and subclass, constructors, method overriding, and inheritance hierarchies - Polymorphism: Overloading methods, dynamic binding, abstract classes and methods - Packages - Interfaces - partial implementation of interfaces.

Module: 3	Multithreading and Exception Handling	7 Hours

Multithreading: Creating, running, synchronizing, and coordinating threads - Exception Handling: Error classification, checked and unchecked exceptions, using try-catch blocks.

Module: 4	String Manipulation , File I/O and Networking	8 Hours

Enumeration and Auto boxing - String Manipulation - File Management: Byte and character streams, text and binary I/O, random access file operations - Networking.

Module: 5	Generics, Collection and Lambda Expression	8 Hours

Generic Class - Generic Method - Collection - List - Stack - Queue - Set - Map - Iterator - Comparator - Lambda Expressions.

Module: 6	GUI Development and Event Handling in Java	8 Hours

Swing Controls - Event Handling - Layout Managers.

Total Lectures	45 Hours

Text Books

1	Herbert Schildt. (2018). *Java: The Complete Reference*. McGraw-Hill. *(11th Edition).* ISBN: 9781260440249.
2	Marc Loy. Patrick Niemeyer. Daniel Leuck. (2020). *An Introduction to Real-World Programming with Java. (5th Edition).* O'Reilly Media. ISBN: 9781492056225.

Reference Books

1	Ken Kousen. *Modern Java Recipes. (1st Edition).* O'Reilly Media. Inc. *(August 2017).* ISBN: 9781491973172.
2	Y. Daniel Liang. *Introduction to Java Programming and Data Structures. (11th Edition).* Pearson. *(March 2017).* ISBN: 9780134670942.

3	Cay Horstmann. (2020).*Core Java. (11th Edition)*. Pearson. ISBN: 978-0135166307
4	John Dean. Ray Dean. (2021). *Introduction to Programming with Java: A Problem Solving Approach. (3rd Edition)*. Tata Mc Graw Hill. ISBN: 9781259875762
5	Joyce Farrell. (2013). *Java Programming. (7th Edition)*. Cengage Learning. ISBN: 978-1285081953.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Object Oriented Programming Laboratory**	**L**	**T**	**P**	**C**
23DC2002		**0**	**0**	**3**	**1.5**

Course Objectives:

Enable the students to:
1. Analyze the Object-Oriented Programming Concepts.
2. Develop programs using object-oriented features such as composition of objects, inheritance, polymorphism etc.
3. Demonstrate software development skills using Java programming for real world applications.

Course Outcomes:

The students will be able to:
1. Illustrate the concept of control statements and arrays for effective logic and data handling.
2. Analyze the fundamentals of classes and objects to build a foundation for object oriented programming.
3. Apply inheritance and interfaces to construct advanced, reusable software architectures.
4. Implement conception handling techniques to ensure robust software performance.
5. Develop and manage multithreaded applications to improve operation efficiency.
6. Design user interfaces with Java swing to enhance user interaction and application usability.

List of Exercises:

1. Using control statements and arrays for logic and data handling
2. Text processing using Java Strings
3. Basics of classes and objects
4. Creating application using inheritance
5. Using interfaces for structure
6. Organizing code with packages
7. Handling errors with exceptions
8. Multithreading using Java
9. File management with Java I/O
10. Building GUIs using Java Swing
11. Collections and generics in Java

Course Code	**Data Structures and Algorithms**	**L**	**T**	**P**	**C**
23DC2003		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the concepts of linear data structures and algorithms.
2. Demonstrate different non-linear data structures such as trees and graphs.
3. Apply the different searching, sorting and selection techniques.

Course Outcomes:

The students will be able to:
1. Analyse the concept of fundamental data structures.
2. Apply complex data structures for efficient data organization.
3. Demonstrate the different types of tree data structures and the application of heap.
4. Demonstrate the graph representations and traversals.
5. Demonstrate the working of sorting and application of hashing.
6. Apply various searching and selection techniques to solve problems efficiently.

Module: 1	**Algorithm Analysis**	**7 Hours**

Data Structures - Abstract Data Types - Algorithm - Analysis of Algorithms - Running Time Analysis - Compare Algorithms - Types of Analysis - Asymptotic Notation - Recursion and Backtracking.

Module: 2	Linked Lists, Stack, Queue	8 Hours

Linked List ADT - Arrays - Comparison of Linked Lists with Arrays and Dynamic Arrays - Singly Linked Lists - Doubly Linked List - Circular Linked List - Memory efficient Doubly Linked List - Stack ADT - Application - Queue ADT - Application.

Module: 3	Trees, Priority Queues and Heaps	8 Hours

Tree - Binary Trees - Types of Binary Trees - Binary Tree Traversals - Generic Trees (N-ary Trees) - Threaded Binary Tree Traversals (Stack or Queue-less Traversals) - Expression Trees - XOR Trees - Binary Search Trees - Balanced Binary Search Trees – AVL Trees - Priority Queue ADT - Heaps and Binary Heaps.

Module: 4	Graph Algorithms	8 Hours

Applications of Graphs - Graph Representation - Graph Traversals - Topological Sort - Shortest Path Algorithms - Minimal Spanning Tree.

Module: 5	Sorting and Hashing	7 Hours

Sorting Necessary - Classification of Sorting Algorithms - Bubble Sort - Selection Sort - Insertion Sort - Shell Sort - Merge Sort - Heap Sort - Quick Sort - Tree Sort - Counting Sort - Radix Sort - Hash Table ADT - Hash Table.

Module: 6	Searching and Selection Algorithms	7 Hours

Types of Searching - Unordered Linear Search - Sorted/ Ordered Linear Search - Binary Search - Symbol Tables and Hashing - String Scorching Algorithms - Selection by Sorting - Partition-based Selection Algorithm.

Total Lectures	45 Hours

Text Books

1	Narasimha Karumanchi. (2023). *Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles.* CareerMonk Publications. ASIN: B0CBW278NC
2	Thomas H. Cormen, Charles E. Leiserson, Ronald L.Rivest, Clifford Stein. (2022). *Introduction to Algorithms .(4th Edition).* Mcgraw Hill/ MIT Press.ISBN: 9780262046305

Reference Books

1	Michael T. Goodrich. Roberto Tamassia. Michael H. Goldwasser. (2021). *Data Structures and Algorithms in Python.* Wiley; ISBN-10: 9354247865. ISBN-13: 978-9354247866.
2	Hemant Jain. (2022). *Problem Solving in Data Structures & Algorithms Using Python.* Hemant Jain. ISBN-13: 978-9356208148.
3	Harsh Bhasin. (2023). *Data Structures with Python: Get familiar with the common Data Structures and Algorithms in Python.* BPB Publications. ISBN-10: 9355513305. ISBN-13: 978-9355513304.
4	Thomas H. Cormen. Charles E. Leiserson. Ronald L.Rivest. Clifford Stein. (2022). *Introduction to Algorithms. (4thEdition).* Mcgraw Hill/ MIT Press. ISBN: 9780262046305 .
5	Alfred V. Aho. Jeffrey D. Ullman. John E. Hopcroft. (2002). *Data Structures and Algorithms. (1st Edition).* Pearson Education. ISBN: 978-8178081021.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Structures and Algorithms Laboratory	L	T	P	C
23DC2004		0	0	3	1.5

Course Objectives:

Enable the students to:

1. Demonstrate the practical skills in utilizing linear data structures and algorithms.
2. Perform analysis on various non-linear data structures and sorting algorithm.
3. Construct solutions using hashing, searching and selection operations.

Course Outcomes:

The students will be able to:

1. Demonstrate stack and queue data structures for proper data manipulation and processing.
2. Apply singly, doubly, and circular linked lists for convenient data organization and manipulation.
3. Perform binary tree traversals and graph traversal algorithms for rapid navigation and analysis of hierarchical and interconnected data structures.
4. Implement sorting algorithms for efficient sorting of data in various computational contexts.
5. Apply hashing and searching algorithms for quick data retrieval and searching tasks.
6. Adapt efficient data sorting and selection operations.

List of Exercises	

1. Implementation of stack ADT
2. Implementation of Queue ADT and Circular Queue
3. Implementation of Singly Linked List and Circular Linked List
4. Implementation of Doubly Linked List
5. Implementation of Binary Tree Traversals
6. Implementation of Graph Traversal
7. Implementation of Bubble Sort and Insertion Sort Algorithms
8. Implementation of Merge Sort and Quick Sort Algorithms
9. Implementation of Hash Table
10. Implementation of Linear Search and Binary Search Algorithms
11. Implementation of Selection Sort and Radix Sort Algorithms
12. Implementation of Partition-based Selection Algorithm

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Cyber Physical System	L	T	P	C
23DC2005		3	0	0	3

Course Objectives:

Enable the students to:

1. Demonstrate the real-world Cyber Physical Systems, design with requirements, explore applications, and learn associated technologies.
2. Implement dynamics concepts to understand Cyber Physical System behaviours; analyse computation models for their roles.
3. Perform the design of embedded systems, IoT, and CPS architectures; assess security and privacy emphasizing network and cloud safety.

Course Outcomes:

The students will be able to:

1. Demonstrate how Cyber Physical Systems operate in reality and their significance in Industry 4.0 and the Industrial Internet of Things (IIoT).
2. Adapt how to design Cyber Physical Systems, learn their requirements, explore real-world uses, and understand the hardware and wireless technologies involved.
3. Apply the concepts of continuous dynamics, discrete dynamics, and hybrid systems to understand the models and behavioural dynamics of Cyber Physical Systems.
4. Analyse various models of computation such as synchronous reactive models, dataflow models, and timed models to understand their role in Cyber Physical Systems.
5. Design embedded Systems, Internet of Things Architecture, and Cyber Physical System architecture, focusing on their respective components and structures.
6. Evaluate the security and privacy of Cyber Physical Systems, focusing on network safety, internet communication, and privacy in cloud-connected setups.

Module: 1	**Computational Foundation of Cyber Physical Systems**	**7 Hours**

Cyber Physical Systems in Real world - Basic Principle of Cyber Physical Systems - Industry 4.0- IIoT

Module: 2	**Cyber Physical System Design and System Requirements**	**8 Hours**

Cyber Physical Systems Design Recommendations - CPS system requirements - Cyber Physical System Application - Case study of Cyber Physical Systems - Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers) - Wireless Technologies for Cyber Physical Systems.

Module: 3	Cyber Physical System – Models and Dynamics Behaviours	6 Hours
Continuous Dynamics - Discrete dynamics - Hybrid Systems.		
Module: 4	Concurrent Models of computation	8 Hours
Structure of Models - Synchronous Reactive models - Dataflow models of computation - Timed models of computation.		
Module: 5	Study of Embedded Systems vs. Internet of Things vs Cyber Physical System	8 Hours
Design of Embedded Systems (I/O Units, Multitasking and Scheduling) - Internet of Things Architecture - CPS Architecture.		
Module: 6	Security and Privacy in Cyber Physical Systems	8 Hours
Security and Privacy Issues in CPSs - Local Network Security for CPSs - Internet - Wide Secure Communication - Security and Privacy for Cloud - Interconnected CPSs - Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0		
Total Lectures		45 Hours

Text Books

1	Rajeev Alur. (2015).*Principles of Cyber Physical Systems*. MIT Press. ISBN: 9780262029117
2	E. A. Lee. Sanjit Seshia. (2017). *Introduction to Embedded Systems – A Cyber–Physical Systems Approach. (2nd Edition).* MIT Press. ISBN: 978-0-262-53381-2.

Reference Books

1	Guido Dartmann. Houbing song. Anke schmeink. (2019). *Big data analytics for Cyber Physical System*. Elsevier. ISBN :9780128166376.
2	Houbing song. Danda B Rawat. Sabina Jeschke. Christian Brecher. (2017). *Cyber Physical Systems Foundations. Principles and Applications*. Elsevier. ISBN: 978-0128038017.
3	Chong Li. Meikang Qiu. (2019). *Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies*. CRC press. ISBN: 978-1138543539.
4	Taha, W. M., Taha, A. M., Thunberg, J. (2020). *Cyber-Physical Systems: A Model-Based Approach.* Germany: Springer International Publishing. ISBN:9783030360719, 3030360717
5	Rajkumar, R., de Niz, D., Klein, M. (2016). *Cyber-Physical Systems.* United Kingdom: Pearson Education. ISBN:9780133416152, 0133416151

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	IoT and its Applications	L	T	P	C
23DC2006		3	0	0	3

Course Objectives:

Enable the students to:
1. Demonstrate the basic concepts of IoT and device connectivity.
2. Apply knowledge in Real time data logging and data analytics on cloud.
3. Analyze the potential areas utilizing embedded controllers/processors in real time systems.

Course Outcomes:

The students will be able to:
1. Illustrate the Internet of Things and its hardware and software components
2. Implement interfacing of I/O devices, sensors & communication modules
3. Demonstrate the data and control devices
4. Distinguish the connectivity technologies and protocols in IOT
5. Examine security issues in IOT
6. Develop real-time IoT projects

Module: 1	Introduction to IoT	5 Hours
Introduction - User Experience design for IoT - Technology of Connected Devices - Networks: Technology of connectivity - Security and Privacy Issues.		
Module: 2	Smart Home	7 Hours
Automating the Home - Smart Steps to Smart Home - Components for Smart Home - Smart Network - Controlling Smart Homes - Interfacing ESP8266 and Relay board - Blynk App - Arduino and libraries installation - IFTTT Applet - Case Study: Smarter Sensing with smart monitors.		

Module: 3	Wearable Tech	10 Hours

Wearables: Fundamentals, Advancement and roadmap for future - Smart Watches, Fitness Trackers, Smart Eyewear - wearable bio and chemical sensors - wearable inertial sensors and applications - Architecture & pin diagram for Arduino - Interacting with Analog & Digital sensors - Dealing with personal data - Monitoring sensor data from cloud platform - Case Study: Application of optical heart rate monitoring.

Module: 4	Health Care	8 Hours

Internet of Medical Things - Smart Medical Devices and Monitoring - Smart Hospitals - Smart Medical records - Insight to Raspberry Pi and Preparing Raspberry Pi board - GPIO Configuration - Programming Raspberry Pi, Internal & External representation of sensor data - Parsing sensor data on import - displaying measured information on IoT Cloud platform - Controlling actuator from IoT Cloud platform.

Module: 5	Smart Farming	8 Hours

Agricultural Internet of Things - Environmental and climatic change - Role of Arduino and Node MCU in agricultural field - Interfacing with external devices - Development of local web server for automation - Labview / Matlab based data logger for agricultural field parameters monitoring system - Case study: Smart control for site specific management of fixed irrigation system.

Module: 6	Smart Drones	8 Hours

Introduction to Drones - Assembling a drone - Preparing a drone for flying - Building a follow me drone - Case study: Building mission control drone.

Total Lectures	45 Hours

Text Books

1	Michael Miller. (2015). *The Internet of Things: How Smart TVs. Smart Cars. Smart Homes and Smart Cities are changing the world*. ISBN: 978-0789754004.
2	Edward Sazonov. Michael R. Neuman. (2014). *Wearable Sensors: Fundamentals. Implementation and Applications*. Academic Press/Elsevier. ISBN: 978-0124186620.

Reference Books

1	Claire Rowland. Elizabeth Goodman. Martin Chalier. Ann Light. Alfred Lui. (2015). *Designing Connected Products: UX for the Consumer Internet of Things*. O'Reilly Media. Inc. ISBN: 978-1449372569.
2	Rajesh Singh. Anita Gehlot. Bhupendra Singh & Sushabhan Choudhury. (2018). *Internet of Things (IoT) Enabled Automation in Agriculture*. ISBN: 9789387973053.
3	Syed Omar Faruk Towaha. (2018). *Building Smart Drones with ESP8266 and Arduino: Build exciting drones by leveraging the capabilities of Arduino and ESP8266*. Packt Publishing. ISBN: 1788477510.
4	Hersent, O., Boswarthick, D., Elloumi, O. (2011). *The Internet of Things: Key Applications and Protocols*. Germany: Wiley. ISBN:9781119966708, 1119966701
5	Lakhwani,D.K.(2020).*Internet of Things (IoT): Principles, Paradigms and Applications of IoT*.India:BPB Publications. ISBN:9789389423365, 9389423368

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	IoT and its Applications Laboratory	L	T	P	C
23DC2007		0	0	2	1

Course Objectives:

Enable the students to:
1. Demonstrate the IoT devices, application areas and technologies involved.
2. Adapt to the various IoT sensors and technological challenges faced by IoT devices.
3. Explore and learn IoT with the help of Raspberry Pi and Arduino.

Course Outcomes:

The students will be able to:
1. Demonstrate the building blocks of Internet of Things and characteristics
2. Apply the concepts of IOT.
3. Operate various sensors used for applications.
4. Demonstrate the working principles of sensors, Arduino boards.
5. Apply IoT to various small-scale real-world applications.
6. Analyse the data received through sensors in IOT.

List of Exercises:
1. Interfacing LED with an Arduino.
2. Controlling an LED with a Push Button using Arduino.
3. Interfacing a Temperature Sensor with an Arduino
4. Interfacing an LCD and a Temperature Sensor with an Arduino.
5. Interfacing an Ultrasonic Sensor with an Arduino to Measure Distance.
6. Interfacing an Ultrasonic Sensor and an LCD with an Arduino.
7. Interfacing a DC Motor with an Arduino.
8. Direction Control of a DC Motor Using an Arduino.
9. Speed and Direction Control of a DC Motor Using an Arduino.
10. Familiarization with Raspberry Pi/ Node MCU to perform necessary software installation and interface LED/Buzzer with Raspberry Pi.

Course Code	Computer Networks	L	T	P	C
23DC2008		3	0	0	3

Course Objectives:

Enable the students to
1. Demonstrate the protocol layers and their service models.
2. Distinguish the connectionless and connection-oriented transport protocols.
3. Analyze the network infrastructure.

Course Outcomes:

The students will be able to
1. Demonstrate the protocol layers, Internet protocol and their service models.
2. Examine the fundamental principles of network applications, protocols, transport layer services, congestion control mechanisms.
3. Apply knowledge of forwarding, routing algorithms, IP addressing (IPv4 and IPv6), and network management protocols to analyze and optimize network performance and design.
4. Analyze the fundamentals of the link layer.
5. Design comprehensive security strategies for computer networks.
6. Evaluate the principles and technologies of wireless and mobile networks.

Module: 1	Overview	7 Hours

Protocol, Access Networks, Physical media, Packet switching, Circuit switching, Delay, loss and throughput, Network topology, Protocol layers and their service models, Networks under attack.

Module: 2	Application Layer & Transport Layer	7 Hours

Principles of network applications, Web and HTTP, Electronic Mail in the Internet, DNS, Peer to Peer File Distribution, Transport Layer Services, Multiplexing and Demultiplexing, UDP, Principles of Reliable Data Transfer, TCP, Principles of Congestion Control, TCP Congestion Control.

Module: 3	Network Layer	7 Hours

Forwarding and Routing, Router Architecture, IPv4 addressing, IPv6 addressing, Generalized Forwarding and SDN, Routing Algorithms – Link State Routing Algorithm, Distance Vector Routing Algorithm, OSPF, BGP, ICMP, Network Management and SNMP, NETCONF/YANG.

Module: 4	Link Layer	8 Hours

Link Layer Services, Error Detection and Correction Techniques, Multiple Access Links and Protocols, Switched Local Area Networks, Link Virtualization, Data Center Networking.

Module: 5	Security in Computer Networks	8 Hours

Principles of Cryptography, Message Integrity and Digital Signatures, End Point Authentication, Securing Email, Securing TCP Connections, Network Layer Security, Operational Security.

Module: 6	Wireless and Mobile Networks	8 Hours

Wireless Links and Network Characteristics, WiFi 802.11 Wireless LANs, Cellular Networks: 4G and 5G, Securing Wireless LANs and 4G/5G Cellular Networks**,** Mobility Management.

Total Lectures		45 Hours
Text Books		
1	James F. Kurose and Keith W. Ross. (2021). *Computer Networking A Top-Down Approach. (8th Edition)*. Pearson. ISBN: 978-1292405469.	
2	Behrouz A. Forouzan. (2017). *Data Communications and Networking. (5th Edition).* McGrawHill Higher education. ISBN: 978-1259064753.	
Reference Books		
1	William Stallings. *Data and Computer Communications. (8th Edition).* Pearson. 2006. ISBN: 978-1425982027.	
2	Tanenbaum, A. S., Feamster, N. (2019). *Computer Networks.* United Kingdom: Pearson Education. ISBN:9780135408001, 0135408008	
3	Howser, G. (2019). *Computer Networks and the Internet: A Hands-On Approach.* Germany: Springer International Publishing. ISBN:9783030344962, 3030344967	
4	Forouzan, B. A., Mosharraf, F. (2012). *Computer Networks: A Top-down Approach.* United Kingdom: McGraw-Hill.ISBN:9780071315159, 0071315152	
5	Peterson, L. L., Davie, B. S. (2011). *Computer Networks: A Systems Approach.* Netherlands: Morgan Kaufmann.ISBN:9780123850607, 0123850606	
Recommended by Board of Studies	24.04.2024	
Approved by Academic Council	11.05.2024	

Course Code 23DC2009	Computer Networks Laboratory	L	T	P	C
		0	0	3	1.5

Course Objectives:

Enable the students to:
1. Illustrate and troubleshoot networking topologies.
2. Simulate various routing and switching protocols and wireless communication technologies
3. Demonstrate testing and troubleshooting of LAN and WAN using Physical Topology

Course Outcomes:

The students will be able to:
1. Implement the various command line interface networking tools.
2. Demonstrate the working of application layer protocols.
3. Illustrate the operation of static and dynamic routing protocols.
4. Implement intra and inter VLAN routing concepts, ACL, and NAT
5. Execute the suitable addressing scheme for network design.
6. Demonstrate IPV4 and IPV6 functionalities.

List of Experiments

1. Basic Networking Troubleshooting Commands.
2. Simulation of LAN Topology – HTTP, DNS & DHCP
3. IP Addressing and Subnetting.
4. Static Routing configuration, testing and troubleshooting.
5. Configuration, testing and troubleshooting of dynamic Routing protocols – RIP V1& V2
6. Configuration, testing and troubleshooting of dynamic Routing protocols – OSPF & EIGRP
7. Configuration, testing and troubleshooting of VLAN.
8. Simulation of LAN using IPV6
9. Configuration, testing and troubleshooting of dynamic Routing protocols, RIPng
10. Configuration, testing and troubleshooting of LAN and WAN using Physical Topology.

Exercises from the above list will be approved by the HoD during the start of the semester.

Recommended by Board of Studies	24.04.2024

Course Code	Database Management Systems	L	T	P	C
23DC2010		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the concepts of basic query language
2. Apply the fundamentals of DDL, DML DCL, and TCL
3. Implement new developments and trends in developing a database.

Course Outcomes:

The students will be able to:
1. Analyze the role of database administrator and database management systems in software applications and other advanced concepts.
2. Apply query language to retrieve data efficiently from the database.
3. Create database for the given requirement specification using the ER method and normalization.
4. Illustrate the database objects such as file structures and index schemes.
5. Demonstrate the techniques for transaction processing and implementing security in the database.
6. Design and implement scalable and efficient data storage solutions using various types of NoSQL databases, including column-oriented, key/value, and graph databases.

Module: 1	Database Architecture and its Applications	8 Hours

System Application, Purpose of Database System, View of Data, Database Language, Relational Database, Database Design, Object-Based and Semi-structured Databases, Data Storage and Querying, Transaction Management, Data Mining and Analysis, Database Architecture, Database Users and Administrators.

Module: 2	Relational Model and Advanced Querying	7 Hours

Relational Model: Structure of Relational Databases, Data Types and Schema, SQL components, Integrity Constraints, Fundamental relational algebra operations, Additional Relational Algebra operations, Extended Relational Algebra, Set Operations, Aggregate functions, Sub-queries, Nested sub-queries, Complex Queries, Null value, Modification of the database, Triggers, Procedures, and Functions, Embedded SQL, and Dynamic SQL

Module: 3	ER Modelling and Normalization	7 Hours

E-R model, Constraints – E-R Diagram, E-R Design Issues, Weak Entity, Extended E-R Features, Database Design for Banking Enterprise, Reduction to Relational Schema Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design.

Module: 4	File Structure and Indexing	7 Hours

File organization, Organization of records in files, Data Dictionary Storage. Indexing and Hashing: Basic Concept, Ordered Indices, B+ Tree Index Files, B-Tree – Index Files, Multiple-Key Access, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing.

Module: 5	Transaction Processing and Security	8 Hours

Transaction: Transaction concepts, Transaction State, Implementation of atomicity and durability, Database Security: Authentication, Authorization and access control – DAC, MAC and RBAC models, SQL injection.

Module: 6	NoSQL Databases	8 Hours

Introduction, Overview, and History of NoSQL Databases – Types of NoSQL Databases – Column-oriented NoSQL databases using Cassandra – Document-based NoSQL databases using MongoDB, Graph-based NoSQL databases using Neo4j.

Total Lectures	45 Hours

Text Books

1	Abraham Silberschatz. Henry F. Korth. S. Sudarshan. *Database System Concepts*. (7th Edition). McGraw-Hill. (2021). ISBN: 978-9390727506.

2	Wu. Xun (Brian). (2018). Kadambi. Sudarshan. Kandhare. Devram. Ploetz. Aaron. *Seven NoSQL Databases in a Week: Get Up and Running with the Fundamentals and Functionalities of Seven of the Most Popular NoSQL Databases*. Packt Publishing. ISBN: 978-1787288867.

Reference Books

1	R. Elmasri and S. Navathe. 2015. *Fundamentals of Database Systems*. Pearson Education. *(5th Edition)*. ISBN: 0133970779. 978-0133970777.
2	Raghu R. and Johannes G. *Database Management Systems*. Tata McGraw Hill. *(3rd Edition)*. 2014. ISBN: 978-9339213114.
3	J. D. Ullman. (2016). *Principles of Database and Knowledge – Base Systems*. Computer Science Press. Volume 1. ISBN-13: 978-0881751888.
4	Serge Abiteboul. Richard Hull. Victor Vianu. (1996). *Foundations of Databases*. Addison-Wesley. ISBN: 9780201537710.
5	Serge Abiteboul, Richard Hull, Victor Vianu, 1996, "*Foundations of Databases*. Addison-Wesley", ISBN: 9780201537710.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Database Management Systems Laboratory**	**L**	**T**	**P**	**C**
23DC2011		**0**	**0**	**3**	**1.5**

Course Objectives:

Enable the students to:
1. Illustrate the concepts of basic query language
2. Apply the fundamentals of DDL, DML DCL, and TCL
3. Implement new developments and trends in developing a database

Course Outcomes:

The students will be able to:
1. Analyze the role of database administrator and database management systems in software applications and other advanced concepts.
2. Apply query language to retrieve data efficiently from the database.
3. Create the database for the given requirement specification using the ER method and normalization.
4. Design and implement significant database objects such as file structures and index schemes.
5. Demonstrate the techniques for transaction processing and security in database.
6. Design, and implement scalable and efficient data storage solutions.

List of Exercises

1. Creating and Managing tables and setting constraints using DDL, and DML commands
2. Database Transaction and Security using DCL and TCL commands
3. Advanced SQL using Relational Algebra Operators
4. Set Operations and Joins
5. Subquery, Nested, and Complex Queries
6. PL/SQL -Functions and Procedures
7. PL/SQL- Triggers
8. Normalization, denormalization, and formation of tables with industry standards
9. Application Development using JDBC
10. Application development using NoSQL database

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Design and Analysis of Algorithm**	**L**	**T**	**P**	**C**
23DC2012		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Gain knowledge on algorithms analysis techniques.
2. Demonstrate the various algorithmic design techniques.
3. Apply efficient algorithms in real time solutions.

Course Outcomes:

The students will be able to:
1. Apply mathematical tools to analyse and derive the running time of algorithms.
2. Demonstrate brute force and divide and conquer design techniques.
3. Apply dynamic programming and greedy techniques for solving various problems.
4. Analyse and implement the shortest path algorithms.
5. Apply iterative improvement technique to solve optimization problems.
6. Analyze the limitations of algorithmic power and handling it in different problems.

Module: 1	Introduction	8 Hours

Notion of an Algorithm- Fundamentals of Algorithmic Problem Solving - Important Problem Types - Fundamentals of the Analysis of Algorithmic Efficiency - Asymptotic Notations and their properties. Analysis Framework - Mathematical analysis for Recursive and Non-recursive algorithms - Master's Theorem.

Module: 2	Brute Force and Divide -and-Conquer	7 Hours

Brute Force - Computing an- String Matching - Closest-Pair and Convex-Hull Problems - Exhaustive Search - Travelling Salesman Problem - Knapsack Problem. Divide and Conquer Methodology: Merge sort and Binary search type strategies - Pivot based strategies - Long integer multiplication - Maximum sub array sum.

Module: 3	Dynamic Programming and Greedy Technique	9 Hours

Dynamic programming - Principle of optimality - Coin changing problem, Computing a Binomial Coefficient - Floyd's algorithm - Multi stage graph - Optimal Binary Search Trees - Knapsack Problem - Longest Common Sequence - Greedy Technique - Container loading problem - 0/1 Knapsack problem, Optimal Merge pattern - Huffman Trees.

Module: 4	Graph Algorithm, Backtracking and Branch-and-Bound	9 Hours

Shortest path algorithms: Dijkstra's Algorithm – Bellman - Ford Algorithm - Minimum Spanning Tree: Prim's and Kruskal's - Topological sorting - All pair shortest path - Floyd-Warshall Algorithm - Johnson's Algorithm - Backtracking - n-Queen problem - Subset Sum Problem. Branch and Bound - Assignment problem - Knapsack Problem - Travelling Salesman Problem.

Module: 5	Iterative Improvement	6 Hours

The Simplex Method - The Maximum-Flow Problem - Maximum Matching in Bipartite Graphs - Ford Fulkerson Problem - Stable marriage Problem.

Module: 6	Coping With the Limitations of Algorithm Power	6 Hours

Lower - Bound Arguments - P, NP, NP Complete and NP Hard Problems - Approximation Algorithms for NP - Hard Problems - Resource allocation using Bin-packing.

Total Lectures	45 Hours

Text Books	
1	Thomas H. Cormen. Charles E. Leiserson. Ronald L. Rivest and Clifford Stein. (2022). *Introduction to Algorithms. (4th Edition).* The MIT Press. ISBN: 978-0262046305.
2	Anany Levitin. (2021). *Introduction to The Design and Analysis of Algorithms*. Pearson. ISBN: 978-9332585485.
3	Ellis Horowitz. Sartaj Sahni. Sanguthevar Rajasekaran. (2019). *Computer Algorithms/ C++. (2nd Edition).* Universities Press. ISBN: 978-9386235145.

Reference Books	
1	Sandeep Sen. Amit Kumar. (2019). *Design and Analysis of Algorithms - A Contemporary Perspective*. Cambridge University Press. ISBN: 978-1108496827.
2	Jeff Erickson. (2019). *Algorithms. (1st Edition).* ISBN: 9781792644832.
3	Steven S. Skiena, (2012), "The Algorithm Design Manual", Springer, ISBN: 978-1-84800-070-4.
4	Jon Kleinberg, Eva Tardos (2005), " Algorithm Design", Pearson Addison Wesley, ISBN 0-321-29535-8
5	Robert Sedgewick, Kevin Wayne (2011), " Algorithms, 4th edition, Pearson Addison-Wesley Professional, ISBN- 9780321573513

Recommended by Board of Studies	24.04.2024

Course Code	Communication for Cyber Physical Systems	L	T	P	C
23DC2013		3	0	0	3

Course Objectives:

Enable the students to:
1. Analyze the IoT fundamentals and its applications.
2. Apply sensors and actuators by defining and interfacing them with embedded systems
3. Design Layer 3 connectivity solutions and CoAP protocols effectively.

Course Outcomes:

The students will be able to:
1. Analyze the foundational concepts of IoT including terms, characteristics, enabling technologies, sensors, edge devices, and communication models.
2. Demonstrate the components of IoT architecture: physical devices, connectivity, communication protocols, edge computing, data management, and application collaboration processes.
3. Apply transducers, sensors, and actuators by defining, classifying, and interfacing them with embedded systems and wireless sensor networks.
4. Analyse Layer 1/2 connectivity technologies including RFID, NFC, Bluetooth, ZigBee, LoRa, Wi-Fi, WiMAX, LTE, and their case studies.
5. Design Layer 3 connectivity solutions by understanding IPv4 vs IPv6 addressing, IPv6 protocol, tunneling, IPsec, QoS, and 6LoWPAN.
6. Apply communication protocols to solve real time use cases.

Module: 1	Introduction	7 Hours

IoT Terms and Basic Definitions - Characteristics - Enabling Technologies in IoT - Sensors - Edge Devices - Embedded Systems - Communications Model - M2M - Wireless Sensor Networks - Cloud Computing - Applications and Vision of IoT.

Module: 2	Architecture Reference Model	8 Hours

Physical Devices and Controllers - Connectivity: Communication Model, Protocols, Communication APIs for IoT - Edge Computing - Data Accumulation - Data Abstraction - Application - Collaboration and Processes.

Module: 3	Transducers, Sensors and Actuators	7 Hours

Defining Transducers, Sensors and Actuators - Workflow - Classification of Transducers, Sensors and Actuators - Interfacing with Embedded Systems - WSN and its Technologies.

Module: 4	Layer 1/2 Connectivity Technologies	7 Hours

RFID - NFC - Bluetooth - ZigBee - LoRa -Wi-Fi - WiMAX - LTE - Case Studies.

Module: 5	Layer 3 Connectivity Technologies	8 Hours

Overview and Motivations - IPv4 Vs IPv6 Addressing - IPv6 Protocol - IPv6 Tunneling - IPsec in IPv6 - Quality of Service in IPv6 - Header Compression Schemes - 6LoWPAN.

Module: 6	Communication Protocols	8 Hours

Classification - Message Queue Telemetry Transport(MQTT) - Architecture - XMPP - Architecture - Advantages - Case studies - DDS - AMQP - Model - Architecture - Protocol - CoAP - Features - Architecture - Applications - REST - Architecture - Case Studies.

Total Lectures	45 Hours

Text Books

1	Srinivasa K G. Siddesh G.M. Hanumantha Raju R. (2017). *Internet of Things*. CENGAGE. (*1st Edition*). ISBN: 978-9386858955.
2	Daniel Minoli. (2013). *Building the Internet of Things with IPv6 and MIPv6. (1st Edition).* John Wiley & Sons. ISBN: 978-1118473474.

Reference Books

1	Sherali Zeadally. Nafaa Jabeur. (2016). *Cyber Physical System Design with Sensor Networking Technologies. (1st Edition).* The Institution of Engineering and Technology. London. UK. ISBN: 978-1849198240.
2	K.Daniel Wong. (2012). *Fundamentals of Wireless Communication Engineering Technologies. (1st Edition).* John Wiley & Sons. ISBN: 978-0470565445.

3	Arshdeep Bahga. Vijay Madisetti. (2015). *Internet of Things: A Hands-on Approach.* (1st Edition). Universities Press. ISBN: 978-8173719547.
4	Adrian McEwen & Hakim Cassimally. (2013). *Designing the Internet of Things*. Wiley. ISBN: 978-1118430620.
5	Husheng Li, 2016, "Communication for control in cyber-physical systems- Theory, Design and Applications in Smart Grids", Todd Green publication, ISBN: 9780128019504.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Operating Systems**	**L**	**T**	**P**	**C**
23DC2014		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the mechanisms of operating system to handle processes, threads and their communication.
2. Describe the process synchronization and deadlock.
3. Apply the basic concepts of scheduling algorithms, page replacement techniques in various real time applications

Course Outcomes:

The students will be able to:
1. Explain how operating systems make it possible for many applications to share resources and to make programming easier for user space applications.
2. Differentiate user and kernel level operating.
3. Analyse the thread context management, synchronization methods and various scheduling algorithms.
4. Apply various memory management schemes especially paging and segmentation in real time applications.
5. Illustrate file systems in operating systems like UNIX/Linux and Windows.
6. Demonstrate the input output management, use of device driver and secondary storage (disk) mechanism.

Module: 1	**Introduction and Architecture of Operating System**	**7 Hours**

Architecture, Goals & Structures of operating system, Basic functions, Interaction of operating system. & hardware architecture, System calls, Batch, multiprogramming. Multitasking, time sharing, parallel, distributed & real - time operating system, Virtual Machines - System Boot. Case study on Linux and Windows OS.

Module: 2	**Process Management**	**8 Hours**

Process Concept, Process states, Process control, Multithreaded Programming, Multithreading models, Threads, Inter-process communication, Scheduling: Types of scheduling: Preemptive, Non preemptive, Scheduling algorithms: FCFS, SJF, RR, Priority, Thread Scheduling, Implementation of real time scheduling (Patient Doctor allocation) using scheduling algorithms.

Module: 3	**Concurrency and Process Synchronization**	**7 Hours**

Concurrency: Principles of Concurrency, Mutual Exclusion: software approaches, hardware Support, Semaphores, pipes, Message Passing, signals, Monitors, Classic Problems of Synchronization: Readers-Writers, Producer Consumer, and Dining Philosopher problem. (Voting process).

Module: 4	**Deadlock and Memory Management**	**8 Hours**

Deadlock: Principles of deadlock (Traffic gridlock), Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Memory Management requirements, Memory partitioning: Fixed and Variable Partitioning, Memory Allocation: Allocation Strategies (First Fit, Best Fit, and Worst Fit), Fragmentation, Swapping, and Paging. Segmentation, Demand paging.

Module: 5	**Virtual Memory, File Management, and Security and Protection**	**8 Hours**

Virtual Memory: Concepts, management of VM, Page Replacement Policies (FIFO, LRU, Optimal, Other Strategies), Thrashing, File concept (Attributes, metadata, and operations), Access methods (Sequential, Direct, Indexed), File types, File operation, Directory structure, File System structure (File Allocation Table (FAT), Inodes, File Control Blocks (FCBs)), Allocation methods (contiguous, linked, indexed), directory implementation, efficiency & performance - Access Control Matrix in Unix/Linux - Access Control Mechanism, Cryptography and Data protection

Module: 6	Secondary-Storage Structure, I/O Management, and Advanced Topics	7 Hours

Disk structure: Platters, Tracks, Sectors, Disk scheduling algorithm: FCFS, SSTF, SCAN, C-SCAN, LOOK, C-LOOK, Disk Scheduling: Elevator algorithm, Shortest Seek Time First (SSTF), I/O devices: Characteristics, Interfaces (Serial, Parallel, USB, Thunderbolt), Device controllers: Functions, Communication protocols, Direct Memory Access (DMA): Purpose, Operation, Advantages, Goals of Interrupt handlers: Handling interrupts, Interrupt service routines (ISRs), Device drivers: Functions, Abstraction layers, Driver development, Device independent I/O software: APIs, Libraries, Kernel-level I/O subsystems, Distributed operating systems, Virtualization, Cloud computing and containerization.

Total Lectures		45 Hours

Text Books

1	Peter Galvin. Greg Gagne Silberschatz. (2012). *Operating System Concepts Essentials.* (9th Edition). Wiley Asia Student Edition. ISBN: 9781118804926
2	William Stallings. (2019). *Operating Systems: Internals and Design Principles.* (9th Edition). Prentice Hall of India. ISBN: 978-9352866717
3	David A. Patterson. John L. Hennessy. (2021). *Computer Organization and Design: The Hardware/Software Interface.* (6th edition). ISBN: 978-9351073963

Reference Books

1	Andrew S. Tanenbaum. *Modern Operating Systems.* (4th Edition). Prentice Hall. (2015). ISBN-10: 013359162X
2	D. M. Dhamdhere. (2009). *Operating Systems.* (2nd Edition). Tata McGraw-Hill Education (India). ISBN: 978-0-07-295769-3.
3	Achyut S. Godbole *Operating Systems with Case Studies in Unix Netware Windows NT.* Tata McGraw-Hill. (2005). ISBN: 007059113X. 9780070591134.
4	Pramod Chandra P. Bhatt. (2003). *An Introduction to Operating Systems: Concepts and Practice.* PHI Learning Pvt. Ltd. ISBN: 9788120323063.
5	Stallings, W. (2001). *Operating Systems: Internals and Design Principles, Prentice Hall, 2000,* ISBN: 978-0130319990.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code 23DC2015	Machine Learning Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

Enable the students to:
1. Analyze human learning aspects and primitives in the learning process by computer
2. Analyze the nature of problems solved with machine learning techniques.
3. Design and implement suitable machine learning techniques for a given application.

Course Outcomes:

The students will be able to:
1. Illustrate the concepts, mathematical background, applicability, and limitations of existing machine learning techniques.
2. Implement the simple feature engineering steps.
3. Apply linear discriminant and Multilayer Perceptron algorithm for a given task.
4. Demonstrate the working principle of distance-based algorithms to handle unlabeled data.
5. Distinguish tree and rule-based machine learning algorithms and appropriately apply to the suitable application.

	6.	Implement ensemble learning methods to improve predictive modeling and decision-making tasks.	

Module: 1	Introduction and Concept Learning	8 Hours

Types of Machine Learning - Examples of Machine Learning Problems - Models and Data - Characteristics of Machine Learning model - Concept Learning: Theory of Generalization - Version Spaces and the Candidate Elimination Algorithm.

Module: 2	Feature Engineering	7 Hours

Data Collection - Preprocessing: Data Cleaning - Data Transformation: Normalization, Binning, Discretization - Scaling - Dimensionality Reduction - Automatic Feature Selection and Extraction, (Data Preprocessing using Population Data) Feature extraction.

Module: 3	Linear Discrimination & Multilayer Perceptrons	7 Hours

Generalizing the Linear Model - Geometry of the Linear Discriminant - Gradient Descent - Logistic Discrimination - Discrimination by Regression - MLP - The Perceptron - Training a Perceptron - Backpropagation Algorithm - Training Procedures.

Module: 4	Distance Based Models	7 Hours

Distance-Based Models: - K-Nearest Neighbors - Variants of K-Means Algorithm (Clustering Road Transport Data) - Hierarchical clustering - DBSCAN - Self-Organizing Feature Map - Fuzzy C -means (Clustering Microarray Gene Expression Data).

Module: 5	Tree and Rule-Based Models	8 Hours

Tree Based Models - Ranking and Probability estimation Trees - Regression trees - Classification and Regression Trees (CART) (Application of CART algorithm using hepatitis disease diagnosis); Rule-Based Models: learning ordered rule lists - learning unordered rule lists - descriptive rule learning - association rule mining - first-order rule learning (Application of rule based algorithm using agriculture dataset).

Module: 6	Combining Multiple Learners	8 Hours

Rationale - Generating Diverse Learners - Model Combination Schemes - Voting - Error-Correcting Output Codes - Bagging - Boosting - Stacked Generalization - Fine-Tuning an Ensemble - Cascading.

Total Lectures	45 Hours

Text Books	
1	Ethem Alpaydın. (2020). *Introduction to Machine Learning. (4th Edition).* MIT press.
2	P. Flach. (2012). *Machine Learning: The art and science of algorithms that make sense of data.* Cambridge University Press. ISBN-10: 1107422221. ISBN-13: 978-1107422223.

Reference Books	
1	Trevor Hastie. Robert Tibshirani. Jerome Friedman. *The Elements of Statistical Learning: Data Mining. Inference. and Prediction. (2nd Edition).* Springer Series in Statistics. (2016). ISBN: 978-0387848570
2	Giuseppe Bonaccorso. (2020). *Mastering Machine Learning Algorithms: Expert techniques for implementing popular machine learning algorithms. fine-tuning your models. and understanding how they work.* Packt Publishing Ltd. *(2nd Edition).* ISBN: 978-1838820299
3	Henrik Brink. Joseph W.Richards. Mark Fetherolf. (2017). *Real-World Machine Learning. Manning Publications. (1st Edition).* ISBN-13: 978-1617291920
4	Bishop. Nasrabadi. (2006). *Pattern recognition and machine learning. (1st Edition). Springer* ISBN: 9780387310732.
5	John Paul Mueller. Luca Massaron. (2021). Machine Learning for Dummies. *(2nd Edition). Wiley.* ISBN:978-1119724018.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Machine Learning Techniques Laboratory	L	T	P	C

23DC2016		**0**	**0**	**3**	**1.5**

Course Objectives:	

Enable the students to:
1. Illustrate the human learning aspects and primitives in the learning process by computer
2. Analyse the nature of problems solved with machine learning techniques.
3. Design and implement suitable machine learning techniques for a given application

Course Outcomes:	

The students will be able to:
1. Demonstrate the concepts, mathematical background, applicability, and limitations of existing machine learning techniques.
2. Execute the simple feature engineering steps.
3. Demonstrate the machine learning algorithms like linear discriminant and Multilayer Perceptron algorithm for a given task.
4. Demonstrate the working principle of distance-based algorithms to handle unlabeled data.
5. Distinguish tree and rule-based machine learning algorithms and appropriately apply them to the suitable application.
6. Apply ensemble learning methods to improve predictive modeling and decision-making tasks.

List of Exercises	

1. Data preprocessing techniques using pandas and Sci-kit – learn
2. Find-S model for concept learning using Python with Scikit learn.
3. Univariate plots for data exploration using Matplotlib and Seaborn
4. Understanding the concept and applications of PCA with Sci-kit learn
5. Implementing a single-layer neural network using TensorFlow
6. Backpropagation algorithm for training MLP using sci-kit learn or tensor flow
7. SVM for classification and regression using python
8. Implementing AdaBoost algorithm and boosting the ensemble technique using python
9. Implementing Random Forest algorithm
10. Gaussian Mixture Models for clustering using python
11. Real–world applications of neural networks using TensorFlow or Pytorch.
12. Time series forecasting using ARIMA.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Data Engineering**	**L**	**T**	**P**	**C**
23DC2017		**3**	**0**	**0**	**3**

Course Objectives:	

Enable the students to:
1. Illustrate the foundational concepts and historical evolution of data engineering.
2. Explain the comprehensive lifecycle of data engineering, emphasizing security, DataOps, and efficient data management.
3. Apply advanced data architecture principles to design systems that are scalable, resilient, and suited to the needs of modern businesses.

Course Outcomes:	

The students will be able to:
1. Analyze the evolution and key roles of data engineering within the technology sector.
2. Demonstrate the critical phases and best practices within the data engineering lifecycle.
3. Apply principles of good data architecture to effectively design scalable and resilient systems.
4. Illustrate the factors that influence technology decisions, considering cost, speed, and environmental suitability.
5. Develop various data generation sources and storage systems, emphasizing modern storage trends.
6. Implement effective techniques for data ingestion and management, suitable for handling diverse data types.

Module: 1	**Introduction to Data Engineering**	**7 Hours**

History of Data Engineering Roles - Data Engineering Lifecycle Overview-Comparisons - Data Engineering vs. Data Science - Parameters on Data Engineering: Skills and Responsibilities of Data Engineers - Technical and Business Responsibilities - Continuum of Data Engineering Roles.

Module: 2	The Data Engineering Lifecycle	7 Hours

Data Engineering Lifecycle Phases - Major Undercurrents: Security, DataOps, Data Management - Parameters on Lifecycle Management: Data Generation: Source Systems - Data Storage and Ingestion Methods - Transformation and Serving Data.

Module: 3	Designing Data Architectures	7 Hours

Good Data Architecture - Major Architecture Concepts: Domains, Services, and Distributed Systems - Parameters on Architectural Design: Designing for Scalability and Failure - Types of Data Architectures: Warehouses, Lakes and Stacks - Architectural Leadership and Decision-Making.

Module: 4	Technology Choices in Data Engineering	8 Hours

Influencing Factors: Cost, Speed, Interoperability - Environment Choices: On-Premises, Cloud, Hybrid, Multicloud - Parameters on Technology Selection: Build vs. Buy Decisions - Open Source vs. Proprietary Solutions - Serverless vs. Server-Based Solutions.

Module: 5	Data Generation and Storage Systems	8 Hours

Data Creation Sources: Files, APIs, Databases - Storage Systems: File, Block, Object, and Distributed Storage - Parameters on Data Storage: Trends in Data Storage: Catalogs, Sharing, Compute Separation - Practical Storage Solutions: HDFS, Streaming Storage, Indexing.

Module: 6	Ingestion and Initial Data Management	8 Hours

Ingestion Techniques: Batch vs. Stream - Bounded vs. Unbounded Data Considerations - Parameters on Data Handling: Common File Formats and Data Sharing Techniques - Practical Issues: Serialization, Deserialization, Data Quality.

Total Lectures		45 Hours

Text Books

1	Reis. Joe. and Matt Housley. (2022). *Fundamentals of Data Engineering: Plan and Build Robust Data Systems. (1st Edition)*. Shroff/O'Reilly. ISBN-10: 9355421540.

Reference Books

1	Malhotra. Mayank. (2024). *Ultimate Data Engineering with Databricks: Develop Scalable Data Pipelines Using Data Engineering's Core Tenets Such as Delta Tables. Ingestion. Transformation. Security and Scalability. (1st Edition)*. Orange Education Pvt Ltd. ISBN-10: 8196994788
2	Martin Kleppmann. (2024). *Designing data-intensive applications: The big ideas behind reliable, scalable, and maintainable systems. (2nd Edition)*. O'Reilly Media, Inc. ISBN: 9781098119058.
3	Fabian Hueske, and Vasiliki Kalavri. (2019). *Stream Processing with Apache Flink Fundamentals, Implementation, and Operation of Streaming Applications. (1st Edition)*. O'Reilly Media, Inc. ISBN: 9781491974292.
4	Bill Inmon, Mary Levins, and Ranjeet Srivastava. (2023). *Rise of the Data Lakehouse. (1st Edition)*. Technics Publications. ISBN: 9781634627986.
5	Alex Petrov. (2019). Database Internals: A deep Dive into How Distributed Data. *(1st Edition)*. O'Reilly Media, Inc. ISBN: 9781492040316.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Quantum Machine Learning	L	T	P	C
23DC2018		3	0	0	3
Course Objectives:					
Enable the students to:					

1. Illustrate the concepts of quantum computing and machine learning
2. Analyze the concepts of quantum gates, and qubits.
3. Formulate the principles, algorithms, and application.

Course Outcomes:	

The students will be able to:
1. Demonstrate the fundamental principles of quantum computing and its relationship to machine learning.
2. Apply quantum algorithms for classification, such as the squared-distance classifier and Grover search.
3. Illustrate the various techniques, including basis states, amplitude encoding, time evolutions, and feature maps.
4. Demonstrate quantum models as kernel methods for solving machine learning problems.
5. Experiment the fault-tolerant quantum machine learning techniques, including linear algebra accelerators, search and amplitude amplification, and probabilistic models.
6. Develop various applications of quantum models based on the Ising models.

Module: 1	Introduction to Quantum Machine Learning	8 Hours

Introduction: The rise of Quantum Machine Learning - Example of a Quantum Algorithm for classification: The Squared - Distance Classifier - Interference with the Hadamard Transformation - Quantum Squared - Distance classifier - Examples of Typical Machine Learning Problems - Risk Minimisation in Supervised Learning - Training in Unsupervised Learning - Methods in Machine Learning.

Module: 2	Quantum Computing	7 Hours

Quantum Theory: The Postulates of Quantum Mechanics - Quantum Computing: Bits and Qubits - Quantum Gates - Measuring Qubits in the Computational Basis - Quantum Parallelism and Function Evaluation - The Deutsch - Josza Algorithm: The Deutsch Algorithm - The Deutsch - Josza Algorithm. Quantum Algorithms: Grover Search - Quantum Phase Estimation - Matrix Multiplication and Inversion.

Module: 3	Representing Data on a Quantum Computing	7 Hours

Encoding Binary Inputs into basis states - Arbitrary State Preparation for Amplitude Encoding - Encoding Inputs as Time Evolutions - Encoding a Dataset via the Hamiltonian - Data Encoding as a Feature Map.

Module: 4	Quantum Models as Kernel Methods	8 Hours

The Connection Between Quantum Models and Kernel Methods - Quantum Computing, Feature Maps and Kernels: Data Encoding as a Feature Map - Quantum Kernels - Making Sense of Matrix - Valued Feature Vectors - Quantum Kernels Derived from Data Encoding - Fourier Representation of Quantum Kernels - The RKHS of Quantum Kernels: Quantum Models as Linear Models - Describing the RKHS - Kernel-Based Training.

Module: 5	Fault - Tolerant Quantum Machine Learning	7 Hours

Linear Algebra Accelerators: Basic Idea - Matrix Inversion for Training - Search and Amplitude Amplification: Finding Closest Neighbours - Adapting Grover's Search to Data Superpositions - Amplitude Amplification for Perceptron Training - Quantum Walks - Sampling and Probabilistic Models: Bayesian Networks - Boltzmann Machines - Superposition and Quantum Ensembles.

Module: 6	Approaches Based on the Ising Model	8 Hours

Quantum Extensions of Ising Models: The Quantum Ising Models - Boltzman Machines with a Transverse Field - Quantum Hopfield Models - Quantum Annealing: Quadratic Unconstrained Optimization - Encoding Classifiers into an Annealer - Annealing Devices as Samplers. Dissecting Quantum Advantages - Learning from Coherent Data.

Total Lectures	45 Hours
Text Books	

1	Maria Schuld. Francesco Petruccoine. (2021). *Machine Learning with Quantum Computers. Quantum Science and Technology*. Springer. ISBN: 978-3030830977.

Reference Books	

1	Claudio Conti. *Quantum Machine Learning - Thinking and Exploration in Neural Network Models for Quantum Science and Quantum Computing. Quantum Science and Technology*. Springer Cham. (2024). ISBN: 978-3031442254.
2	Maria Schuld. Francesco Petruccoine. (2018). *Supervised Learning with Quantum Computers. Quantum Science and Technology*. Springer Cham. ISBN: 978-3030071882.
3	Jack Hidary. (2021). *Quantum Computing: An applied approach.* Springer International Publishers. (*1st Edition).* ISBN-13: 978-3030672711.
4	Chris Bernhardt. (2019). *Quantum Computing for Everyone.* MIT Press *(1st Edition).* ISBN 978-0262039253
5	Ray LaPierre. (2021). Introduction to Quantum Computing. Springer .*(1st Edition).* ISBN:978-3030693183.

| **Recommended by Board of Studies** | 24.04.2024 |
| **Approved by Academic Council** | 11.05.2024 |

Course Code	**Federated Learning**	**L**	**T**	**P**	**C**
23DC2019		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:

1. Illustrate the basics of federated learning.
2. Analyze the privacy preserving Mechanisms.
3. Demonstrate the applications of federated learning.

Course Outcomes:

The students will be able to:

1. Demonstrate the knowledge of the basic concepts, architecture, and applications of Federated Learning.
2. Illustrate the concepts of Horizontal and Vertical Federated Learning.
3. Demonstrate the encoding techniques in classical data transmission.
4. Apply the incentive mechanism design in Federated Learning.
5. Develop privacy-preserving Federated Learning algorithms and guarantees.
6. Design research and application trends in Federated Learning.

Module: 1	**Introduction to Federated Learning**	**7 Hours**

Introduction to Federated Learning - Privacy Preserving - Distributed Machine Learning - Threats to Federated Learning - Date Valuation - Machine Learning with Sensitive Data: Drug Discovery - Self-Driving Cars - The Federated Learning Lifecycle - The Federated Setting.

Module: 2	**Horizontal and Vertical Federated Learning**	**8 Hours**

HFL: Definition- Architecture of HFL: The client-Server Architecture - Peer-to-peer Architecture - Global Model Evaluation - The Federated Averaging Algorithm: Federated Optimization - The FedAvg Algorithm - The Secured FedAvg Algorithm - Improvement of FedAvg Algorithm: Communication Efficiency - Client Selection.

VFL: Definition- Architecture of VFL - Algorithms of VFL: Secure Federated Linear Regression - Secure Federated Tree – Boosting - Challenges and outlook.

Module: 3	**Exploration of Federated Learning and Analytics Technologies**	**7 Hours**

Encoding Binary Inputs into basis states - Arbitrary State Preparation for Amplitude Encoding - Encoding Inputs as Time Evolutions - Encoding a Dataset via the Hamiltonian - Data Encoding as a Feature Map.

Module: 4	**Federated Transfer Learning and Incentive Mechanism Design**	**8 Hours**

Heterogeneous Federated Learning - Federated Transfer Learning - The FTL Framework: Additively Homomorphic Encryption - The FTL Training Process - The FTL Prediction Process - Security Analysis - Secret Sharing-Based FTL - Paying for Contributions: Profit - Sharing Games - Reverse Auctions - A Fairness - Aware Profit Sharing Framework: Modeling Contributions - Modeling Cost - Regret- Temporal Regret.

Module: 5	**Optimization Fundamentals for Secure Federated Learning**	**8 Hours**

Gradient Decent-Type Methods - Privacy Preserving Federated Learning Algorithms and Guarantees - Assessing Vulnerabilities and Securing Federated Learning - Adversarial Robustness in Federated Learning - Evaluating Gradient Inversion Attacks and Defenses - Fairness in Federated Learning - Meta Federated Learning - Hyper - Parameter Optimization for Federated Learning.

Module: 6	Federated Learning Application	7 Hours

Federated Recommendation Systems: Definition - Categorization of FRD - Challenges: Algorithm Level challenges - System Level challenges - FL for open Banking - Statistical Heterogeneity in FL: Clustered Federated Learning - Personalized Modelling - Model Architecture Heterogeneity - Federated Learning with EHR.

Total Lectures	45 Hours

Text Books

1	Lam M. Nguyen. Trong Nghia Hoang. Pin-Yu Chen. (2024). *Federated Learning Theory and Practice*. ISBN: 978-0443190377.
2	Emily Glanz. Nova Fallen. (2021). *What is Federated Learning?*. O'Reilly Media. Inc. ISBN: 9781098107246.
3	Qiang Yang (ed.); Lixin Fan (ed.); Han Yu (ed.). (2020). *Federated Learning*. Springer Internation Publishing. ISBN: 978-0443190377.

Reference Books

1	Saravanan Krishnan. A.Jose Anand. R. Srinivasan. R. Kavitha. S. Suresh. (2023). *Handbook on Federated Learning- Advances. Applications and Opportunities*. (*1st Edition*). CRC press. ISBN: 978-1032471624.
2	Heiko Ludwig. Nathalie Baracaldo. (2022). *Federated Learning- A Comprehensive Overview of Methods and Applications*. ISBN : 978-3030968953.
3	Qiang Yang. Yang Liu. Yong Cheng. Yan Kang. Tianjian Chen. Han Yu. (2019). *Federated Learning. Morgan & Claypool Publishers*. ISBN: 978-1681736990.
4	Han Yu, Lixin Fan, Qiang Yang. (2020). *Federated Learning: Privacy and Incentive*. (*1st Edition*). Springer . ISBN: 97821012162725.
5	Mohamed Medhat Gaber, Muhammad Habib ur Rehman. (2021). Federated Learning Systems: Towards Next-Generation AI. Germany: Springer. ISBN: 9783030706043.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Science Ecosystem	L	T	P	C
23DC2020		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the roles of data science and different data handling techniques with its evaluation metrics
2. Apply data science methods to solve real-world challenges.
3. Apply text mining and NLP techniques to enable impactful decision-making across diverse domains.

Course Outcomes:

The students will be able to:
1. Explain the data science principles and inference techniques
2. Analyse the unstructured data for insights and decision-making
3. Implement various python libraries for data visualization, and dashboard design principles
4. Demonstrate data science methods for real-world applications
5. Implement the text mining and NLP techniques
6. Apply cutting-edge technologies for impactful decision-making in diverse domains

Module: 1	Introduction to Data Science	7 Hours

Importance of Data Science - Data Science Process - Business Intelligence and Data Science - Prerequisites for a Data Scientist - Components of Data Science - Tools and Skills Needed, Data Types - Variable Types - Statistics - Sampling Techniques and Probability - Information Gain and Entropy -

Probability Theory - Probability Types - Probability Distribution Functions - Bayes' Theorem - Inferential Statistics.

Module: 2	Handling Unstructured Data for Data Science	8 Hours

Advanced NoSQL for Data Science: Why NoSQL - Document Databases for Data Science: Introduction - Getting Started - Creating, Updating, and Deleting Documents.

Module: 3	Data Visualization	8 Hours

Python Libraries: Data Frame Manipulation with pandas and NumPy - Exploration Data Analysis with Python - Time Series Data, Introduction to Data Visualization and Tableau - Dimensions and Measures, Descriptive Statistics - Basic Charts - Dashboard Design & Principles - Special Chart Types - Integrate Tableau with Google Sheets.

Module: 4	Data Science Methodology, Methods and Machine Learning	8 Hours

Analytics for Data Science - Examples of Data Analytics - Data Analytics Life Cycle, Regression Analysis: Linear Regression - Logistic Regression - Multinomial Logistic Regression - Time-Series Models, Machine Learning: Decision Trees - Naïve Bayes - Support Vector Machines - Nearest Neighbour learning - Clustering: k-Means clustering - Agglomerative clustering - Confusion Matrix.

Module: 5	Data Analytics and Text Mining	7 Hours

Text Mining: Major Text Mining Areas: Information Retrieval - Data Mining - Natural Language Processing (NLP), Text Analytics: Text Analysis Subtasks: Cleaning and Parsing - Searching and Retrieval - Text Mining - Part-of-Speech Tagging - Stemming - Lemmatization - Text Analysis Steps, Introduction to Natural Language Processing: Major Components and Stages of NLP - Statistical Processing of Natural Language: Document Preprocessing - Parameterization, Applications of NLP.

Module: 6	Applications	7 Hours

Recommender Systems: Challenges and Opportunities in the Age of Big Data and Artificial Intelligence, Machine Learning for Data Science Applications, Credibility Assessment of Healthcare Related Social Media Data, Predict the Crime Rate against Women Using Machine Learning Classification Techniques.

Total Lectures		45 Hours

Text Books

1	Sanjeev J. Wagh. Manisha S. Bhende. Anuradha D. Thakare. (2022). *Fundamentals of Data Science*. CRC press. Taylor & Francis Group. LLC. ISBN: 978-1-138-33618-6 (hbk).
2	Shannon Bradshaw. Eoin Brazil. Kristina Chodorow. (2019). *MongoDB: The Definitive Guide*. (3rd Edition). O'Reilly Media. Inc. ISBN: 9781491954461.

Reference Books

1	Herbert Jones. (2020). *Data Science: The Ultimate Guide to Data Analytics. Data Mining. Data Warehousing. Data Visualization. Regression Analysis. Database Querying. Big Data for Business and Machine Learning for Beginners*. Bravex Publications. ISBN-13: 978-1647483043.
2	Maxine Chen. (2024). *Mastering Data Science and Big Data Analytics: Mastering big data: strategies and tools for effective analysis*. Pearson. ISBN: 979-8869202000.
3	Kieran Healy. (2018). *Data Visualization: A Practical Introduction*. Princeton University Press. ISBN-10: 0691181624.
4	Usman Qamar. Muhammad Summair Raza. (2021). *Data Science Concepts and Techniques with Applications. (1st Edition)*. Springer Verlag. Singapore; ISBN-10: 9811561354.
5	Aakanksha Sharaff. G. R. Sinha. (2021). *Data Science and Its Applications*. Taylor & Francis-Chapman and Hall/CRC. ISBN: 9780367608866.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Science Ecosystem Laboratory	L	T	P	C
23DC2021		0	0	3	1.5

Course Objectives:

Enable the students to:

1. Develop expertise in data manipulation, exploratory analysis, and decision-making for comprehensive data management and analysis
2. Implement MongoDB, Python libraries, Tableau, and regression techniques
3. Demonstrate analysis on classification, tree-based methods and skilled in NLP techniques.

Course Outcomes:	

The students will be able to:
1. Demonstrate data manipulation with Pandas and Numpy,
2. Develop expertise in exploratory data analysis and statistical inference techniques for robust data-driven decision-making.
3. Apply MongoDB and data visualization using Python libraries.
4. Develop visualization dashboards with Tableau and perform regression technique performance analysis.
5. Perform performance analysis on classification techniques, with a focus on tree-based classification methods
6. Develop proficiency in working with NLP techniques and acquiring/analyzing data from real-time systems.

List of Exercises	

1. Introduction to Data Science with Python programming
2. Working with Data using Pandas, Numpy
3. Exploratory Data analysis
4. Statistical Inference
5. Working with MongoDB
6. Data visualization using Python Libraries
7. Visualization Dashboard using Tableau
8. Performance analysis on regression techniques
9. Performance analysis on classification techniques
10. Performance analysis of tree based classification techniques
11. Working with NLP
12. Data acquisition and analysis from real time systems.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Explainable AI	L	T	P	C
23DC2022		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the fundamental concepts in Explainable AI
2. Analyze the explainability for image, text and tabular data
3. Demonstrate the alternative explainability techniques and Interact with Explainable AI.

Course Outcomes:

The students will be able to:
1. Demonstrate comprehension of current challenges and applications related to Explainable AI.
2. Implement the feature importance of explainability for tabular data
3. Analyze explainability for image data with integrated gradients
4. Analyze the building models for text data explanation
5. Assess the alternative techniques for explainability and to evaluate explainability
6. Develop interaction with explainable AI users and to analyze the pitfalls in explainability

Module: 1	Introduction to Explainable AI	9 Hours

Introduction - Why and What is Explainable AI - Challenges in explainability - Evaluating explainability - Exploring the applications of explainability - An overview of explainability: Interpretability and explainability - Explainability Consumers - Types of explanations - Core themes in explainability - Integration of different explainability techniques.

Module: 2	Explainability for Tabular Data	7 Hours

Permutation Feature Importance - Shapley Values - SHAP - Visualizing Local and Global Feature Attributions - Interpreting Feature Attributions - Tree-Based Models - Partial Dependence Plots - Individual Conditional Expectation Plots - Accumulated Local Effects.

Module: 3	Explainability for Image Data	7 Hours

Integrated Gradients - Explainable AI from Radiance - Gradient-weighted Class Activation Mapping - Local Interpretable Model - agnostic Explanations (LIME) - Guided Backpropagation - Guided Grad - CAM.

Module: 4	Explainability for Text Data	7 Hours

Building Models with Text Data - Tokenization - Word Embeddings - LIME for text data - Gradient x Input - Layer Integrated Gradients - Layer-Wise Relevance Propagation - Choosing the appropriate method for text data explanation - Language Interpretability Tool (LIT).

Module: 5	Advanced and Emerging Topics	7 Hours

Alternative Explainability Techniques - Alternate Input Attribution - Influence function-based explanations - Concept-based explanations - Other Modalities - Time-Series Data - Multimodal Data - Evaluation of Explainability Techniques - Theoretical Approach - Empirical Approaches.

Module: 6	Interacting with Explainable AI	8 Hours

Who Uses Explainability - How to Effectively Present Explanations - Consumer's Existing Understanding - Common Pitfalls in Using Explainability.

Total Lectures		45 Hours

Text Books

1	Michael Munn and David Pitman. (2022). *Explainable Al for practitioners. (1st Edition).* O'Reilly Media Inc. ISBN: 9781098119102.
2	Denis Rothman. (2020). *Hands-On Explainable AI (XAI) with Python: Interpret. visualize. explain. and integrate reliable AI for fair. secure. and trustworthy AI apps*. Packt Publishing Ltd, ISBN: 9781800202764.

Reference Books

1	Denis Rothman,(2020), *Hands-On Explainable AI (XAI) with Python: Interpret, visualize, explain, and integrate reliable AI for fair, secure, and trustworthy AI apps*, Packt Publishing Ltd, ISBN: 9781800202764
2	Ajay Thampi, (2022), *Interpretable AI: Building explainable machine learning systems,* Simon and Schuster publications, ISBN: 9781638350422
3	John Liu and Uday Kamath, (2021), *Explainable AI: An Introduction to Interpretable Machine Learning. (1st Edition).* Springer Nature. ISBN: 978-3030833558

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Zero Trust Architecture	L	T	P	C
23DC2023		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the fundamental concepts of Zero Trust Architecture.
2. Demonstrate the zero trust architecture standards.
3. Apply the security of zero trust enclave design, operations and reference architecture.

Course Outcomes:

The students will be able to:
1. Implement proficiency in implementing and analysing zero trust architecture.
2. Illustrate the working of zero trust capabilities.
3. Analyze and implement the zero trust reference architecture.
4. Demonstrate segmentation in zero trust architecture.
5. Apply zero trust architecture to secure enterprise against unauthorized access.
6. Design zero trust architecture for real time applications

Module: 1	Introduction to Zero Trust Architecture	7 Hours
Zero Trust Origins - Planning for Zero Trust - Zero Trust Organizational Dynamics - Policy & Governance - Identity - Vulnerability Management.		

Module: 2	Zero Trust Capabilities	8 Hours
CISCO Zero Trust Capabilities - Policy & Governance Pillar - Authentication, Authorization, and Accounting (AAA) - Certificate Authority - Network Access Control (NAC) - Provisioning - Privileged Access - Multifactor Authentication (MFA) - Asset Identity - Endpoint Protection - Cloud Access Security Broker (CASB) - Data Loss Prevention (DLP).		

Module: 3	Reference Architecture and Enclave Design	7 Hours
Branch - Campus - Core Network - WAN - Data Center - Cloud - User Layer - Proximity Networks - Cloud - Enterprise - DMZ - Common Services - Payment Card Industry Business Services - Payment Card Industry Business Services.		

Module: 4	Segmentation & Zero Trust Common Challenges	8 Hours
Summary of the OSI Model - Upper Layer Segmentation Models - Common Network-Centric Segmentation Models - Applying Segmentation Throughout Network Functions - Methods and Considerations for Segmentation in an Ideal World - Gaining Visibility into the Unknown (Endpoints) - Understanding the Expected Behaviour of Endpoints - Understanding External Access Requirements - Macrosegmentation vs. Microsegmentation for the Network.		

Module: 5	Enforcement and Zero Trust Operations	8 Hours
Endpoint Monitor Mode - Endpoint Traffic Monitoring - Enforcement - Environmental Considerations - Practical Considerations Within Contextual Identity - Zero Trust Organization: Post-Implementation - Adoption Barriers - Applications Owners and Service Teams - The Life Cycle of Zero Trust Policies - Moves, Adds, and Changes in a Zero Trust Organization - Zero Trust Operations: Continuous Improvements.		

Module: 6	Zero Trust Architecture Standards, Frameworks, and Guidelines	7 Hours
Executive Order (EO) 14028 - Improving the Nation's Cybersecurity – National Cybersecurity Center of Excellence (NCCoE) – Cloud Security Alliance (CSA) – European Union – PagerDuty's Zero Trust Network		
Total Lectures		45 Hours

Text Books

1	Cindy Green-Ortiz. Brandon Fowler. David Houck. Hank Hensel. Patrick Lloyd. Andrew McDonald. Jason Frazier. (2023). *Zero Trust Architecture*. Cisco Press. ISBN: 978-0137899739
2	Razi Rais. Christina Morillo. Evan Gilman. Doug Barth. (2024). *Zero Trust Networks. (2nd Edition).* O'Reilly Media. Inc. ISBN: 978-1492096597.

Reference Books

1	Chase Cunningham and John Kindervag. (2021). *Zero Trust Security: Securing the Enterprise.* ISBN-13: 978-1491962190.
2	Jason Garbis. Jerry W. Chapman. (2021). *Zero Trust Security: An Enterprise Guide*. Apress. ISBN: 978-1484267011.
3	Ed Moyle, Diana Kelley. (2020). Practical Cybersecurity Architecture - A Guide to Creating and Implementing Robust Designs for Cybersecurity Architects. *(1St Edition).* Packt Publishing.ISBN: 9781838982195
4	Chris *Dotson*. (2019). *Practical Cloud Security: A Guide for Secure Design and Deployment.(1st Edition).* O'Reilly Media. ISBN: 9781492037484.
5	Jennifer Minella. (2022). *Wireless Security Architecture Designing and Maintaining Secure Wireless for Enterprise. (1st Edition).* Wiley. ISBN: 9781119883074.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Modern Cryptography**	**L**	**T**	**P**	**C**
23DC2024		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the fundamental concepts of cryptography, block ciphers and stream ciphers
2. Demonstrate the cryptographic protocols and algorithms.
3. Apply the security of cryptosystems against attacks.

Course Outcomes:

The students will be able to
1. Solve the basic cryptographic mechanisms.
2. Illustrate the workings of symmetric-key cryptography.
3. Demonstrate the working principle of public key cryptography.
4. Analyze the digital certificates for secure communication.
5. Apply cryptographic techniques against attacks.
6. Operate copyright protection mechanisms.

Module: 1	Introduction to Cryptography	8 Hours

Cryptosystems and Basic Cryptographic Tools - Message Integrity - Cryptographic Protocols and Security - Simple Cryptosystems - Cryptanalysis - Affine Cipher, Substitution Cipher, Vigenere Cipher, Hill Cipher, LFSR Stream Cipher.

Module: 2	Block Ciphers and Stream Ciphers	7 Hours

Substitution-Permutation Networks - The Data Encryption Standard - The Advanced Encryption Standard - Modes of Operation - Stream Ciphers - Security Hash Functions - Iterated Hash Functions - SHA-3, HMAC.

Module: 3	The RSA and Public Key Cryptography	7 Hours

Number Theory - RSA Cryptosystem - The Miller-Rabin Algorithm - Shanks Algorithm - Elliptic Curves - over the Reals, Modulo a Prime, over Finite fields, Properties, Pairings.

Module: 4	Signature Schemes and Post-Quantum Cryptography	7 Hours

RSA Signature Scheme - The ElGamal Signature Scheme - The Schnorr Signature Scheme - Certificates - Signing and Encrypting. Post-Quantum Cryptography-Introduction - Lattice-based cryptography.

Module: 5	Cryptosystem and Authentication System	8 Hours

Message Authentication - Forgery Attack - Substitute Attack - Affine Transformation, Discrete Logarithm and Knapsack Problem.

Module: 6	Copyright Protection and Blockchain Technology	8 Hours

Identity-Based Cryptography - Copyright Protection: Fingerprinting - Identifiable Parent Property - 2-IPP Codes - Tracing Illegally Redistributed Keys - Bitcoin and Blockchain Technology: Basic aspect of cryptography.

Total Lectures	45 Hours

Text Books

1	Jonathan Katz and Yehuda Lindell. (2015). *Introduction to Modern Cryptography. (3rd Edition)*. Chapman and Hall/CRC; ISBN: 978-0815354369.
2	Douglas R. Stinson and Maura B. Paterson. (2019). *Cryptography Theory and Practice. (4th Edition)*. ISBN: 978-1584885085.

Reference Books

1	Dan Boneh and Victor Shoup. (2017). *A Graduate Course in Applied Cryptography. (Kindle Edition)*. ASIN: B09HR17HX1.
2	Zhiyong Zheng. *Modern Cryptography*. Volume 1. Springer Singapore. (2021). ISBN: 978-981-19-0919-1.
3	Jean-Philippe Aumasson. (2024). *Serious Cryptography: A Practical Introduction to Modern Encryption. (2nd Edition)*. No Starch Press. ISBN: 978-1718503847

| 4 | Zhiyong Zheng. (2022). *Modern Cryptography: A Classical Introduction to Informational and Mathematical Principle. (2023rd Edition).* Springer Nature. ISBN-13: 978-9811976469 |
| 5 | William Easttom. (2022*). Modern Cryptography: Applied Mathematics for Encryption and Information Security. (2021st Edition).* Springer Nature. ISBN-13 : 978-3030631178 |

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Biometrics and Security	L	T	P	C
23DC2025		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate knowledge on basics of Biometrics and its functionalities.
2. Demonstrate the concept of IRIS and sensors.
3. Apply encryption techniques to secure data using biometric

Course Outcomes:

The students will be able to:
1. Operate the various Biometric technologies.
2. Illustrate the design of biometric recognition for the organization.
3. Develop simple applications for privacy.
4. Analyze the need of biometric in the society.
5. Evaluate the possible security attacks and their effective countermeasures
6. Estimate the security issues in the network and resolve it.

Module: 1	**Introduction**	**8 Hours**

Person Recognition - Biometric systems - Biometric functionalities: verification, identification - Biometric systems errors - The design cycle of biometric systems - Applications of Biometric systems - Security and privacy issues.

Module: 2	**Finger Print and Facial Recognition**	**7 Hours**

Fingerprint: Introduction - Friction ridge pattern - finger print acquisition: sensing techniques, image quality - Feature Extraction - matching - indexing. Face Recognition: Introduction - Image acquisition: 2D sensors ,3D sensors - Face detection - Feature extraction - matching.

Module: 3	**IRIS and Other Traits**	**7 Hours**

Design of an IRIS recognition system-IRIS segmentation - normalization - encoding and matching - IRIS quality - performance evaluation - other traits - ear detection - ear recognition - gait feature extraction and matching - challenges - hand geometry - soft biometrics.

Module: 4	**Behavioral Biometrics**	**7 Hours**

Introduction - Features - classification of behavioral biometrics - properties of behavioral biometrics - signature - keystroke dynamics - voice - merits - demerits - applications - error sources-types - open issues - future trends.

Module: 5	**Biometric Cryptography**	**8 Hours**

Protection of biometric data - biometric data shuffling scheme - experimental results - security analysis - cryptographic key Reservation - cryptographic key with biometrics - Revocability in key generation system - Adaptations of Generalized key Regeneration scheme - IRIS Biometrics - Face Biometrics - Extension of Key Regeneration scheme.

Module: 6	**Biometric Data Protection**	**8 Hours**

Biometric data - Concept of personal data - Data protection and privacy - Security criteria for Biometric system - Adoption of security - Revocation procedures - Security and organizational aspects of biometric system.

Total Lectures	**45 Hours**
Text Books	

1	James wayman. Anil k. Jain. Arun A. Ross. Karthik Nandakumar. (2011). *Introduction to Biometrics*. Springer. ISBN: 978-0-387-77325-4.
2	David Check Ling Ngo. Andrew Beng Jin Teoh. (2015). Jiankun Hu *Biometric Security* Cambridge Scholars. ISBN: 978-1443871839.

Reference Books	
1	Panasiuk. Mariusz Rybnik and soharab H.Sgaikh .(2017). *New Directions in Behavioral Biometrics*. ISBN: 978-1498784627.
2	Patrizio campisi. *Security and Privacy in Biometrics* .Springer .(2013).
3	Richard Jiang. (2016). *Biometric Security and Privacy: Opportunities & Challenges in The Big Data* Era. ISBN: 978-3-319-47300-0.
4	Michael Fairhurst. (2018). *Biometrics Vsi P. (Illustrated edition).* OUP Oxford. ISBN-13 : 978-0198809104
5	Andreas Uhl, Christoph Busch, Sébastien Marcel, Raymond Veldhuis. (2019). *Handbook of Vascular Biometrics. (1ˢᵗ Edition).* Springer. ISBN-13:978-3030277307

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Social Network Security**	**L**	**T**	**P**	**C**
23DC2026		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the concept of semantic web and related applications.
2. Demonstrate the knowledge representation using ontology.
3. Analyze human behaviour in social web and related communities.

Course Outcomes:

The students will be able to:
1. Demonstrate web related applications.
2. Analyze security issues in social networks.
3. Develop real time applications using ontology.
4. Evaluate human behaviour in social web and related communities.
5. Assess and visualize different social networks.
6. Estimate the access control requirements for Social Network.

Module: 1	**Fundamentals of Social Networking**	**7 Hours**

Introduction to Semantic Web, Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Historical overview of privacy and security - Major paradigms for understanding privacy and security.

Module: 2	**Security Issues in Social Networks**	**7 Hours**

The evolution of privacy and security concerns with networked technologies - Contextual influences on privacy attitudes and behaviors - Anonymity in a networked world.

Module: 3	**Extraction and Mining in Social Networking Data**	**7 Hours**

Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Big data and Privacy.

Module: 4	**Predicting Human Behavior and Privacy Issues**	**8 Hours**

Understanding and predicting human behavior for social communities - User data Management - Inference and Distribution - Enabling new human experiences - Reality mining - Context, Awareness - Privacy in online social networks - Trust in online environment.

Module: 5	**Visualization and Applications of Social Networks**	**8 Hours**

Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node - Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.

Module: 6	Access Control, Privacy and Identity Management	8 Hours

Understand the access control requirements for Social Network - Enforcing Access Control Strategies - Authentication and Authorization - Roles-based Access Control - Host, storage and network access control options - Firewalls, Authentication, and Authorization in Social Network - Identity and Access Management - Single Sign-on - Identity Federation - Identity providers and service consumers - The role of Identity provisioning.

Total Lectures	45 Hours

Text Books

1	Peter Mika. (2010). *Social Networks and the Semantic Web. (1st Edition)*. Springer ISBN: 978-0-387-71000-6.
2	BorkoFurht. (2010). *Handbook of Social Network Technologies and Application. (1st Edition)*. Springer. ISBN: 978-1-4419-7141-8.
3	David Easley. Jon Kleinberg. (2010). *Networks. Crowds. and Markets: Reasoning about a Highly Connected World. (1st Edition)*. Cambridge University Press. ISBN: 978-0521195331.

Reference Books

1	Guandong Xu. Yanchun Zhang and Lin Li. (2011). *Web Mining and Social Networking – Techniques and applications. (1st Edition)* Springer. ISBN: 978-1-4419-7734-2.
2	Max Chevalier. Christine Julien and Chantal Soulé-Dupuy. (2009). *Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling*. IGI Global Snippet. ISBN: 9781605663074.
3	John G. Breslin. Alexandre Passant and Stefan Decker. (2009). *The Social Semantic Web*. Springer. ISBN: 978-3-642-01171-9.
4	V.Surya, K.Raju, N.Ramshankar, S.Preethi. (2024). *Social Network Security. (1st Edition)*. Scientific International Publishing House. ISBN: 978-93-6674-032-4
5	Brij B. Gupta, Somya Ranjan Sahoo. (2023). *Online Social Networks Security*. (1st Edition). CRC Press. ISBN-13 : 978-0367707354.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Health Care System Data Analytics	L	T	P	C
23DC2027		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the health data formats, health care policy and standards
2. Apply the machine learning and deep learning algorithms in healthcare
3. Develop healthcare analytic system for critical care applications

Course Outcomes:

The students will be able to:
1. Illustrate the different health data formats used across systems
2. Develop the machine learning algorithms for health data analysis
3. Apply python for the health data management techniques
4. Demonstrate the importance of healthcare data analysis
5. Design the deep learning models for clinical data analysis
6. Analyze the advanced healthcare analytics and emergency care systems

Module: 1	Introduction to Healthcare Analysis	7 Hours

Overview - History of Healthcare Analysis Parameters on medical care systems - Health care policy Standardized code sets - Data Formats - Machine Learning Foundations: Tree Like reasoning, Probabilistic reasoning and Bayes Theorem, Weighted sum approach.

Module: 2	Machine Learning Pipeline and Pre-processing	7 Hours

Machine Learning Pipeline - Pre-processing - Visualization - Feature Selection - Training model parameter - Evaluation model: Sensitivity, Specificity, PPV, NPV, FPR, Accuracy, ROC, Precision, Recall Curves, Valued target variables.

Module: 3	Python Essentials for Machine Learning	7 Hours

Python: Variables and types, Data Structures and containers, Pandas Data Frame: Operations - Scikit - Learn: Pre-processing, Feature Selection.

Module: 4	Healthcare Management	8 Hours

IOT- Smart Sensors - Migration of Healthcare Relational database to NoSQL Cloud Database - Decision Support System - Matrix block Cipher System - Semantic Framework Analysis - Histogram bin Shifting and Rc6 Encryption - Clinical Prediction Models - Visual Analytics for Healthcare.

Module: 5	Healthcare and Deep Learning	8 Hours

Introduction on Deep Learning - DFF network CNN - RNN for Sequences - Biomedical Image and Signal Analysis - Natural Language Processing and Data Mining for Clinical Data - Mobile Imaging and Analytics - Clinical Decision Support System.

Module: 6	Advanced Healthcare Analytics	8 Hours

Predicting Mortality for cardiology Practice - Smart Ambulance System using IOT - Hospital Acquired Conditions (HAC) program - Healthcare and Emerging Technologies - ECG Data Analysis.

Total Lectures	45 Hours

Text Books

1	Chandan K.Reddy. Charu C. Aggarwal. (2015). *Health Care Data Analysis. (1st Edition).* CRC. ISBN: 978-0367575687.
2	Vikas Kumar. (2018). *Health Care Analysis Made Simple*. Packt Publishing. ISBN: 1787286703.
3	Nilanjan Dey. Amira Ashour. Simon James Fong. Chintan Bhatl. (2018). *Health Care Data Analysis and Management. (1st Edition).* Academic Press. ISBN: 9780128153680.

Reference Books

1	Kulkarni. Siarry. Singh. Abraham. Zhang. Zomaya. Baki. (2020). *Big Data Analytics in HealthCare*. Springer. ISBN: 978-3-030-31671-6.
2	Hui Jang. Eva K. Lee. (2016). *HealthCare Analysis: From Data to Knowledge to Healthcare Improvement. (1st Edition).* Wiley. ISBN: 978-1118919392.
3	Balamurugan Malviya, Rishabha, Sharma, Pramod Kumar, Sundram, Sonali, Dhanaraj, Rajesh Kumar, Balusamy. (2022). *Bioinformatics Tools and Big Data Analytics for Patient Care. (1st Edition).* Taylor & Francis Ltd. ISBN-13 : 978-1032129310.
4	Kamarul Imran Musa,Wan Nor Arifin Wan Mansor, Tengku Muhammad Hanis. (2023). *Data Analysis in Medicine and Health using R (1st Edition).* Chapman and Hall/CRC. ISBN-13 : 978-1032284149.
5	Om Prakash Jena, Bharat Bhushan, Utku Kose. (2024). *Machine Learning and Deep Learning in Medical Data Analytics and Healthcare Applications. (1st Edition).* CRC Press. ISBN-13: 978-1032127644.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Exploration and Visualization	L	T	P	C
23DC2028		2	0	0	2

Course Objectives:

Enable the students to:
1. Illustrate knowledge on exploratory data analysis and suitable visualizations for effective data exploration and interpretation.
2. Demonstrate data cleaning techniques and demonstrate the transformative benefits.
3. Evaluate statistical concepts, and enable the inference and application of advanced data analysis techniques in real-world scenarios.

Course Outcomes:		

The students will be able to:
1. Illustrate exploratory data analysis fundamentals
2. Implement the appropriate visualization methods
3. Apply data cleaning techniques
4. Operate the benefits of data transformation in enhancing data quality and analysis accuracy.
5. Evaluate the statistical concepts of data analysis and interpretation
6. Analyze the advanced data analysis techniques and application of statistical methods in real-world scenarios.

Module: 1	Exploratory Data Analysis Fundamentals	5 Hours

Understanding data science - The Significance of EDA - Steps in EDA - Numerical data, Categorical data, Measurement scales - Measurement scales - Comparing EDA with classical and Bayesian analysis - Software tools available for EDA - NumPy, Pandas, SciPy, Matplotlib.

Module: 2	Visual Aids of EDA	5 Hours

Technical requirements - Line chart - Bar charts - Scatter plot - Area plot and stacked plot - Pie chart - Table chart - Polar chart - Histogram - Lollipop chart - Choosing the best chart.

Module: 3	Technical Requirements of EDA	5 Hours

Data cleaning - Loading the CSV file - Converting the date - Removing NaN values - Applying descriptive statistics - Data refactoring - Dropping columns - Refactoring timezones - Data Analysis

Module: 4	Data Transformation	5 Hours

Merging database - style dataframes - Transformation techniques: Performing data deduplication - Replacing values - Handling missing data - Renaming axis indexes - Discretization and binning - Outlier detection and filtering - Permutation and random sampling - Computing indicators/dummy variables - String manipulation, Benefits of Data transformation.

Module: 5	Descriptive Statistic	5 Hours

Understanding Statistic: Distribution function - Cumulative distribution function - Descriptive analysis, Measure of central tendency - Measures of dispersion: Standard deviation - Variance - Skewness - Kurtosis - Calculating percentiles - Quartiles.

Module: 6	Grouping Datasets and Correlation	5 Hours

Understanding Groupby - Groupby mechanics - Data aggregation - Pivot tables and cross-tabulations, Correlation - Types of analysis - Multivariate analysis, Time series Analysis - Understanding the time series dataset - TSA with open power system data - EDA on Wine Quality Data Analysis.

Total Lectures	30 Hours

Text Books

1	Suresh Kumar. Mukhiya and Usman Ahmed. (2020). *Hands-On Exploratory Data Analysis with Python. Perform EDA techniques to understand. summarize. and investigate your data*. Packt. ISBN: 978-1789537253.
2	Dr. Ossama Embarak. (2018). *Data Analysis and Visualization Using Python Analyze Data to Create Visualizations for BI Systems*. ISBN: 978-1-4842-4108-0.

Reference Books

1	Sam Lau. Joseph Gonzalez. Deborah Nolan. (2023). *Learning Data Science: Data Wrangling. Exploration. Visualization. and Modeling with Python*. O'Reilly Media; ISBN: 9781098113001.
2	Claus O. Wilke. (2019). *Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures. (1st Edition)* .Shroff/O'Reilly; ISBN-10: 9352138112.
3	Michael Walker. (2022). *Data Cleaning and Exploration with Machine Learning: Get to grips with machine learning techniques to achieve sparkling-clean data quickly. (1st Edition)*. Packt Publishing. ISBN-13 : 978-1803241678.
4	Sharada Sringeswara, Purvi Tiwari, U. Dinesh Kumar. (2022). *Data Visualization: Storytelling Using Data. (1st Edition)*. Wiley India Pvt Ltd. ISBN-13: 978-9354643132.

5	Krishna Shah. (2024). Kibana 8.x - *A Quick Start Guide to Data Analysis: Learn about data exploration, visualization, and dashboard building with Kibana. (1st Edition).* Packt Publishing. ISBN-13: 978-1803232164.
Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Science in Robotics	L	T	P	C
23DC2029		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Develop knowledge on mathematical foundation of data science
2. Analyze the role of statistics in robotics.
3. Evaluate the role of robotics in data science domain.

Course Outcomes:

The students will be able to:
1. Apply the basic concepts of data science
2. Demonstrate the mathematical concepts involved in data science
3. Evaluate the statistical concepts
4. Demonstrate the basics of robotics
5. Apply sensors and actuators for the applications of robotics
6. Formulate the kinematics of serial robots

Module: 1	**Introduction**	**5 Hours**

Introduction Data Science – Applications - Comparative Study of data science with databases - scientific computing - computational science.

Module: 2	**Linear Algebra for Data Science**	**8 Hours**

Vectors, matrices - product of matrix & vector – rank - null space - solution of over-determined set of equations and pseudo-inverse. Geometric view: vectors – distance – projections - eigenvalue decomposition.

Module: 3	**Statistics for Data Science**	**8 Hours**

Inferential Statistics - Probability distributions - univariate and multivariate normal distributions - Hypothesis testing – ANOVA - Correlation and Regression.

Module: 4	**Robotics**	**6 Hours**

Robotics - laws of robotics - degrees of freedom - robot joints - robot coordinates - reference frames - types of robots – workspace - applications.

Module: 5	**Sensors and Actuators**	**9 Hours**

Sensors - sensor utilization - position sensors - velocity sensors - acceleration sensors - force sensors - miscellaneous sensors. Actuators – pneumatic - hydraulic and electric actuators - characteristics and control - applications.

Module: 6	**Kinematics of Serial Robots: Position Analysis**	**9 Hours**

Robots as Mechanisms - Matrix Representation - Homogeneous Transformation Matrices - Representation of Transformations - Inverse of Transformation Matrices - Forward and Inverse Kinematics of Robots.

Total Lectures		**45 Hours**
Text Books		
1	Saeed. B. Niku. (2019). *Introduction to Robotics: Analysis. Control. Applications. (3rd Edition).* Wiley. ISBN: 978-1119527626.	
2	Gilbert Strang. (2016). *Introduction to Linear Algebra. (5th Edition).* Wellesley-Cambridge Press. ISBN: 978-1733146678.	
3	Cathy O'Neil and Rachel Schutt. (2014). *Doing Data Science. Straight Talk from The Frontline.* O'Reilly. ISBN: 978-1449358655.	

4	Peter Bruce. Andrew Bruce. (2017). *Practical Statistics for Data Scientists*. O'Reilly ISBN: 978-8194435006.
Reference Books	
1	Anil Maheshwari. (2021). *Data Analytics made accessible*. Amazon Digital Publication. ISBN: 978-9355324559.
2	Song. Peter X. K. (2007). *Correlated Data Analysis: Modeling. Analytics. and Applications*. Springer-Verlag New York. ISBN: 978-0-387-71392-2.
3	Nikolaus Correll. Bradley Hayes. Christoffer Heckman. Alessandro Roncone. (2022). *Introduction to Autonomous Robots*. MIT Press. ISBN:978-0262047555
4	Larry Wasserman. (2014). *All of Statistics A Concise Course in Statistical Inference*. Springer New York. ISBN: 9780387217369.
5	John J. Craig. (2008). *Introduction to Robotics: Mechanics and Control*, *(3rd Edition)*, Pearson Publications. ISBN: 978-8131718360
Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Foundations of Data Analytics	L	T	P	C
23DC2030		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the foundational concepts of Data Science
2. Apply data techniques for real-world datasets and design efficient data warehouse architectures.
3. Analyze text and web data for insights and patterns using mining techniques

Course Outcomes:

The students will be able to:
1. Analyze the fundamental concepts of Data Science and its applications.
2. Demonstrate the theoretical foundations of various data modeling techniques
3. Apply data gathering, selection, cleansing, and preparation techniques to real-world datasets
4. Analyze the data warehouse design principles.
5. Develop the text and web data using text mining and web mining techniques
6. Assess the business and technological implications of Bigdata

Module: 1	**Introduction to Data Analytics**	**7 Hours**

Need for Data Science - Data Science Process - Business Intelligence and Data Science - Components of Data Science - Statistics and Probability - Data Types - Variable Types - Sampling Techniques and Probability - Information Gain and Entropy - Probability Theory - Probability Types - Probability Distribution Functions - Bayes Theorem - Inferential Statistics.

Module: 2	**Data Modelling and Analytics**	**7 Hours**

Analytics for Data Science - Data Analytics Life Cycle - Regression Analysis - Linear Regression, Logistic Regression, Multinomial Logistic Regression - Time Series Models - Machine Learning- Decision Trees - Naïve Bayes - Support Vector Machine - Nearest Neighbour Learning - Clustering, Confusion Matrix.

Module: 3	**Data Mining**	**7 Hours**

Gathering and Selecting Data - Data Cleansing and Preparation - Outputs of data mining - Evaluating data mining results - Data Mining Techniques - Tools and Platforms of Data Mining - Data Mining Mistakes.

Module: 4	**Data Warehousing**	**8 Hours**

Data Warehouse Design Considerations - Data Warehouse Development Approaches - Data Warehouse Architecture – Sources - Data Loading Process - Data Warehouse Design - Data Warehouse Access.

Module: 5	**Data Analytics - Text Mining and Web Mining**	**8 Hours**

Text Mining, Text Analytics - Text Analytics Subtasks, Basic Text Analytics Steps, Introduction to Natural Language Processing, Web Mining - Web Content Mining, Web Structure Mining, Wen Usage Mining, Web Mining Algorithm.

Module: 6	Big Data and Data Modelling Primer	8 Hours
Definition - Big Data Landscape - Business Implications of Big Data - Technology Implications of Big Data - Big Data Technologies - Management of Big Data - Evolution of Data Management System - Relational Data Model - Implementing the Relational Data Model - Database Management System - Structured Query Language.		
Total Lectures		**45 Hours**

Text Books

1	Sanjeev J. Wagh. Manisha S. Bhende. and Anuradha D. Thakare. (2022). *Fundamentals of Data Science*. CRC Press. ISBN : 9780429443237.
2	Dr. Anil Maheswari. 2015.*Data Analytics Made Accessible*. (Kindle Edition). Atlantic Publisher.

Reference Books

1	Avrim Blum , John Hopcroft , Ravindran Kannan.(2020). *Foundations of Data Science*. Cambridge University Press.ISBN: 978-1108485067
2	Qurban A. Memon, Shakeel Ahmed Khoja.(2020).*Data Science Theory Analysis And Applications.* ISBN : 978-0367208615
3	Joel Grus. (2015). *Data Science From Scratch: First Principles with Python, 2nd Edition,* O'reilly. ISBN: 978-9352130962
4	Ronald E. Walpole. Raymond H. Myers. Sharon L. Myers. Keying E. Ye. (2010). *Probability and Statistics for Engineers and Scientists. (9th Edition)*. Pearson. ISBN: 978-0321629111.
5	Jiawei Han. Micheline Kamber. Jian Pei. (2011). *Data Mining: Concepts and Techniques, (3rd Edition)*. Morgan Kaufmann Publisher. ISBN: 978-9380931913

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Generative AI	L	T	P	C
23DC2031		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Analyze the generative models, including their underlying principles, algorithms, and applications.
2. Implement various generative models using popular frameworks.
3. Illustrate advanced applications of generative AI in various domains such as image generation, text generation.

Course Outcomes:

The students will be able to:
1. Analyze the different varieties of generative AI models and the working of GPT.
2. Illustrate the key components and working of LangChain.
3. Develop the skills necessary to apply generative AI techniques creatively for building chatbots
4. Estimate the on-going research on customizing LLM.
5. Demonstrate the impact of generative AI on data science.
6. Evaluate the LLM apps.

Module: 1	Introduction to Generative AI	7 Hours
Introduction to generative AI, Generative AI models, Large Language models-PaLM2, LLaMa 2, Claude and Claude 2, Working of GPT, Pretraining, Tokenization, scaling, conditioning, Text to Image models.		

Module: 2	LangChain for LLM Apps	7 Hours
Introduction to LangChain, Exploring key components of LangChain, Working of LangChain, Comparing LangChain and other frameworks.		

Module: 3	Building a Chatbot	7 Hours
Introduction to chatbot, Understanding retrieval and vectors, Loading and retrieving, Implementing a chatbot, moderating responses.		

Module: 4	Customizing LLM	8 Hours
Customizing LLMs, Conditioning LLM, Fine Tuning, Prompt Engineering.		

Module: 5	LLM's for Data Science	8 Hours

Impact of generative models on Data Science, Automated Data Science, Using agents to answer data Science questions, Data exploration with LLM.

Module: 6	Generative AI in Production	8 Hours

Getting LLM apps ready for production, Evaluation of LLM apps, Deployment of LLM apps, Observation of LLM apps.

Total Lectures	45 Hours

Text Books

1	Auffarth. Ben. (2023). *Generative AI with LangChain: Build Large Language Model (LLM) Apps with Python. ChatGPT. and Other LLMs*. United Kingdom: Packt Publishing. ISBN: 9781835088364.
2	Dhamani. Numa. Engler. Maggie.(2024). *Introduction to Generative AI*. United States: Manning. ISBN: 9781633437197.

Reference Books

1	Michael McTear. Marina Ashurkina. (2024). *Transforming Conversational AI Exploring the Power of Large Language Models in Interactive Conversational Agents*. Apress Berkeley. CA. ISBN: 979-8-8688-0110-5.
2	Joseph Babcock. Raghav Bali. (2021). *Generative AI with Python and TensorFlow 2 Create Images. Text. and Music with VAEs. GANs. LSTMs. Transformer Models*. Packt Publishing. ISBN: 9781800208506.
3	David Foster. (2019). *Generative Deep Learning Teaching Machines to Paint. Write. Compose. and Play*. O'Reilly Media. ISBN: 9781492041894.
4	Kulkarni. A. Shivananda. A. Kulkarni. A. Gudivada. D. (2023). *Applied Generative AI for Beginners: Practical Knowledge on Diffusion Models. ChatGPT. and Other LLMs*. United States: Apress. ISBN: 9781484299937.
5	Palash Goyal. Sumit Pandey. Karan Jain. (2018). *Deep Learning for Natural Language Processing: Creating Neural Networks with Python (1st Edition)*, Apress Publisher. ISBN:978-1484236840

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Full Stack Development	L	T	P	C
23DC2032		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the front-end design of web pages using HTML5, CSS3 and Bootstrap4.
2. Develop interactive web application design using JavaScript and jQuery.
3. Develop simple web applications using React and Angular JS and Node.js framework with different back-end design

Course Outcomes:

The students will be able to:
1. Design responsive web pages using front-end UI tools like HTML5, CSS3 and Bootstrap4.
2. Create dynamic web pages using JavaScript and jQuery.
3. Construct simple web applications using AngularJS framework.
4. Develop simple web applications using ReactJS framework.
5. Analyze different web applications using node.js framework.
6. Invent the real time web applications with backend tools.

Module: 1	Introduction to Frontend Design	7 Hours

Introduction to full stack development - Front-end web UI frameworks fundamentals - Basics of HTML5 & CSS3 - Responsive web design - Overview of Bootstrap4 - Containers - Grid system - Bootstrap4 CSS - Bootstrap4 Layout components - Themes - simple web application design.

Module: 2	Java Script and jQuery	7 Hours

An Introduction to JavaScript - JavaScript Objects - DOM model - functions - Event handling - jQuery overview - Selectors - Events - jQuery Traversing - jQuery Effects - jQuery HTML - jQuery and AJAX.

Module: 3	Angular.JS Framework	7 Hours

JavaScript frameworks: MEAN stack frameworks - Introduction to Angular JS - Binding and Expression - Directives - Controllers - Filters - Modules - Services - Scopes - Tables & forms - AngularJS DOM - Animations - Simple application.

Module: 4	React.JS Framework	8 Hours

Introduction to React Router - Single Page Applications - React Forms - Flow Architecture - Introduction to Redux - More Redux - Client-Server Communication.

Module: 5	Node.JS Framework	8 Hours

Introduction to Node.js - Node.js Architecture - NPM (Node Packaging Manager) - Installing NPM module - Creating and locating modules - Creating a simple HTTP server.

Module: 6	MySQL, MongoDB with Node.js Framework	8 Hours

Introduction to MySQL with Node.js – Basic DDL & DML Operations - NoSQL Database - Basic CRUD Operations - Indexing - Aggregation - Data Modelling concepts - Connecting MongoDB using Mongoose.

Total Lectures		45 Hours

Text Books

1	Paul J. Deitel, Harvey Deitel .(2020). *Internet and World Wide Web How To Program*. (6th *Edition)*. Pearson. ISBN: 978-9352868599.
2	Frank Zammetti. 2020. *Modern Full-Stack Development: TypeScript, React, Node.js*. (1st Edition). Apress. ISBN: 978-1-4842-8810-8.
3	Brad Dayley & Brendan Dayley. (2018). *Node.js, MongoDB and Angular Web Development*. (2nd *Edition)*. Pearson Education. ISBN: 978-0134655536.

Reference Books

1	Chris Northwood. (2018). *The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer*. A Press Publisher. ISBN: 978-1484241516.
2	Adam Bretz & Colin J Ihrig. (2015). *Full Stack JavaScript Development with MEAN*. Sitepoint publisher. ISBN: 978-0992461256.
3	Vasan Subramanian. (2019). *Pro MERN Stack: Full Stack Web App Development with Mongo. Express. React and Node (2nd Edition)*. Apress publisher. ISBN: 978-1484243909.
4	Marijn Haverbeke. (2018). *Eloquent Javascript*, (*3rd Edition*), NostarchPress. ISBN: 978-1593279509
5	Shannon Bradshaw , Eoin Brazil , Kristina Chodorow, (2020). *MongoDB: The Definitive Guide - Powerful and Scalable Data Storage, (3rd Edition)*, O'Reilly Publisher, ISBN: 978-9352139576

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Full Stack Development Laboratory	L	T	P	C
23DC2033		0	0	3	1.5

Course Objectives:

Enable the students to:
1. Create front-end design of web pages using HTML5, CSS3 and Bootstrap4.
2. Develop interactive web application design using JavaScript and jQuery.
3. Demonstrate a simple web application using Nodejs; Angular JS and React with different back-end design

Course Outcomes:

The students will be able to:
1. Develop responsive web pages using HTML and CSS.
2. Implement client-side scripting using Java Script.
3. Create interactive web pages using React and Angular JS

4. Design web page using jQuery.
5. Demonstrate the server-side scripts using Node JS.
6. Construct real time web applications with backend tools.

List of Exercises:
1. Design a responsive website to display information about your department details using HTML5, CSS3, Bootstrap4. Use Boostrap4 features like grids, jumbotron, carousel, etc.
2. Implement simple random quote generator using JavaScript. When the user clicks on the New Quote button, it will generate new quote and display it to the user randomly. There is a collection of pre-defined quotes collected and store in constant. Whenever the new quote is displayed to the user, background colour should also be changed.
3. Create a password strength checker application using jQuery.
4. Design simple scientific calculator using AngularJS framework.
5. Develop to-do-list application using AngularJS.
6. Develop a BMI calculator application using node.js framework.
7. Create a simple server application using node.js.
8. Create a simple library management system using node.js and MySQL/MongoDB.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Robotic Process Automation	L	T	P	C
23DC2034		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate the fundamental concepts and scope of RPA
2. Demonstrate the skills required for successful RPA implementation
3. Analyze the trends in advanced automation and their potential impact on future RPA developments.

Course Outcomes:

The students will be able to:
1. Describe the history of RPA and its evolution, including key milestones and developments.
2. Illustrate the RPA methodologies and planning process
3. Create a bot to develop the UiPath and establish the workflow structures
4. Analyze the deployment strategies, data preparation and monitoring process with their challenges
5. Distinguish large and small RPA software developers and vendors
6. Demonstrate the process automation like mail, word, excel and presentation automation with UI path

Module: 1	Introduction to RPA	7 Hours

RPA Foundations - History of RPA - Benefits and downsides of RPA - Consumer Willingness for Automation - The Workforce of the Future - RPA Skills - Web Technology - OCR - Databases - APIs - Artificial Intelligence.

Module: 2	RPA Methodologies and Planning Process	9 Hours

RPA methodologies: Six Sigma roles and levels - Lean Six Sigma - Applying Lean and Six Sigma to RPA - RPA planning process: Preliminaries - Consulting firm - Case studies - ROI for RPA - RPA use cases and plan - Automation.

Module: 3	Bot Development	8 Hours

Approaches for bot development - Installation of UiPath - Activities - Flowcharts and sequences - Log message - Variables - Loops and conditionals - Debug - Common UiPath functions - UiPath Orchestrator.

Module: 4	Deployment and Monitoring	7 Hours

Ensuring long term Success - Testing - Production - Monitoring - Security - Scaling - Data preparation: AI and process mining - Types of data - Big data - Issues with big data - Data process - Types of algorithms - Bias.

Module: 5	Vendors and Process Mining	6 Hours
RPA vendors: Major players - Uipath - IQ Bot - Bot Store - Validation of automation - Blue Prism - Edgeverve - PEGA - Verint - WorkFusion - Nintex - Softomotive - Intellibot - Process mining - Using software to optimize processes - Future of RPA - Privacy and ethics.		

Module: 6	Automation Techniques	8 Hours
Mail Automation - Word Automation - Excel Automation - File Automation - Presentation Automation.		
Total Lectures		**45 Hours**

Text Books

1	Tom Taulli. (2020). *The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems.* Apress Publisher. ISBN-13: 978-1-4842-5729-6.
2	Adeel Javed. Anum Sundrani. Nadia Malik. Sidney Madison Prescott. (2021). *Robotic Process Automation using UiPath StudioX: A Citizen Developer's Guide to Hyperautomation*. Apress Publisher. ISBN-13: 978-1-4842-6794-3.

Reference Books

1	Nandan Mullakara. Arun Kumar Asokan. (2020). *Robotic Process Automation Projects: Build real-world RPA* Packt Publishing. ISBN : 978-1839217357.
2	Alok Mani Tripathi (2018). *Learning Robotic Process Automation - Create Software Robots and Automate Business Processes with the Leading RPA Tool – UiPath*. Packt Publishing Release. ISBN: 978-1788470940.
3	Vaibhav Srivastava (2020). *Getting started with RPA using Automation Anywhere* BPB publication. ISBN: 978-9389898286.
4	Lentin Joseph (2019). *Learning Robotics using Python*. Packt Publishing. ISBN: 978-1788623315.
5	Bartneck, C., Belpaeme. T., EysselF. KandaT., Keijser M., Sabanovic, S. (2020). *Human-Robot Interaction: An Introduction.* Singapore. Cambridge University Press. ISBN: 978-1108735407.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Robotic Process Automation Laboratory	L	T	P	C
23DC2035		0	0	2	1

Course Objectives:

Enable the students to:
1. Apply proficiency in using UiPath Studio and Orchestrator
2. Demonstrate RPA bots with different data sources
3. Implement advanced features of UiPath

Course Outcomes:

The students will be able to:
1. Design the UiPath Studio interface, tools, and functionalities to create basic automation workflows.
2. Develop automation techniques for working with Excel and PDF files using UiPath.
3. Apply skills in automating interactions with web applications using UiPath.
4. Implement UiPath's image recognition capabilities for automating tasks based on screen elements
5. Demonstrate advanced features of UiPath, such as AI integration (e.g., OCR, image recognition), UiPath Apps development, and Orchestrator functionalities
6. Develop end-to-end automation solutions using UiPath, covering entire business processes from data extraction to reporting.

List of Exercises

1. UiPath Studio Familiarization
2. Data Scraping
3. Email Automation
4. Excel/ PDF Automation
5. Web Automation
6. Image Recognition
7. Multi-Bot Collaboration

8. UiPath Orchestrator
9. UiPath AI Fabric Integration
10. End-to-End Process Automation

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Augmented Reality and Virtual Reality	L	T	P	C
23DC2036		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the fundamental principles of virtual reality.
2. Analyze the essential information about the virtual environment.
3. Design a virtual environment with different objects.

Course Outcomes:

The students will be able to:
1. Analyze the augmented reality and virtual reality technologies.
2. Demonstrate motion trackers, and navigators in augmented and virtual reality environments.
3. Estimate the effect of virtual reality and augmented reality simulation on users.
4. Analyze camera tracking and 3D rendering in augmented reality.
5. Implement various modelling techniques in virtual reality.
6. Design real-time applications using virtual and augmented reality.

Module: 1	Introduction to Immersive Technologies	8 Hours

Application: Building a simple 2D and 3D world, Introduction to Augmented Reality and Virtual Reality – The five Classic Components of a Virtual Reality System – Early Commercial Virtual Reality Technology – Reality, Virtuality and Immersion – Virtual Reality, Augmented Reality: similarities and differences – The future of human experience.

Module: 2	Motion Tracking, Navigation and Human Perception	7 Hours

Application: Ball tracking in Basketball games, moving vehicle tracking on the road, Rotating wheels using Navigation – Position and Motion Trackers – Trackers – Navigation and Manipulation Interfaces – Data Gloves and Gesture Interfaces – Human Perception and Cognition – Virtual Reality Health and Safety Issues.

Module: 3	Camera Tracking and 3D Rendering for Immersive Environment	7 Hours

Application: Object creation and movement in Android mobile platform, object tracking in Android mobile platform – Inside-out camera tracking – Depth Sensing – Mobile Platforms – Full-Body tracking – Rendering Architecture – Graphics Accelerators – 3D Rendering APIs, OpenGL – Optimization techniques – Distributed Virtual Reality Architectures.

Module: 4	Modelling the Physical World	8 Hours

Application: Object positioning in the android mobile platform, Managing multi-models in a 3D world Kinematics Modelling – Homogeneous Transformation Matrices – Object Position – Transformation Invariants – Object Hierarchies – Scale, Perspective and Perception – Physical Modelling – Collision Detection – Surface Deformation – Force computation – Force Smoothing and Mapping – Haptic Texturing – Model Management – Level-of Detail Management – Cell Management.

Module: 5	VR Programming	8 Hours

Application: Explore the world of virtual reality by building immersive projects using Unity 3D Toolkits and Scene graph, Worldtoolkit, Java 3D, General Haptics Open software toolkit, Peopleshop, Introduction to Virtual Reality using Unity 3D.

Module: 6	Applications of VR and AR	7 Hours

Application: Real-time applications of Augmented and Virtual Reality technologies – Virtual Reality: Medical applications, Education arts and Entertainment, VR application in manufacturing – Applications of VR in Robotics – Information Visualization, Augmented Reality: Sales and Marketing, Assembly and

maintenance, Medical AR trials, Interactive Museum experience, Holoportation Using AR in the Workplace.

Total Lectures	45 Hours

Text Books

1	Kelly S. Hale. Kay M. Stanne. (2014). *Handbook of Virtual Environments: Design. Implementation. And Applications. (2ⁿᵈ Edition).* CRC Press. (Human Factors and Ergonomics). ISBN-13: 978-1466511842.
2	Schmalstieg and T. Hollerer.(2016). *Augmented* Reality. *(1ˢᵗ edition).* Pearson Education. ISBN-13: 978-0321883575.
3.	Linowes. Jonathan. (2020). *Unity 2020 virtual reality projects: Learn VR development by building immersive applications and games with Unity 2019.4 and later versions.* Packt Publishing Ltd. ISBN: 978-1839217333.

Reference Books

1	Jason Jeral. (2015). *The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery.* Morgan & Claypool Publishers. ISBN-13: 978-1970001129.
2	Aukstakalnis. (2017). *Practical Augmented Realiity. (1ˢᵗ Edition).* Pearson Education. ISBN-13: 978-0134094236.
3	GrigoreC Burdea and Philippe Coiffet. (2012). *Virtual Reality Technology. (3ʳᵈ Edition).* John Wiley and Sons. ISBN-13: 978-1118014806.
4	Linowes J., Babilinski K. (2017). *Augmented Reality for Developers: Build Practical Augmented Reality Applications with Unity, ARCore, ARKit, and Vuforia.* United Kingdom. Packt Publishing. ISBN: 978-1787288041.
5	Glover J. Linowes, J. (2019). *Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the Power of Unity and Become a Pro at Creating Mixed Reality Applications.* United Kingdom. Packt Publishing. ISBN: 978-1838644864.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Cognitive Computing	L	T	P	C
23DC2037		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the basics of Cognitive Computing
2. Describe the role of big data in Cognitive computing
3. Demonstrate the applications involved in this domain

Course Outcomes:

The students will be able to:
1. Define the basic concepts of Cognitive Computing
2. Analyse the various components to build the cognitive systems
3. Describe Big Data's role in Cognitive Computing
4. Apply Machine Learning Concepts for Cognitive Computing
5. Explore the Deep Learning Concepts for Cognitive Computing
6. Develop the healthcare applications of Cognitive Computing

Module: 1	Foundation of Cognitive Computing	7 Hours

Cognitive computing as a new generation, the uses of cognitive systems, system cognitive, gaining insights from data, Artificial Intelligence as the foundation of cognitive computing, understanding cognition.

Module: 2	Design Principles of Cognitive System	7 Hours

Components of a cognitive system, building the corpus, bringing data into cognitive system, machine learning, hypotheses generation and scoring, presentation and visualization services.

Module: 3	Big Data and Cognitive Computing	8 Hours

Relationship between Big Data and Cognitive Computing: Dealing with human-generated data, defining big data, architectural foundation, analytical data warehouses, Hadoop, data in motion and streaming data, integration of big data with traditional data.

Module: 4	Cognitive Computing with Machine Learning	8 Hours

Building Company earning call transcript application-Machine learning Techniques for cognitive decision making - Hypothesis Generation and Scoring.

Module: 5	Cognitive Computing with Deep Learning	8 Hours

Representing Knowledge - Taxonomies and Ontologies - Deep Learning -Support of Cognitive System.

Module: 6	Application of Cognitive Computing	8 Hours

Cognitive Systems in health care - Cognitive Assistant for visually impaired - AI for cancer detection, Predictive Analytics - Text Analytics - Image Analytics -Speech Analytics.

Total Lectures	45 Hours

Text Books

1	Judith H Hurwitz. Marcia Kaufman. Adrian Bowles. (2015). *Cognitive computing and Big Data Analytics*. Wiley. ISBN: 9781119183648.
2	Mamta Mittal. Rajiv Ratn Shah. Sudipta Roy. (2021). *In Cognitive Data Science in Sustainable Computing. Cognitive Computing for Human-Robot Interaction*. Academic Press. ISBN: 9780323857697.

Reference Books

1	Noah D. Goodman. Joshua B. Tenenbaum. The ProbMods Contributors. (2016). *Probabilistic Models of Cognition (2nd Edition)*. ISBN: 978-0124079489.
2	Kai Hwang. (2017). *Cloud Computing for Machine Learning and Cognitive Applications*. MIT press. Cambridge. England. ISBN: 9780262036412.
3	Hurwitz. Kaufman. and Bowles. (2005). *Cognitive Computing and Big Data Analytics*. Wiley. Indianapolis IN. ISBN: 978-1-118-89662-4.
4	Hwang. K., Chen M., (2017). *Big-Data Analytics for Cloud, IoT and Cognitive Computing*. United Kingdom. Wiley. ISBN: 978-1119247029.
5	High R., Bakshi T. (2019). *Cognitive Computing with IBM Watson: Build Smart Applications Using Artificial Intelligence as a Service*. Packt Publishing. ISBN: 978-1788478984.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Nature Inspired Optimization	L	T	P	C
23DC2038		3	0	0	3

Course Objectives:

Enable the students to:
1. Illustrate the basics of evolutionary computation and its terminology, including how biological processes inspire computational techniques.
2. Apply evolutionary and swarm intelligence techniques like genetic algorithms, PSO, and ACO to solve optimization problems in both continuous and discrete domains.
3. Analyze and solve complex optimization problems with dynamic, multimodal, and constrained characteristics using advanced swarm intelligence algorithms and optimization techniques.

Course Outcomes:

The students will be able to:
1. Illustrate the foundational concepts of computation inspired by nature, including biological processes, evolution, and learning.
2. Evaluate the principles and terminologies of evolutionary computation, including encoding/decoding, selection/reproduction, crossover, and mutation.
3. Apply evolutionary strategies, including CMA-ES and differential evolution, for optimization tasks.
4. Analyze particle swarm optimization (PSO) and ant colony optimization (ACO) for continuous and discrete optimization problems.

5. Distinguish various swarm intelligence algorithms, such as glowworm-based optimization and cuckoo search, for optimization tasks.
6. Demonstrate the dynamic, multimodal, and constrained optimization problems

Module: 1	Introduction	7 Hours

Introduction – Computation Inspired by Nature, Biological Processes, Evolution vs. Learning, Swarm Intelligence, Heuristics, Metaheuristics and Hyper – Heuristics, Optimization, Performance Indicators, Simulated Annealing – Basic Simulated Annealing, Variants of Simulated Annealing.

Module: 2	Genetic Algorithms	7 Hours

Genetic Algorithms – Introduction to Evolutionary Computation, Terminologies of Evolutionary Computation, Encoding/Decoding, Selection/Reproduction, Crossover, Mutation, Non Canonical Genetic Operators, Exploitation vs. Exploration, Two-Dimensional Genetic Algorithms, Real – Coded Genetic Algorithms, Genetic Algorithms for Sequence Optimization, Genetic Programming – Syntax Trees, Causes of Bloat, Bloat Control, Gene Expression Programming.

Module: 3	Evolutionary Strategies	7 Hours

Basic Algorithm, Evolutionary Gradient Search and Gradient Evolution, CMA Evolutionary Strategies, Differential Evolution – DE Algorithm, Variants of DE, Binary DE Algorithms, Convergence of Evolutionary Algorithms, Parallel Evolutionary Algorithms, Coevolution, Fitness Approximation.

Module: 4	Swarm Optimization	8 Hours

Basic PSO Algorithms, PSO variants using different neighbourhood topologies, PSO and EA: Hybridization, Discrete PSO, Multi Swarm PSO, Ant Colony Optimizations, Bee Metaheuristics – Introduction, Artificial Bee Colony Algorithm, Marriage in Honeybees Optimization, Bee Colony Optimization.

Module: 5	Natural Metaheuristics	8 Hours

Swarm Intelligence – Glowworm Based Optimization, Group Search Optimization, Shuffled Frog Leaping, Collective Animal Search, Cuckoo Search, Bat Algorithm, Swarm Intelligence Inspired by Animal Behaviors, Plant Based Metaheuristics, Search Based on Human Behaviors – Seeker Optimization Algorithm, Teaching Learning Based Optimization, Imperialist Competitive Algorithm.

Module: 6	Advanced Optimization	8 Hours

Dynamic Optimization, Multimodal Optimization, Constrained Optimization, Multiobjective Optimization – Multiobjective Evolutionary Algorithms, Performance Metrics, Many Objective Optimization, Multiobjective PSO, Multiobjective EDAs.

Total Lectures	45 Hours

Text Books

1	Ke-Lin Du. M.N.S Swamy. (2018). *Search and Optimization by Metaheuristics: Techniques and Algorithms Inspired by Nature*.ISBN: 978-3-319-41191-0.
2	Xin-She Yang. Springer. (2019). *Swarm Intelligence: Principles. Advances. And Applications*. ISBN: 978-0367737542.

Reference Books

1	Thomas Bäck. (2021). *Evolutionary Algorithms in Theory and Practice*. Oxford University Press. ISBN: 978-0195099713.
2	Mauro Birattari. (2019). *Bio-Inspired Computation: A Review and Future Directions*. Academic Press. ISBN: 978-8126541256.
3	Michel Gendreau and Jean – Yves Potvin. (2019). *Handbook of Meta heuristics*. Springer. ISBN: 978-3030990817.
4	Xin-She Yang (2014). *Nature-Inspired Optimization Algorithms*. Elsevier. ISBN: 978-0124167452.
5	Blum C., Raidl, G. R. (2016). *Hybrid Metaheuristics: Powerful Tools for Optimization*. Germany. Springer International Publishing. ISBN: 978-3319308838.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Cloud Security Foundation Laboratory**	L	T	P	C
23DC2039		**0**	**0**	**3**	**1.5**

Course Objectives:

Enable the students to:
1. Demonstrate and access management features of AWS.
2. Perform secure network access to AWS resources.
3. Implement the available methods for encrypting data at rest and data in transit.

Course Outcomes:

The students will be able to:
1. Operate security benefits and responsibilities of using the Amazon Web Services (AWS) Cloud.
2. Demonstrate the identity and access management features of AWS.
3. Perform how to secure network access to AWS resources.
4. Implement the available methods for encrypting data at rest and data in transit.
5. Execute which AWS services can be used for monitoring and incident response.
6. Perform AWS techniques to respond and manage an incident

List of Exercises:

1. Introduction to security on AWS.
2. Securing access to cloud resources.
3. Securing cloud infrastructure.
4. Protecting data in application.
5. Logging and monitoring.
6. Responding to and managing an incident.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	**Deep Learning**	L	T	P	C
23DC2040		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate foundational concepts of neural networks
2. Apply Neural Networks to various classification and regression tasks
3. Analyze the emerging trends in Deep Learning

Course Outcomes:

The students will be able to:
1. Analyze various neural network architectures, including fully connected networks, convolutional neural networks, and recurrent neural networks.
2. Implement perceptron learning algorithms using linear algebra and understand gradient-based learning techniques.
3. Apply convolutional neural networks and transfer learning techniques to solve complex image classification problems using pre-trained models.
4. Demonstrate recurrent neural network models, including LSTMs, to predict time sequences and perform text auto-completion.
5. Evaluate the performance of natural language models and generate accurate word embeddings using word2vec and GloVe.
6. Design and implement sequence-to-sequence learning models and incorporate attention mechanisms and transformers for neural machine translation tasks.

Module: 1	**Introduction**	**8 Hours**

Rosenblatt perceptron - The perceptron learning algorithm - Implementing perceptrons with linear algebra - Gradient based learning

Module: 2	**Fully Connected Networks**	**8 Hours**

Fully connected networks applied to multiclass classification - DL framework and Network tweaks - Fully connected networks applied to Regression

Module: 3	**Convolutional Neural Networks**	**7 Hours**

Convolutional Neural Networks applied to image classification - Deeper CNN's and pretrained models – VGGNet – GoogLeNet – ResNet - Transfer Learning

Module: 4	Time Series models	7 Hours

Predicting time sequences with Recurrent Neural Network - LSTM - Text auto completion with LSTM and Beam search

Module: 5	Natural Language Models and word Embeddings	8 Hours

Natural Language models - n-gram model - skip gram model - Neural language model - Word embeddings from word2vec and GloVe

Module: 6	Sequence to sequence Networks , Attention and Transformers	7 Hours

Encoder - Decoder Model for Sequence - to-Sequence Learning - Introduction to the Keras Functional API - Programming Example: Neural Machine Translation - Attention and the transformer

Total Lectures	45 Hours

Text Books

1	Ekman, M. (2021). *Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, and Transformers Using TensorFlow*. United Kingdom: Pearson Education. ISBN-13 : 978-0137470358
2	Ian Goodfellow, YoshuaBengio, Aaron Courville.(2016). "*Deep Learning*". MIT Press.(1st Edition) . ISBN: 9780262035613

Reference Books

1	Seth Weidman.(2019). *Deep Learning from Scratch: Building with Python from First Principles. O'Reilly publications.(ebok)*. ISBN: 9781492041412
2	Michael Nielsen.(2015). *Neural Networks and Deep Learning* . Determination Press.
3	Wani, M. Arif., Bhat, Farooq Ahmad., Afzal, Saduf., Khan, Asif Iqbal.(2019.). *Advances in Deep Learning*. Springer Nature Singapore.(ebook).ISBN:9789811367946, 9811367949
4	Francois Chollet.(2021). *Deep Learning with Python.*(2nd Edition). Manning Publications. ISBN: 9781617298823.
5	Aston Zhang., Zachary C., Lipton., Mu Li., Alexander J. Smola.(2019). *Dive into Deep Learning*. ISBN: 9780262043552.

Recommended by Board of Studies	
Approved by Academic Council	20.08.2024

Course Code	Deep Learning Laboratory	L	T	P	C
23DC2041		0	0	3	1.5

Course Objectives:

Enable the students to:
1. Implement various neural network architectures and algorithms from scratch
2. Demonstrate neural network models using appropriate performance metrics
3. Develop advanced deep learning frameworks (e.g., TensorFlow, Keras) and tools to build, train, and deploy sophisticated models for diverse applications

Course Outcomes:

The students will be able to:
1. Implement various foundational and advanced neural network algorithms to solve classification, regression, and sequence prediction problems.
2. Demonstrate analyze the performance of different neural network models by interpreting evaluation metrics
3. Apply and fine-tune optimization techniques to improve model effectiveness.
4. Construct complex neural network architectures using deep learning frameworks like TensorFlow and Keras
5. Develop practical solutions for real-world applications, such as image classification, time series forecasting, and natural language processing tasks
6. Design, train, and deploy robust models for diverse AI applications.

List of Exercises:

1. Build and train a fully connected neural network for a multiclass classification problem using a dataset like MNIST.
2. Implement a fully connected neural network for a regression task, such as predicting house prices.
3. Construct and train a CNN on an image classification dataset like CIFAR-10.
4. Use a pretrained model (e.g., VGGNet, ResNet) to classify images in a new dataset.
5. Implement an RNN to predict future values in a time series dataset (e.g., stock prices).
6. Train an LSTM network for text generation using a dataset like Shakespeare's works.
7. Train word2vec and GloVe models on a text corpus.
8. Implement an encoder-decoder model for a sequence-to-sequence task, such as translating text from one language to another.
9. Implement a simple transformer model for a text classification task.
10. Build a neural machine translation model using the Keras Functional API. Train the model on a parallel text dataset (e.g., English to French) and evaluate translation quality using BLEU scores.

Recommended by Board of Studies	
Approved by Academic Council	**20.08.2024**

Course Code	Theory of Computation	L	T	P	C
23DC2042		3	0	0	3

Course Objectives:
1. Illustrate the logical and mathematical foundations of computer science.
2. Analyze various abstract models of computation.
3. Apply the mathematical concepts to solve computational problems.

Course Outcomes:

The student will be able to
1. Demonstrate the concept of languages and grammars.
2. Assess deterministic and non-deterministic finite automata.
3. Analyze push down automata from a given context free language or context free grammar.
4. Evaluate the context sensitive grammars.
5. Design turing machine for recursively enumerable language
6. Develop solutions for undecidability problems

Module: 1	Introduction and Computational Complexity	8 Hours

Alphabet - strings - languages and grammars - productions and derivation - Chomsky hierarchy of languages - Computational Complexity - Efficiency of Computation - Turing Machine model and complexity - The complexity classes P and NP - Polynomial - Time Reduction.

Module: 2	Regular Languages and Finite Automata	8 Hours

Regular expressions and languages - deterministic finite automata (DFA) & equivalence with regular expressions - nondeterministic finite automata (NFA) & equivalence with DFA - regular grammars & equivalence with finite automata - properties of regular languages - pumping lemma for regular languages - minimization of finite automata.

Module: 3	Context-Free Languages and Pushdown	7 Hours

Named Entity Recognition by Parsing XML - Tower of Hanoi using PushDown Automata - Palindrome checking - Context-free grammars (CFG) and languages (CFL) - Chomsky and Greibach normal forms - nondeterministic pushdown automata (PDA) and equivalence with CFG - parse trees - ambiguity in CFG - pumping lemma for context-free languages - deterministic pushdown automata - closure properties of CFLs.

Module: 4	Context-Sensitive Languages	6 Hours

Context-sensitive grammars (CSG) and languages - linear bounded automata and equivalence with CSG.

Module: 5	Turing Machines	9 Hours

Turing Test in Artificial Intelligence - Design of a Calculator using Turing Machine - List Appending - The basic model for Turing machines (TM) - Turing recognizable (recursively enumerable) and Turing decidable (recursive) languages and their closure properties - variants of Turing machines - nondeterministic TMs and equivalence with deterministic TMs - unrestricted grammars and equivalence with Turing machines - TMs as enumerators.

Module: 6	Undecidability	7 Hours

Non Recursive Enumerable (RE) Language - Undecidable Problem with RE - Undecidable Problems about TM - Post's Correspondence Problem - The Class P and NP problems	
Total Lectures	**45 Hours**

Text Books	
1	Peter Linz.(2022). *An introduction to Formal Languages and Automata.* (7th Edition). Jones & Bartlett Learning. ISBN: 9781284231618
2	Ding- Zhu Du, Donglei Du, Chenchen Wu, Dachuan Xu.(2022). *Theory and Applications of Models of Computation.* Springer. **I**SBN:9783031203503, 303120350X

Reference Books	
1	Harry R. Lewis and Christos H. Papadimitriou.(2015).*"Elements of the Theory of Computation"*, (2nd Edition). Pearson Education Asia. ISBN 9789332549890.
2	Dexter C. Kozen.(2012). "*Automata and Computability,*" Undergraduate Texts in Computer Science, Springer. ISBN 9781461273097.
3	John Martin.(2009).*Introduction to Languages and The Theory of Computation*.(3rd Edition). Tata McGraw Hill. ISBN 9780070660489.
4	John E. Hopcroft., Rajeev Motwani., Jeffrey D. Ullman.(2007). "*Introduction to Automata Theory, Languages, and Computation*".(3rd Edition), Pearson Education. ISBN: 9780321462251.
5	Michael Sipser.(2012). *Introduction to the Theory of Computation .(3rd Edition).* Cengage Learning. ISBN: 9781111130590.

Recommended by Board of Studies	
Approved by Academic Council	20.08.2024

Course Code	**Cloud computing for Data Analytics**	**L**	**T**	**P**	**C**
23DC2043		**3**	**0**	**0**	**3**

Course Objectives:

Enable the students to:
1. Illustrate foundational cloud computing principles
2. Demonstrate the skills in cloud platform onboarding and management with practical experience
3. Analyze various advanced cloud technologies and managed machine learning systems.

Course Outcomes:

The students will be able to:
7. Illustrate the foundational concepts of cloud computing, including PaaS, Infrastructure as Code, and continuous delivery principles, and demonstrate setting up a Hugo static site.
8. Demonstrate cloud onboarding processes for AWS, GCP, and Azure, and utilize tools like Docker and CircleCI to achieve continuous integration.
9. Analyze virtualization and containerization technologies such as Docker and Kubernetes, including their application in hybrid and multi-cloud environments.
10. Design and implement effective cloud storage solutions, addressing challenges in distributive computing, data governance, and various types of databases.
11. Develop serverless applications using technologies like AWS Lambda and Google Cloud Functions, focusing on ETL processes and solving real-world data integration problems.
12. Evaluate various managed machine learning platforms such as AWS Sagemaker and Google AutoML, and apply these tools to practical data analytics projects.

Module: 1	**Cloud Computing Foundations**	**7 Hours**

Introduction – Paas Continuous Delivery - Infrastructure as Code – Continuous delivery and Continuous deployment – Continuous delivery for hugo static site from Zero.

Module: 2	**Cloud on boarding for AWS, GCP and Azure**	**7 Hours**

Amazon Web Services – Microsoft Azure – Google cloud Platform – case study :Setup cloud environment continuous integration from zero with Docker and CircleCi

Module: 3	**Virtualization & Containerization & Elasticity**	**8 Hours**

Elastic Resources – Container: Docker - Container Registries – Kubernetes in the cloud – Hybrid and Multi cloud Kubernetes – Running Kubernetes locally with Docker Desktop and skylearn flask-Operationalizing a micro service Overview – Creating a locust load test with flask – Server less Best Practices – Disaster Recovery and Backups for Microservices.

Module: 4	Cloud Storage	8 Hours

Challenges and Opportunities in Distributive Computing – Cloud storage types – Data Governance – Cloud Database – Key value Databases – Graph Databases – Batch vs Streaming Data and Machine learning – Cloud Data warehouse – GCP Big Query.

Module: 5	Server less ETL Technologies	8 Hours

AWS Lambda – Developing AWS Lambda functions - Function as a service - Chalice Framework on AWS Lambda – Google cloud functions – Cloud ETL – Real world problems with ETL building a social network from scratch

Module: 6	Managed Machine Learning System	7 Hours

Jupyter Notebook workflow – AWS sagemaker Overview – AWS Sagemaker Elastic Architecture –Azure ML Studio overview - Google AutoML computer vision – Data Analytics case Studies and Projects.

Total Lectures		45 Hours

Text Books

1	Noah Gift (2021). *Cloud Computing for Data Analysis: The Missing Semester for Data Science. (6th Edition).* O'Reilly Media. ISBN: 978-1098119642.
2	**Jules J. Berman (2018).** *Data Analytics in the Cloud: Models, Techniques, and Applications.***(1st Edition). Elsevier. ISBN: 978-0128148117.**

Reference Books

1	**Arvind Panagariya, Ajay Shankar, and Shivendra Panwar (2020).** *Cloud Data Design, Orchestration, and Management Using Microsoft Azure.* (1st Edition). Apress. ISBN: 978-1484258156.
2	Ramuka, M. (2019). *Data Analytics with Google Cloud Platform: Build Real Time Data Analytics on Google Cloud Platform.* (1st Edition). BPB. ISBN:9789389423631, 9389423635
3	Syed Thouheed Ahmed, Syed Muzamil Basha, Sajeev Ram Arumugam, Kiran Kumari Patil.(2021). *Big Data Analytics and Cloud Computing: A Beginner's Guide.*(ebook).MileStone Research Publications. ISBN:9789354738289, 9354738281
4	Rajesh Kumar.(2021). *Azure Data Engineering.* Packt Publishing. ISBN: 9781800562910
5	Thomas Erl, Ricardo Puttini, Zaigham Mahmood.(2013). *Cloud Computing: Concepts, Technology & Architecture.*(1st Edition). Pearson Education. ISBN: 978-0133439623.

Recommended by Board of Studies	
Approved by Academic Council	20.08.2024

SKILL BASED COURSES

Course Code	Exploratory Data Analysis Using Tableau	L	T	P	C
23DC2501		0	0	2	1

Course Objectives:

Enable the students to:
1. Analyse and visualize data using Tableau.
2. Illustrate the Tableau's capabilities for comprehensive data analysis
3. Assess patterns, and communicate findings effectively through data analysis and visualization using Tableau.

Course Outcomes:

The students will be able to:
1. Analyze and interpret data.
2. Apply the Tableau for data pre-processing tasks.
3. Demonstrate statistical analysis using Tableau.
4. Implement the forecasting techniques to predict future outcomes

5. Create bar charts, line charts, scatter plots, and histograms.
6. Construct interactive maps for visualizing geospatial data.

List of Exercises	

1. Data Analysis and Exploration using Tableau
2. Preprocess a dataset in Tableau and perform aggregation operations to summarize data at different levels of granularity. Statistical Analysis.
3. Conduct statistical analysis to identify correlations and dependencies between variables.
4. Build predictive models by applying techniques such as forecasting and trend analysis to predict future outcomes.
5. Create basic visualizations in Tableau to represent different aspects of the data
6. Use Tableau to build interactive maps visualizing geospatial data.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Docker and Kubernetes Laboratory	L	T	P	C
23DC2502		0	0	2	1

Course Objectives:

Enable the students to:
1. Illustrate the fundamentals of containerization using Docker and its role in modern software development and deployment.
2. Apply Kubernetes architecture and its core components to effectively orchestrate containerized applications.
3. Experiment with Helm and Custom Resource Definitions (CRDs) to streamline deployment and management of complex applications in Kubernetes environments.

Course Outcomes:

The students will be able to:
1. Identify the process of packaging an application using Docker, creating Dockerfiles, and Docker images efficiently.
2. Demonstrate competence in Kubernetes architecture, including the control-plane and data-plane components
3. Develop web applications using open-source Docker images from DockerHub
4. Employ Helm to simplify the deployment and management of web applications within Kubernetes clusters, utilizing Helm charts.
5. Apply the Custom Resource Definitions (CRDs) for extending the Kubernetes API
6. Design and implement a control-plane and data-plane architecture within Kubernetes.

List of Exercises	

1. Introduction to Docker and packaging an application with docker
2. Introduction to Kubernetes architecture and building a web-app with open-source docker images from dockerHub
3. Introduction to Helm and launching web-apps with Helm
4. Developing a Custom Resource Definition (CRD) 1
5. Developing a Custom Resource Definition (CRD) 2
6. Control-plane and Data-plane architecture (having 1 control-plane namespace configuring Multiple Data-plane namespaces)

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Cloud Foundations	L	T	P	C
23DC2503		0	0	2	1

Course Objectives:

Enable the students to:
1. Analyze the global infrastructure components of AWS.
2. Demonstrate applications over commercial cloud computing infrastructures such as AWS.
3. Analyze the security and privacy issues in cloud computing.

Course Outcomes:

The students will be able to:
1. Demonstrate the global infrastructure components of AWS.
2. Implement security and compliance measures of the AWS Cloud.
3. Create an AWS Virtual Private Cloud (Amazon VPC).
4. Demonstrate when to use Amazon Elastic Compute Cloud (EC2), AWS Lambda and AWS Elastic Beanstalk.
5. Execute the AWS Database services for various use cases.
6. Implement key concepts related to Elastic Load Balancing (ELB), Amazon CloudWatch, and Auto Scaling.

List of Exercises:

1. AWS Global Infrastructure Overview
2. AWS Cloud Security
3. Networking and Content Delivery
4. Compute
5. Storage
6. Databases
7. Cloud Architecture
8. Automatic Scaling and Monitoring

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	Data Engineering Processes and Tools	L	T	P	C
23DC2504		**0**	**0**	**2**	**1**

Course Objectives:

Enable the students to:
1. Execute decisions about the infrastructure of a data pipeline.
2. Illustrate a data pipeline by using AWS services to meet a generalized use case.
3. Develop scaling considerations for building pipelines that handle large-scale datasets.

Course Outcomes:

The students will be able to:
1. Apply the role and value of data science in a data-driven organization.
2. Demonstrate the suitable data storage option for a given data analytics use case.
3. Operate all data formats in a data pipeline that is built with AWS.
4. Implement the concept of MapReduce and how Amazon EMR is used in big data pipelines.
5. Analyze data by using AWS tools that are appropriate to a given use case.
6. Implement the data visualization solution that is aligned to an audience and data type.

List of Exercises:

1. Hydrating the data lake via DMS.
2. Transforming in the data lake with Glue.
3. Consuming the data lake with Athena & QuickSight.
4. Machine learning in the data lake.
5. AWS Lake Formation Lab.
6. Modernize Data Warehouse with Amazon Redshift Spectrum.
7. Apache Hadoop on Amazon EMRLinks to an external site.
8. Processing, analyzing and visualizing data for ML.

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024

Course Code	AI Practitioner Laboratory	L	T	P	C
23DC2505		**0**	**0**	**2**	**1**

Course Objectives:

Enable the students to:
1. Execute AI models using Watson Studio
2. Demonstrate the techniques for optimizing and validating AI models using AutoAI to improve efficiency and accuracy in model development.

3.	Develop proficiency in utilizing Watson Natural Language Understanding (NLU) for conducting sentiment analysis and extracting insights from textual data.

Course Outcomes:

The students will be able to:

1. Demonstrate AI models using Watson Studio, including tasks such as data preparation, model training, and deployment
2. Integrate the ability to optimize and validate AI models using AutoAI
3. Demonstrate sentiment analysis using Watson NLU
4. Develop proficiency in predicting outcomes using regression algorithms,
5. Design marketing emails using WatsonX,
6. Develop applications to extract sentiment from textual data using WatsonX.

List of Exercises

1. Run AI Models with Watson Studio
2. Optimize and Validate Using AutoAI
3. Conducting Sentiment Analysis with Watson NLU
4. Predicting with Regression Algorithms
5. Generating Marketing Emails with WatsonX
6. Extracting Sentiment with WatsonX
7. Developing the Smartest Chatbot in the Room

Exercises from the above list will be approved by the HoD during the start of the semester

Recommended by Board of Studies	24.04.2024
Approved by Academic Council	11.05.2024