AUTONOMY SCHEME

Sr. No.	Heading	Particulars
1	Title of the Course	Computer Science and Engineering (Data Science)
2	Eligibility for Admission	As per the Institute Examination Ordinance
3	Theory Passing Marks (IAE / ESE)	40%
4	Continuous Assessment (CA) / Oral / Practical	50%
5	To be implemented from Academic Year	With effect from Academic Year: 2026-27
6	Total Credits	Maximum 168
7	Honor / Minor Courses offered	• Additional Credits: 18 • Offered via MOOCs
8	Eligibility Criteria for Honor / Minor	• Students with no backlog in semester I, II and III. • The CGPI based on Semester I, II and III of the students must be 6.75 and above. • For Direct Second Year (DSE) Students – No backlog in semester III and CGPI must be 6.75 and above.

Preface

University Grants Commission vide Letter No. F. 2–10/2023 (AC–Policy) dated 19th January 2024 conferred the autonomous status to St. John College of Engineering and Management, Village Vevoor, Manor Road, Palghar (East), 401404 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations 2023. Designing the curriculum as an autonomous institution raises challenges pertaining to maintaining quality engineering education.

Systematic approach has been adapted in the design and implementation of curriculum with the intent of ensuring quality education catering to the sensitive needs of a learner, society, and industry. The curriculum is aligned with NEP and UGC guidelines as per Government of Maharashtra guidelines for autonomous institutions Government Resolution dated 4th July 2023.

Based on recent recommendations of the GR, holistic curriculum for 2026-30, a "H-Tree Model" of Engineering Education is offered. A unique "H-Tree Model" of Engineering Education Curriculum is followed, and curriculum is designed to systematically develop IQ (Intelligence Quotient), PQ (Physical Quotient), EQ (Emotional Quotient), and SQ (Spiritual Quotient) of a learner. This curriculum aims at the development of an all-rounded personality with holistic approach to education in which a learner receives 34% teacher-led learning, 15% peer learning, 26% self-learning, and 25% experiential learning. The curriculum model is outcome based that focuses on learning by doing. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. It ensures multiple choices to a leaner acquiring skills through systematic planning. It has 7 verticals aligned to GR recommendations with strong science and mathematics foundation and program core, sequel of electives, multidisciplinary minor courses, humanities & management courses, and sufficient experiential learning through projects and semester-long industry/research internship along with employable skill-based courses. A learner gets an opportunity to acquire skills through NSDC aligned courses during summer vacations. Additional options of choosing from Honors/Double Minor/Honors with Research are also provided to a learner.

The curriculum balances contact hours and total credits of the entire program. The total credits are 168, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore, in the present curriculum, skill-based laboratories, mini-projects, multi-disciplinary projects, and internships are made mandatory across all disciplines of engineering, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the scheme and syllabus are in line with AICTE model curriculum. SJCEM: R-25 (Second Year) and SJCEM: R-24C (Third and Final Year) curriculum will be implemented in Computer Science and Engineering (Data Science) from the academic year 2026-27.

Nomenclature

Abbreviation	Title
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC	Program Elective Courses
MDM	Multidisciplinary Minor
OE	Open Elective
SC	Skill Courses
LLC	Liberal Learning Courses
VSEC	Vocational and Skill Enhancement Course
VEC	Value Education Course
SEC	Skill Enhancement Courses
AEC	Ability Enhancement Course
IKS	Indian Knowledge System
CC	Co-curricular Courses

Credit Specification:

- Theory: 1 credit = 15 hours of teaching
- Lab: 1 Credit = 30 hours of lab work.
- Workshop Based Activities: 1 Credit = 30 hours of hands-on activities related to vocation/professional practice/skill based
- Seminar/Group Discussion: 1 Credit = 15 hours of participation
- Community Engagement Projects: 1 Credit = 30 hours of contact time along with 15 hours of activities preparation, report writing, independent reading etc. (Total 45 hours)

Mrs. Joslyn Gracias
BoS Chairman

Dr. Kamal Shah
Principal

Evaluation and Assessment Scheme

A. Internal Assessment Examination (IAE)

Theory Credit	Component	Details	Marks	Duration
2 or 3	IAE 1	Covers any 3 Course Outcomes (COs)	20 Marks	1 Hour
	IAE 2	Covers remaining 3 Course Outcomes (COs)	20 Marks	1 Hour
1	IAE 1	Covers any 3 Course Outcomes (COs)	10 Marks	30 Minutes
	IAE 2	Covers remaining 3 Course Outcomes (COs)	10 Marks	30 Minutes

B. End Semester Theory Examination (ESE)

Theory Credits	Component	Details	Marks	Duration
2 or 3	ESE	Based on entire syllabus	60 Marks	2 Hours
1	ESE	Based on entire syllabus	30 Marks	1 Hour

C. Continuous Assessment (CA)

Component	Details	Marks
Experiments / Tutorials	8 to 10 experiments covering all COs	10 Marks
Attendance	Theory & Practical attendance	05 Marks
Teacher Assessment Examination (TAE)	Anyone/more activity from listed options	10 Marks

TAE Activity Options

Sr. No.	Activity
1	Assignment
2	Case Study
3	Debate
4	Solution for Social Problems
5	Field Visit
6	Group Project
7	Flip Classroom
8	Topic Review
9	Quiz
10	Mind Mapping
11	Research Paper Review
12	Any other (as per subject need)

D. Oral & Practical Examination

Component	Details	Marks
Practical / Implementation/ written test	Based on Experiments performed	15 Marks
Oral Exam	Based on Syllabus / Experiments	10 Marks

SUSTAINABLE DEVELOPMENT GOALS (SDGs)

Bachelor of Technology

In

Computer Science & Engineering (Data Science)

Second Year
Semester – III

SJCEM : R–25

Effective from Academic Year 2026-27

Program Structure for Second Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)

Semester III

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
25CSDSPCC301	PCC	Discrete Mathematics	3	1	-	3	1	-	4
25CSDSPCC302	PCC	Data Structures	3	-	2	3	-	1	4
25CSDSPCC303	PCC	Microprocessor and Computer Architecture	3	-	2	3	-	1	4
25CSDSPCC304	PCC	Database Management System	3	-	2	3	-	1	4
25CSDSPCC305	PCC	Programming Language I: (Python)	1	-	2	1	-	1	2
25CSDSVEC301	VEC	Universal Human Values	2	1	-	2	1	-	3
25CSDSAEC301	AEC	Employability Enhancement Program – I (Communication)	-	1	-	-	1	-	1
		Total	**15**	**3**	**8**	**15**	**3**	**4**	**22**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/ PR	Total
25CSDSPCC301	PCC	Discrete Mathematics	20	20	60	25	-	125
25CSDSPCC302	PCC	Data Structures	20	20	60	25	25	150
25CSDSPCC303	PCC	Microprocessor & Computer Architecture	20	20	60	25	-	125
25CSDSPCC304	PCC	Database Management System	20	20	60	25	25	150
25CSDSPCC305	PCC	Programming LanguageI (Python)	10	10	30	25	25	100
25CSDSVEC301	VEC	Universal Human Values	10	10	30	25	-	75
25CSDSAEC301	AEC	Employability Enhancement Program – I (Communication)	-	-	-	25	-	25
		Total	**100**	**100**	**300**	**175**	**75**	**750**

Syllabus

for

Second Year

Computer Science & Engineering (Data Science)

Semester – III

SJCEM : R–25

(With Effect from 2026-27)

Course Title: Discrete Mathematics												
Semester: III			Term: ODD				Course Code: 25CSDSPCC301					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	1	-	3	1	-	4	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed

1. To cultivate clear thinking and creative problem solving.
2. To define functions and distinguish between functions and relations.
3. Define partial order relations and lattices and understand their properties.
4. Define orthogonal sets and orthonormal bases and understand their importance in applications such as signal processing and linear algebra.
5. To study the Matrix algebra and its application in Engineering Problems.
6. To understand the concept of Fourier series and enhance problem-solving skills.

Course Outcomes:

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

1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2. Define and differentiate between relations and functions, and identify different types of functions.
3. Apply concepts of lattices to solve problems in various areas, such as discrete mathematics, computer science, and order theory.
4. Define the inner product of vectors, orthogonal bases.
5. Apply the concepts of eigenvalues and eigenvectors to solve engineering problems.
6. Demonstrate the Fourier series to study the behavior of periodic functions and their applications in system communications, digital signal processing and field theory.

Module	Contents	Hours	Cos
I	**Logic** Propositional Logic, Predicate Logic, Laws of Logic, Duality, Quantifiers, Binary Predicates, Mathematical Induction. **Self-learning Topics:** Normal Forms, Inference Theory of Predicate Calculus	7	CO1
II	**Relations and Functions** Basic concepts of Set Theory, **Relations:** Definition, Types of Relations, Representation of Relations, Closures of Relations, Warshall's algorithm, Equivalence relations and Equivalence Classes. **Functions:** Definition, Types of functions, Composition of functions, Identity and Inverse function **Self-learning Topics:** Operations on Relations- complementary relation, Inverse relation, Intersection and Union	8	CO2
III	**Posets and Lattice** Partial Order Relations, Poset, Supremum and Infimum, Hasse Diagram, Lattice, Types of Lattice- Sub -lattice, Distributive lattice. **Self-learning Topics:** Dual of Poset, Dual in a Lattice, Bounded lattice, Complemented lattice	8	CO3
IV	**Linear Algebra-I** Vector Arithmetic, Norm, Euclidean Inner Product, Unit vector, Angle between two vectors, Cauchy-Schwarz Inequality, Orthogonality, Orthogonal Set, Orthonormal set, Gram-Schmidt Process **Self-learning Topics:** Orthogonal Projection	7	CO4
V	**Linear Algebra-II** Characteristic Equation, Eigenvalues and Eigenvectors and properties (without proof), Cayley-Hamilton Theorem (without proof), verification and reduction of higher degree polynomials, Similarity of matrices, diagonalizable and non-diagonalizable matrices **Self-learning Topics:** Derogatory and non-derogatory matrices, Functions of Square Matrix, Linear Transformations, Quadratic forms.	8	CO5

Reference Books:

1. Advanced Engineering Mathematics, C. Ray Wylie, Louis C. Barrett, McGraw- Hill Book Co., New York, 6th Edition.
2. Y N Singh, "Discrete Mathematical Structures", Wiley-India

Text Books:

1. Higher Engineering Mathematics, Dr. B .S. Grewal, Khanna Publication, 44th Edition.
2. Linear Algebra & its applications, David C. Lay, Pearson Publication, 3rd Edition.
3. Bernad Kolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman,

Useful Links

1. https://www.edx.org/learn/discrete-mathematics
2. https://www.coursera.org/specializations/discrete-mathematics
3. https://nptel.ac.in/courses/106/106/106106094

Course Title: Data Structures												
Semester: III			Term: ODD				Course Code: 25CSDSPCC302					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives: The course aims

1. To understand the standard and abstract data representation methods.
2. To acquaint with the structural constraints and advantages in usage of the data.
3. To understand the memory requirement for various data structures.
4. To operate on the various structured data.
5. To understand various data searching and sorting methods with pros and cons.
6. To understand various algorithmic strategies to approach the problem solution.

Course Outcomes:

At the end of the course students will be able:

1. Apply linear and non-linear data structures to solve computational problems.
2. Design solutions using stacks and queues for programming applications.
3. Implement linked list structures for efficient data management.
4. Apply tree operations and traversals in problem-solving scenarios.
5. Implement graph operations and traversals for real-world applications.
6. Select and apply appropriate searching and sorting techniques for application development.

Module	Contents	Hours	Cos
I	**Introduction to Data Structures:** Concept of ADT, Types of Data Structures- Linear and Nonlinear, Operations on Data Structures. Arrays, Multidimensional Arrays, Array of Pointers, String Manipulation. **Self-Learning:** Structures with pointers	5	CO1
II	**Stack and Queues:** **Stack:** Introduction, ADT of Stack, Operations on Stack, Array Implementation of Stack, Applications of Stack-Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation, Recursion. **Queue:** Introduction, ADT of Queue, Operations on Queue, Array Implementation of Queue, Types of Queue-Circular Queue, Priority Queue, Introduction of Double Ended Queue, Applications of Queue. **Self-learning:** Implementation of stack and queue using structure	9	CO2
III	**Linked List:** Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List, Circular Linked List, Doubly Linked List, Operations on Singly Linked List and Doubly Linked List, Stack and Queue using Singly Linked List, **Self-Learning:** Singly Linked List Application-Polynomial Representation and Addition.	9	CO3
IV	**Trees:** Introduction, Tree Terminologies, Binary Tree, Binary Tree Representation, Types of Binary Tree, Binary Tree Traversals, Binary Search Tree, Operations on Binary Search Tree, Applications of Binary Tree-Expression Tree, Huffman Encoding, Search Trees-AVL, rotations in AVL Tree, operations on AVL Tree, Introduction of B Tree, B+ Tree. **Self-Learning:** Red-Black trees	9	CO4
V	**Graphs:** Introduction, Graph Terminologies, Representation of Graph, Graph Traversals - Depth First Search (DFS) and Breadth First Search (BFS), **Self-Learning:** Graph Application- Topological Sorting.	5	CO5

VI	**Sorting and Searching Techniques:** Sorting Techniques: Bubble sort, insertion sort, selection sort Searching Techniques: Linear Search, Binary Search Hashing-Concept, Hash Functions, Collision resolution Techniques **Self-Learning:** Merge sort and quick sort.	8	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Implement Stack ADT using array.	CO1, CO2
2	Convert an Infix expression to Postfix expression using stack ADT.	CO2
3	Evaluate Postfix Expression using Stack ADT.	CO2
4	Implement Linear Queue ADT using array.	CO2
5	Implement Circular Queue ADT using array.	CO2
6	Implement Priority Queue ADT using array.	CO2
7	Implement Singly Linked List ADT.	CO3
8	Implement Circular Linked List ADT.	CO3
9	Implement Doubly Linked List ADT.	CO3
10	Implement Stack / Linear Queue ADT using Linked List.	CO3
11*	Implement Binary Search Tree ADT using Linked List.	CO4
12*	Implement Graph Traversal techniques: a) Depth First Search b) Breadth First Search	CO5
13	Applications of Binary Search Technique.	CO6
14	Implement of Selection and Bubble Sort	CO6
15	Implement of Merge / Quick Sort	CO6

Reference Books:

1. Rajesh K. Shukla, *Data Structures Using C and C++*, Wiley-India.
2. E. Balagurusamy, *Data Structure Using C*, Tata McGraw-Hill Education India.
3. Robert Kruse, C. L. Tondo, Bruce Leung, *Data Structures and Program Design in C*, Pearson Edition.
4. Prof. P. S. Deshpande, Prof. O. G. Kakde, *C and Data Structures*, DreamTech Press

Text Books:

1. Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein, *Data Structures Using C*, Pearson Publication.
2. Jean Paul Tremblay, P. G. Sorenson, *Introduction to Data Structure and Its Applications*, McGraw-Hill Higher Education.
3. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, 2nd Edition, CENGAGE Learning.
4. ISRD Group, *Data Structures Using C*, 2nd Edition, Tata McGraw-Hill.

Useful Links

1. https://swayam.gov.in/nd1_noc19_cs67/preview
2. https://nptel.ac.in/courses/106/102/106102064/
3. https://www.edx.org/course/data-structures-fundamental

Course Title: Microprocessor and Computer Architecture												
Semester: III			Term: ODD				Course Code: 25CSDSPCC303					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To conceptualize the basics of organizational and features of a digital computer.
2. To study microprocessor architecture and assembly language programming.
3. To equip students with the fundamental knowledge and basic technical competence in the field of Microprocessors.
4. To emphasize on instruction set and logic to build assembly language programs.
5. To prepare students for higher processor architectures and embedded systems.
6. To prepare students for learning various threading technologies.

Course Outcomes:

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

1. Explain the organization of a computer system and develop assembly language programs using the 8086 microprocessor.
2. Analyze control unit design techniques and instruction-level parallelism concepts.
3. Apply the core concepts and programming features of the 8086 microprocessor.
4. Identify and evaluate the specifications of peripheral interfacing chips.
5. Design 8086-based systems using memory and peripheral devices.
6. Explain advanced processor architectures and hyper-threading technology.

Module	Contents	Hours	COs
I	**Overview of Computer architecture and Organization** Introduction of Computer Organization and Architecture, Von Neumann Model, Performance Measure of Computer Architecture. Architecture of 8086 Family, Instruction Set, Addressing Modes. **Self-learning Topics:** Basic Organization of Computer and Block Level Description of the Functional Units, Evolution of Computers	5	CO1
II	**Processor organization and architecture** CPU Architecture, Instruction Formats, Basic Instruction Cycle with Interrupt Processing. Control Unit: Soft Wired (Microprogrammed) and Hardwired Control Unit. Microinstruction Sequencing and Execution, Micro Operations, Introduction to Parallel Processing Concepts, Flynn's Classifications, Instruction Pipelining, Pipeline Hazards. **Self-learning Topics:** Instruction Interpretation and Sequencing, Concepts of Nano Programming.	7	CO2
III	**The Intel microprocessors 8086 architecture** 8086CPU Architecture, Programmer's Model, Functional Pin Diagram. Memory Segmentation, Banking in 8086, Functioning of 8086 in Minimum mode and Maximum mode. Timing diagrams for Read and Write operations in minimum and maximum mode. **Self-learning Topics:** De-multiplexing of Address/Data bus, Interrupt structure and its servicing.	8	CO3
IV	**Memory and peripherals Interfacing** Memory Interfacing - RAM and ROM Decoding, 8255-PPI-Block diagram, CWR, operating modes, interfacing with 8086. 8257-DMAC-Block diagram, DMA operations and transfer modes. Programmable Interrupt Controller 8259-Block Diagram. **Self-learning Topics:** Techniques Partial and Absolute, Interfacing the 8259 in single and cascaded mode.	10	CO4

V	**80386Dx processor and Pentium processor** Architecture of 80386 microprocessor. 80386 registers-General purpose Registers, EFLAGS and Control registers. Real mode, Protected mode, virtual 8086 mode. Pentium Architecture, Superscalar Operation, Integer &Floating-Point. Pipeline Stages, Branch Prediction Logic. **Self-learning Topics:** 80386 memory management in Protected Mode Descriptors and selectors, descriptor tables, the memory paging mechanism, Cache Organization and MESI protocol.	10	CO5
VI	**Pentium 4 and ARM processor** Comparative study of 8086, 80386, Pentium 1, Pentium II and Pentium. Pentium 4: Net burst micro architecture. Instruction translation look aside buffer and branch prediction, Hyper threading technology and its use in Pentium 4, Recap of modules, Outcomes, Applications and summarization. **Self-learning Topics:** Application and Features of ARM processors**.**	5	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	COs
1	Use of programming tools (Debug/TASM/MASM/8086kit) to perform basic arithmetic operations on 8-bit/16-bit data.	CO1
2	Assembly programming for 16-bit addition, subtraction, multiplication and division (menu based)	CO1, CO2
3	Assembly program based on string instructions (overlapping/non-overlapping block transfer/ string search/ string length).	CO1, CO2
4	Assembly program to display the contents of the flag register.	CO2, CO3
5	Any Mixed Language programs.	CO2, CO3
6	Assembly program to sort numbers in ascending/ descending order.	CO3, CO4

7	Assembly program to find minimum/maximum number from a given array.	CO3, CO4
8	Assembly program using macro.	CO4, CO5
9	Program and interfacing using 8255.	CO5, CO6
10	Program and interfacing of ADC/DAC/ Stepper motor.	CO5, CO6

Reference Books:

1. B. Govindarajulu, *Computer Architecture and Organization: Design Principles and Applications*.
2. Barry B. Brey, *Intel Microprocessors*, 8th Edition, Pearson Education.
3. James Antonakos, *The Pentium Microprocessor*, Pearson Education.
4. Douglas Hall, *Microprocessor and Interfacing*, Tata McGraw Hill

Text Books:

1. I. C. Hamacher, Z. Vranesic and S. Zaky, *Computer Organization*, McGraw Hill.
2. W. Stallings, *Computer Organization and Architecture: Designing for Performance*, Pearson.
3. John Uffenbeck, *8086/8088 Family: Design, Programming and Interfacing*, PHI.
4. Yu-Cheng Liu and Glenn A. Gibson, *Microcomputer System: The 8086/8088 Family, Architecture, Programming and Design*, Prentice Hall.
5. Walter A. Triebel, *The 80386DX Microprocessor: Hardware, Software and Interfacing*, Prentice Hall.
6. Tom Shanley and Don Anderson, *Pentium Processor System Architecture*, Addison-Wesley.

Useful Links

1. https://nptel.ac.in/courses/106/105/106105163/
2. https://www.udemy.com/course/computer-organization-and-architecture-j/
3. https://nptel.ac.in/courses/108/105/108105102/
   https://www.mooc-list.com/tags/microprocessors

Course Title: Database Management System												
Semester: III			Term: ODD				Course Code: 25CSDSPCC304					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To learn the basics and understand the need of database management system.
2. To construct conceptual data model for real world applications
3. To Build Relational Model from ER
4. To introduce the concept of SQL to store and retrieve data efficiently Using Query Optimization Techniques.
5. To demonstrate notions of normalization for database design.
6. To understand the concepts of transaction processing- concurrency control & recovery procedures.

Course Outcomes:

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

1. Design ER models for real-world database applications.
2. Apply relational algebra operations to formulate database queries.
3. Construct SQL queries using DDL, DML, and DCL commands.
4. Apply normalization techniques for relational database design.
5. Analyze query processing, transaction management, concurrency, and recovery mechanisms.
6. Perform database operations using IBM Db2 and explore related certification opportunities.

Module	Contents	Hours	Cos
I	**Module 1: Database System Architecture and Entity Relationship Model** Database Management System Architecture , Data Abstraction and Data Independence , Entity Relationship Model : Entity Types , Entity Sets , Attributes and Keys , Relationship Types , Relationship Sets. Converting Entity Relational Model to Tables (Relational Database). **Self-Learning**: Object Relational Database Management System (ORDBMS).	8	CO1
II	**Module 2: Relational Algebra** Selection Operation, Projection Operation, Union Operation, Intersection Operation, Cartesian Operation and Join Operation. **Self-Learning**: Relational Calculus.	8	CO
III	**Module 3: Structured Query Language (SQL)** SQL Standards, Data Definition Commands, Set operations, aggregate function, null values, Data Manipulation commands, Data Control commands, Complex Retrieval Queries using Group By, Recursive Queries, and nested Queries. **Self-Learning**: Triggers, Procedures, Functions and Packages. Embedded SQL.	8	CO3
IV	**Module 4: Relational Database Design** 1NF, 2NF, 3NF, BCNF, Algorithm for Decomposition Using functional Dependencies, Decomposition Using Multivalued Attribute. **Self-Learning**: NoSQL Data Models.	8	**CO4**
V	**Module 5: Query Optimization and Transaction Concurrency Control** Query Optimization: Transformation Of Relational Expression, Estimating Statistics Of Expression Result, Choice Of Evaluation Plan. Transaction Concept, ACID Properties, Serializability, Lock Based Protocols, Multiple Granularity, Insertion-Deletion and Predicate Reads, Timestamp Based Protocols, Validation Base Protocols, Log Based Recovery **Self-Learning** : Distributed Transactions and TCL , Performance Tuning	9	**CO5**

VI	**Module 6: Foundations of IBM Db2** **IBM Db2 Overview** Introduction, Features, Editions, Industry Use Cases, Comparison with Other RDBMS, Db2 Installation and Interface System Requirements, Installation, CLP, IBM Data Studio, Db2 Web Console, Basic SQL Operations in Db2 CREATE, INSERT, UPDATE, DELETE, SELECT, Constraints, NULL Handling, Joins **Self-Learning:**. Db2 on Cloud, Backup & Recovery, Indexing & Performance Tuning, Distributed Databases, Db2 Warehouse on Cloud	4	**CO6**
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	ER Diagram Design: Design ER diagram for a university/library/hospital system.	CO1
2	Convert ER Diagram into Relational Model	CO1, CO2
3	Schema Creation**:** Write DDL queries to create tables with constraints.	CO1. CO2
4	Simple Queries: Write DML and DQL commands.	CO2, CO3
5	Joins**:** Use various types of joins on relational tables.	CO3, CO4
6	Nested Queries and Subqueries	CO3. CO4
7	Aggregate Functions with GROUP BY and HAVING	CO4, CO5
8	Implementation of Triggers (basic level)	CO4, CO5
9	Normalization**:** Convert an unnormalized relation to 1NF, 2NF, 3NF.	CO5, CO6
10	Transaction Control**:** Demonstrate COMMIT and ROLLBACK.	CO5, CO6

Reference Books:

1. Elmasri and Navathe, Fundamentals of Database Systems, 6th Edition, Pearson education.
2. Korth, Silberchatz, Sudarshan, Database System Concepts, 6th Edition, McGraw Hill.

Text Books:

1. An Introduction to Database System by C. J. Date Sixth Edition.
2. Database Systems The Complete Book By Jeffery D. Ullman Second Edition.

Useful Links

1. https://ocw.mit.edu/courses/6-830-database-systems-fall-2010/
2. https://www.youtube.com/playlist?list=PL9ysvtVnryGpnIj9rcIqNDxakUn6v72Hm

Course Title: Programming Language I: (Python)												
Semester: III			Term: ODD				Course Code: 25CSDSPCC305					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
1	-	2	1	-	1	2	10	10	30	25	25	100

IAE: Internal Assessment Examination ESE:
End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To introduce the fundamental concepts of Python programming.
2. To learn Python control flow with conditional statements and loops, creation and usage of functions.
3. To learn Object Oriented Programming concepts in python.
4. To learn Concepts of modules and packages in python.
5. To learn how to develop GUI-based applications using Python.
6. To equip students with the skills to handle email communication in Python.

Course Outcomes:

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

1. Understand the structure, syntax, semantics and data types of the Python language.
2. Familiarize with various control flow structures and functions in Python.
3. Illustrate the concepts of object-oriented programming as used in Python.
4. Create Python applications using modules and packages.
5. Design GUI applications and evaluate database operations in python.
6. Develop Python scripts to send and receive emails using libraries.

Module	Contents	Hours	Cos
0	**Prerequisite:** Basic Programming syntax of Java/C. Installation and configuration of python		
I	**Basics of Python:** Introduction, Basic & Built-in Math functions, Basic data types (Numeric, Boolean, Compound), Quotes, print() function, range() function, Tuples, Lists, Dictionaries, Sets, Numpy Arrays, Strings. **Self-learning Topics:** Practical applications with combined data types.	3	CO1
II	**Control Statements and Function:** Control flow statements: Conditional statements (if, if...else, nested if),Looping in Python (while loop, for loop, nested loops), Built-in functions in python, Defining a Function, Checking & Setting Your Parameters, Default arguments, Variable length arguments, Defining and calling functions within a function, Recursive functions, Anonymous Functions (Lambda, Map, Reduce, Filter). **Self-learning Topics:** Zip() function, Function decorators.	3	CO2
III	**Object Oriented Programming:** Creating Classes and Objects, Self-Variable, Constructors, Inheritance, Polymorphism. **Self-learning Topics:** Exceptions Handling, User Defined Exceptions.	3	CO3
IV	**Modules and Packages:** Importing own module as well as external modules, Understanding Packages, modules and external packages, Opening and Reading Files and Folders (Python OS Module, Python Datetime Module, Python Math and Random Modules). **Self-learning Topics:** Regular expression in python, Text Processing.	2	CO4

V	**GUI Programming with Database Connectivity:** GUI Programming Toolkits, Creating GUI Widgets with Tkinter, Creating Layouts, Form Components, Dialog Boxes. Types of Databases used with Python, Mysql database Connectivity with Python, Performing DML operations on database. **Self-learning Topics:** File handling, Pickle in Python.	2	CO5
VI	**Advanced Python:** Emails with Python: Introduction to Emails with Python, Sending Emails with Python, Receiving Emails with Python. **Self-learning Topics:** Networking in Python: Client Server socket programming.	2	CO6
	Total	**15**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Write python programs to understand Expressions, Variables, Quotes, Basic Math operations.	CO1
2	Write a Python program to implement Basic String Operations & String Methods.	CO1
3	Write a Python program to implement functions of List, Tuples, and Dictionaries.	CO1
4	Write a Python program to implement Arrays / Numpy Array (1D, 2D) applications.	CO1
5	Write python programs to demonstrate applications of different decision-making statements.	CO2
6	Write a Python program to implement Functions and Recursion.	CO2
7	Write a Python program to implement Programs based on Lambda, Map and Reduce Functions.	CO2
8	Write python programs to implement Classes & objects, Constructors.	CO3
9	Write python programs to implement Inheritance & Polymorphism.	CO3

10	Write python programs to create user-defined modules/packages and import them in a program.	CO4
11	Write python programs to understand GUI designing and database operations (Programs based on GUI designing using Tkinter, Mysql database creation & Database connectivity with DML).	CO5
12	Write python program to implement sending automated emails with Python.	CO6

Reference Books:

1. Zed A. Shaw, "Learn Python 3 the Hard Way", Zed Shaw's Hard Way Series.
2. Martin C. Brown," Python: The Complete Reference", McGraw-Hill Publication.
3. Paul Barry," Head First Python", 2nd Edition, O'Reilly Media, Inc.

Text Books:

1. Dr. R. Nageswara Rao," Core Python Programming" , Dreamtech Press, Wiley Publication
M. T. Savaliya , R. K. Maurya, "Programming through Python", StarEdu Solutions.
2. E-Balagurusamy, "Introduction to computing and problem solving using python", McGraw Hill Publication.

Useful Links

1. https://onlinecourses.swayam2.ac.in/cec22_cs20/preview
2. http://docs.python.org/release/3.0.1/tutorial/
3. http://spoken-tutorial.org
4. www.staredusolutions.org
5. https://www.tutorialspoint.com/python/index.htm

Course Title: Universal Human Values												
Semester: III			**Term: ODD**				**Course Code: 25CSDSVEC301**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
2	1	-	2	1	-	3	10	10	30	25	-	75

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To become more aware of themselves, and their surroundings (family, society, nature).
2. To gain clarity about the basic human aspirations of happiness and prosperity, and understand the role of right understanding, human relationships, and physical facilities in fulfilling them.
3. To become more responsible in life, especially in addressing day-to-day challenges by seeking sustainable and human-centered solutions.
4. To recognize and reflect on their role in human relationships, and respond with sensitivity, trust, and mutual respect in their personal and social life.
5. To become sensitive to their commitment towards what they have understood, including universal human values, harmony in relationships, and contribution to a just and humane society.
6. To apply the understanding of values and harmony in real-life situations within the self, family, society, and nature, thus making a conscious beginning towards value-based living.

Course Outcomes:

At the end of the course students will be able:

1. Explain the interdependence between Values and Skills in ensuring sustained happiness and prosperity, which are the core aspirations of all human beings.
2. Develop a holistic perspective among students towards life and profession through a correct understanding of human reality as the coexistence of self and body.
3. Understand the foundational values of trust and respect in human relationships and their role in achieving happiness and prosperity in family and society.
4. Apply the understanding of harmony and co-existence in nature to develop a holistic perception of existence.
5. Demonstrate ethical human conduct and natural acceptance of human values based on holistic understanding.

6 . Demonstrate trust and mutually fulfilling human behaviour, and mutually enriching interaction with nature and profession based on a value-based approach.

Module	Contents	Hours	Cos
I	Introduction to Value Education Understanding Value Education Self-exploration as the Process for Value Education- Continuous Happiness and Prosperity the Basic Human Aspirations Right Understanding, Relationship and Physical Facility Happiness and Prosperity Current Scenario Method to Fulfil the Basic Human Aspirations	**6**	CO 1
II	Harmony in the Human Being Understanding Human being as the Co-existence of the Self and the Body Distinguishing between the Needs of the Self and the Body The Body as an Instrument of the Self Understanding Harmony in the Self Harmony of the Self with the Body Programme to Ensure self-regulation and Health	**6**	CO1
III	Harmony in the Family and Society Harmony in the Family the Basic Unit of Human Interaction Values in Human-to-Human Relationship the Foundational Value in Relationship 'Respect' as the Right Evaluation Understanding Harmony in the Society Vision for the Universal Human Order	**6**	CO2
IV	Harmony in the Nature (Existence) Understanding Harmony in the Nature Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence	**5**	CO2
V	Implications of the Holistic Understanding Natural access acceptance of Human Values Definitiveness of (Ethical) Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order	**4**	CO3
VI	Professional Ethics Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies Strategies for Transition towards Value-based Life and Profession	**3**	CO3
	Total	**30**	

List of Tutorials

Sr. No.	Topic	Hours.	COs
1	Sharing about oneself	1	CO1
2	Exploring human consciousness	1	CO1
3	Exploring natural acceptance	1	CO1
4	Exploring the difference of needs of self and body	1	CO1
5	Exploring sources of imagination in the self	1	CO1
6	Exploring harmony of self with the body	1	CO2
7	Exploring the feeling of trust	1	CO2
8	Exploring the feeling of respect	1	CO2
9	Exploring systems to fulfill human goal	1	CO2
10	Exploring the four orders of nature	1	CO2
11	Exploring coexistence in existence	1	CO3
12	Exploring ethical human conduct	1	CO3
13	Exploring humanistic models in education	1	CO3
14	Exploring steps of transition towards universal human order	1	CO3
	Total Hours	**14**	

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj _ PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Text Books:

1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2 nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034- 53-2

Useful Links:

https://www.youtube.com/watch?v=PXSEpPFCn38

Course Title: Employability Enhancement Program – I (Communication)												
Semester: III			**Term: ODD**				**Course Code: 25CSDSAEC301**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
--	01	--	--	01	--	01	--	--	--	25	--	25

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To train students on grooming and their all-round development.
2. To instill confidence amongst learners about interviewing influential personnel.

Course Outcomes:

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

1. Understand and demonstrate improved formal dressing and appearance.
2. Apply ideas, ask insightful questions and build connections through interview experiences.
3. Develop required vocabulary and updated knowledge of current affairs at a global level.
4. Apply ethical behavioral skills at both academic as well as in professional life.

List of Tutorials:

Tut. No.	List of Tutorials	Hours	COs
	Speaking Skills		
1.	Role Play	01	CO1
2.	Poster Presentation (Group): Assignment 5	01	CO1
3.	Interviewing an influential person with Geo tag photo or video: Assignment 8	01	CO2
4.	Story Telling with moral/value	01	CO1
5.	Impromptu	01	CO3
	Reading Skills		
6.	Summarization – unseen passage Assignment 2	01	--
7.	Book Review Presentation: Assignment 4	01	CO1
8.	Reading Newspaper Article	01	--
	Writing Skills		
9.	Vocabulary Building: Crossword	01	CO3
10.	One Word Substitution, Collocation, Phrases & Idioms - Assignment 1	01	CO3
11.	Expansion of an Idea- Assignment 3	01	CO3
12.	Behavioral Ethics: Ethical Code of Conduct: Assignment 6	01	CO4
13.	Dress & Appearance: Assignment 7	01	CO1
14.	Paragraph Writing	01	--
15.	Dialogue Writing (Formal)	01	--
	Total	**15**	

Reference Books:

1. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
2. Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
3. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
4. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008

5. Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
6. Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
7. Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
8. Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008
9. Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

Text Books:

1. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008

Useful Links:

Speaking Skills

https://youtu.be/iNxl16ZkM-A?si=_smlyYEtxvHBD40S

https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI

https://youtu.be/ftwVrEF_OlQ?si=sYiKRfg_xX1erVf6

https://youtu.be/TKfwenWIHhk?si=xn8GDiZIBYKB14M4

https://youtu.be/pbhK_OhMgA4?si=DeROjEtA6V_w5dL

https://youtu.be/a2dTNAryZ8g?si=6tA9U-ZAX4wQBi_x

https://youtu.be/QBnGmmBAgyc?si=JGm-TpmrslhE-ZB8

https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI

https://youtu.be/z9F68dJSbOE?si=VVMrBOeNnc5XNln8

Reading Skills

https://youtu.be/KadZ3KYzM0I?si=XRmUOk2O8UmoMfEK

https://youtu.be/kCthrwUz68w?si=L4U4TJjuO72Us_dD

https://youtu.be/tpHp8oEHANQ?si=R-YOMfSa5LIuyXMR

Writing Skills

https://youtu.be/Zx-JcXsbUqQ?si=ysfXU8ZR4UM3U22P

https://youtu.be/5o_oph2vhGM?si=_4D6h8ZMiYSe0ZV4

Bachelor of Technology

In

Computer Science & Engineering (Data Science)

Second Year
Semester – IV

SJCEM: R–25

Effective from Academic Year

2026-27

Program Structure for Second Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)

Semester IV

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
25CSDSPCC401	PCC	Statistics and Probability	3	1	-	3	1	-	4
25CSDSPCC402	PCC	Analysis of Algorithm	3	-	2	3	-	1	4
25CSDSPCC403	PCC	Computer Networks	2	1	-	3	-	-	3
25CSDSPCC404	PCC	Operating System	3	-	2	3	-	1	4
25CSDSAEC401	AEC	Employability Enhancement Program -II (Communication)	-	-	2	-	-	1	1
25CSDSVSE401	VSEC	Employability Enhancement Program -III (Industry Certification)	-	-	2	-	-	1	1
25MDM401X	MDM	Multidisciplinary Minor	3	-	2	1	-	1	1
25CSDSVEC401	VEC	Environmental Studies	1	-	-	-	-	-	-
25CSDSOJT401	OJT	Internship I	-	-	3	-	-	1	1
		Total	**15**	**2**	**13**	**15**	**1**	**6**	**22**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/ PR	Total
25CSDSPCC401	PCC	Statistics and Probability	20	20	60	25	-	125
25CSDSPCC402	PCC	Analysis of Algorithm	20	20	60	25	25	150
25CSDSPCC403	PCC	Computer Networks	20	20	60	25	-	125
25CSDSPCC404	PCC	Operating System	20	20	60	25	25	150
25CSDSAEC401	AEC	Employability Enhancement Program -II (Communication)	-	-	-	25	-	25
25CSDSVSE401	VSEC	Employability Enhancement Program -III (Industry Certification)	-	-	-	-	25	75
25MDM401X	MDM	Multidisciplinary Minor	20	20	60	25	-	25
25CSDSVEC401	VEC	Environmental Studies	-	-	-	G	-	G
25CSDSOJT401	OJT	Internship I	-	-	-	-	25	25
		Total	**100**	**100**	**300**	**150**	**100**	**750**

Syllabus

for

Second Year

Computer Science & Engineering (Data Science)

Semester – IV

SJCEM: R–25

(With Effect from 2026-27)

Course Title: Statistics and Probability														
Semester: IV				**Term:** Even				**Course Code:** 24CSDSPCC401						
Teaching Scheme								**Evaluation Scheme**						
Contact Hrs.					**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**			**Th**	**Tu**	**Pr**							
2	**1**	**-**			**2**	**1**	**-**	**3**	**20**	**20**	**60**	**25**	**-**	**125**

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment, TW: Term Work

Course Objectives: The course is aimed

1. To study the basic techniques of statistics like correlation, regression and curve fitting for data analysis, Machine learning and AI.
2. To understand probability theory and random process that serve as an essential tool for applications of engineering sciences.
3. To acquaint students with the concepts of probability distributions.
4. To understand the various types of hypothesis tests and learn how to choose the most appropriate test based on the type of data and the research question.
5. Enhance problem-solving skills through the application of counting principles to solve a wide range of problems in mathematics, computer science, engineering, and other disciplines.
6. To learn about different types of graphs, Understand their properties and characteristics.

Course Outcomes:

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

1. Apply the concept of Correlation and Regression to the engineering problems in data Science, machine learning and AI.
2. Illustrate understanding of concepts of probability and expectation for getting the speed of the data and distribution of probabilities.
3. Apply the concepts of probability distribution to engineering problems.
4. Apply the most suitable hypothesis test for different types of data and research designs, such as t-tests, chi-square tests.
5. Apply counting principles, the pigeonhole principle, and recurrence relations effectively in various mathematical, computational, and real-world problem-solving contexts.
6. Develop proficiency in applying various graph algorithms, including traversal algorithms, shortest path algorithms.

Module	Contents	Hours	Cos
I	**Statistical Techniques:** Karl Pearson's coefficient of correlation (r), Spearman's Rank correlation coefficient (R) (with repeated and non-repeated ranks), Lines of regression, Fitting of first- and second-degree curves. **Self-Learning Topics:** Covariance, fitting of exponential curve.	8	CO1
II	**Probability Theory:** Definition and basics of probability, conditional probability, Total Probability theorem and Bayes' theorem, Discrete and continuous random variable with probability distribution and probability density function, Expectation, Variance and Standard Deviation. **Self-Learning Topics:** Cumulative Distribution Function, Moment generating function, Skewness and Kurtosis of distribution (data).	8	CO2
III	**Probability Distribution:** Probability Distribution: Binomial, Poisson and Normal distribution - problems (No derivation for mean and standard deviation) **Self-Learning Topics:** Bernoulli's Distribution, Uniform Distribution, Exponential Distribution	7	CO3
IV	**Sampling Theory:** Introduction, Parameter and Statistics, Test of Hypothesis, Level of Significance, Critical region, One-tailed, and two-tailed test, Degree of freedom. Z- test (Large Sample), Students' t-distribution (Small sample). Test the significance of mean and Difference between the means of two samples. Chi Square Test: Test of goodness of fit and independence of attributes. **Self-Learning Topics**: Yate's Correction.	9	CO4
V	**Counting** Basic Counting Principle-Sum Rule, Product Rule, Inclusion Exclusion Principle, Pigeonhole Principle, Recurrence relations-Linear Homogeneous and Non-Homogeneous Recurrence Relation(where f(n)= A or A.n^m or An+B) , Solving recurrence relations. **Self-Learning Topics:** Extended Pigeonhole Principle, Non-Homogeneous Recurrence Relation(where f(n)= An^2+Bn+C or A.a^n or (An+B)e^n)	6	CO5
VI	**Graph Theory:** Introduction, Simple Graphs, Multigraphs, Isomorphic Graphs, Subgraphs, Handshaking lemma(Without proof), Complete graph, Regular, Planar graph, Walks, Trials, Path, Cycle, Connected and Disconnected Graph, Bipartite graph, Euler and Hamiltonian Graphs, Components of graph, Cut-Set, Cut Vertex, Weighted graph, Dijkstra's Algorithm.	7	CO6

	Self-Learning Topics: Traversal algorithms: breadth-first search, depth-first search		
	Total	**45**	

Reference Books:

1. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
2. Narsing Deo, "Graph Theory with applications to engineering and computer science", PHI Publications.

Text Books:

1. Introductory Probability and Statistical Applications, B L Mayer, Wiley Eastern Limited, 2nd Edition.
2. Discrete and Combinatorial Mathematics-An Applied Introduction, Ralph P. Grimaldi and B V Ramana, Pearson Education, Asia, 5th Edition.

Useful Links:

1. https://www.coursera.org/specializations/discrete-mathematics
2. https://www.edx.org/learn/discrete-mathematic

Course Title: Analysis of Algorithms												
Semester: VI			**Term: EVEN**				**Course Code:** 25CSDSPCC402					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**-**	**2**	**3**	**-**	**1**	**4**	**20**	**20**	**60**	**25**	**25**	**150**

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment, TW: Term Work

Course Objectives:

1. To provide mathematical approaches for Analysis of Algorithms
2. To understand and solve problems using various algorithmic approaches
3. To analyze algorithms using various method
4. To solve problems using various strategies
5. To analyze strategies for solving problems not solvable in polynomial time.
6. To provide mathematical approach for Analysis of Algorithms.

Course Outcomes:

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

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer strategy.
3. Describe, apply and analyze the complexity of greedy strategy.
4. Describe, apply and analyze the complexity of dynamic programming strategy.
5. Explain and apply backtracking, branch and bound and string matching techniques to deal with some hard problems.
6. Describe the classes P, NP, and NP-Complete and be able to prove that a certain problem is NP Complete.

Module	Contents	Hours	Cos
I	**Introduction to analysis of algorithm:** Performance analysis, Space and Time complexity, Growth of function – Big –Oh, Omega , Theta notation , Mathematical background for algorithm analysis, Analysis of selection sort , Insertion sort. **Recurrences:** -The substitution method -Recursion tree method -Master method **Divide and Conquer Approach:** General method. Analysis of Merge sort, Analysis of Quick sort, Analysis of Binary search, Finding minimum and maximum algorithm and analysis **Self-Learning Topics**: Strassen's matrix multiplication	13	CO1
II	**Dynamic Programming Approach :** General Method, Multistage Graphs, Single source shortest path, All pair shortest path Assembly-line scheduling , 0/1 knapsack, Travelling salesman problem, Longest common subsequence **Self-Learning Topics:** Principles of Dynamic Programming Problems	7	CO2
III	**Greedy Method Approach:** General Method, Single source shortest path, Knapsack problem Job sequencing with deadlines • Minimum cost spanning trees-Kruskal's and Prim's algorithm **Self-Learning Topics:** Optimal storage on tapes	7	CO3
IV	**Backtracking and Branch-and-bound:** General Method, N-queen problem, Sum of subsets, Graph coloring, 15 puzzle problem, Travelling salesman problem. **Self-Learning Topics:** Optimization in Backtracking, Constraint Propagation	7	CO4
V	**String Matching Algorithms:** The naïve string matching Algorithms , The Rabin Karp algorithm String matching with finite automata, The Knuth-Morris-Pratt algorithm **Self-Learning Topics:** Boyer-Moore Algorithm	6	CO5

VI	**Non-deterministic polynomial algorithms:** Polynomial time, Polynomial time verification, NP Completeness and reducibility, NP Completeness proofs, Vertex Cover Problems , Clique Problems **Self-Learning Topics:** Importance of NP Problems	5	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Selection Sort, Insertion Sort, Merge sort, Quick sort, Binary search	CO1
2	All pair shortest path, Longest common subsequence.	CO2
3	Fractional Knapsack problem, Job sequencing with deadlines	CO3
4	N-queen problem and Graph coloring	CO4
5	The naïve string matching algorithm	CO5
6	The Rabin-Karp algorithm	CO5,CO5

Reference Books:

1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Tata McGraw- Hill Edition.
2. S. K. Basu, "Design Methods and Analysis of Algorithm", PHI.
3. John Kleinberg, Eva Tardos, "Algorithm Design", Pearson.
4. Michael T. Goodrich, Roberto Tamassia, "Algorithm Design", Wiley Publication.

Text Books:

1. T.H. Coreman , C.E. Leiserson, R.L. Rivest, and C. Stein, "Introduction to algorithms", 2nd edition , PHI publication 2005.
2. Ellis Horowitz , Sartaj Sahni , S. Rajsekaran. "Fundamentals of computer algorithms" University Press

Useful Links:

1. https://leetcode.com/explore/interview/card/leetcodes-interview-crash-course-data structures-and-algorithms/703/arraystrings/
2. https://ocw.mit.edu/courses/6-006-introduction-to-algorithms-spring-2020/
3. https://visualgo.net/en

Course Title: Computer Networks												
Semester: IV			**Term: EVEN**				**Course Code:** 25CSDSPCC403					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	-	2	3	-	1	4	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives: The course aims

1. To introduce concepts and fundamentals of data communication and computer networks. 2. To explore the inter-working of various layers of OSI.
3. To explore the issues and challenges of protocols design while delving into TCP/IP protocol suite.
4. To assess the strengths and weaknesses of various routing algorithms.
5. To understand various transport layer and application layer protocols.
6. To understand various application layer protocols.

Course Outcomes:

At the end of the course students will be able:

1. Demonstrate the concepts of data communication and compare ISO–OSI model with TCP/IP model.
2. Explore different concepts and design issues at physical layer.
3. Explore different design issues at data link layer.
4. Design the network using IP addressing and sub netting / supernetting schemes.
5. Analyze transport layer protocols and congestion control algorithms.
6. Explore protocols at application layer

Module	Contents	Hours	COs
I	**Introduction to Networking** 1.1. Introduction to computer network, network application, network software and hardware components (interconnection networking devices), network topology, protocol hierarchies, design issues for the layers, connection-oriented and connectionless services. 1.2. Reference models: Layer details of OSI, TCP/IP models. Communication between layers. **Self-learning Topics:** Explore real-world applications of each network topology.	5	CO1
II	**Physical Layer** 2.1. Introduction to communication: Electromagnetic spectrum 2.2. Guided transmission media: Twisted pair, coaxial, fiber optics. 2.3. Unguided transmission media: Radio waves, micro waves, infrared **Self-learning Topics:** Examine use cases where guided or unguided transmission media are preferred based on factors like bandwidth, distance, and cost.	7	CO2
III	**Data Link Layer** 3.1. DLL design issues (services, framing, error control, flow control), error detection and correction (Hamming code, CRC, checksum), Elementary data link protocols, Stop and Wait, Sliding Window (Go Back N and Selective Repeat) 3.2. Medium access control sublayer: Channel allocation problem, multiple access protocol (ALOHA, Carrier Sense Multiple Access (CSMA/CD) & (CSMA/CA)) **Self-learning Topics:** Analyze how ALOHA, CSMA/CD, and CSMA/CA protocols are applied in wired and wireless networks to optimize medium access.	8	CO3
IV	**Network Layer** 4.1. Network layer design issues, Communication primitives: unicast, multicast, broadcast. IPv4 addressing (classfull and classless), subnetting, supernetting design problems, IPv4 protocol, network address translation (NAT), IPv6 4.2. Routing algorithms: Shortest path (Dijkastra's), link state routing, distance vector routing 4.3. Protocols - ARP, RARP, ICMP, IGMP 4.4. Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters, token & leaky bucket algorithms **Self-learning Topics:** Compare the differences between IPv4 and IPv6, focusing on their features and migration strategies.	10	CO4
V	**Transport Layer** 5.1. Transport service: Transport service primitives, Berkeley sockets, connection management (handshake), UDP, TCP, TCP state transition,	10	CO5

	TCP timers 5.2. TCP flow control (sliding window), TCP congestion control: Slow start algorithm **Self-learning Topics:** Role of TCP timers in ensuring reliable data transmission.		
VI	**Application Layer** 6.1. DNS: Name Space, Resource Record, and Types of Name Server. HTTP, SMTP, Telnet, FTP, and DHCP **Self-learning Topics:** Learn about various types of name servers and their functions within the DNS ecosystem.	5	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	COs
1	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route)	CO1
2	Study of RJ45 and CAT6 Cabling and connection using crimping tool.	CO2
3	Build a simple network topology and configure it for static routing protocol using packet tracer. Setup a network and configure IP addressing, subnetting, masking.	CO4
4	Perform network discovery using discovery tools (e.g.. Nmap, mrtg)	CO4
5	Use Wire shark to understand the operation of TCP/IP layers: 1. Ethernet Layer: Frame header, Frame size etc. 2. Data Link Layer: MAC address, ARP (IP and MAC address binding) 3. Network Layer: IP Packet (header, fragmentation), ICMP (Query and Echo) 4. Transport Layer: TCP Ports, TCP handshake segments etc. 5. Application Layer: DHCP, FTP, HTTP header formats	CO4
6	Use simulator (e.g., NS2) to understand functioning of ALOHA, CSMA/CD.	CO3
7	Socket programming using TCP or UDP	CO5
8	Perform File Transfer and Access using FTP	CO6

Reference Books:

A. S. Tanenbaum, Computer Networks, 4th Edition, Pearson Education
B. A. Forouzan, Data Communications and Networking, 5th Edition, TMH
James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, 6th Edition, Addison Wesley

Text Books:

1. S. Keshav, An Engineering Approach to Computer Networking, Pearson
2. Natalia Olifer & Victor Olifer, Computer Networks: Principles, Technologies & Protocols for Network Design, Wiley India, 2011.
3. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Second Edition, The Morgan Kaufmann Series in Networking.

Useful Links

1. https://www.netacad.com/courses/networking/networking-essentials
2. https://www.coursera.org/learn/computer-networking
3. https://nptel.ac.in/courses/106/105/106105081
4. https://www.edx.org/course/introduction-to-networkin

Course Title: Operating System												
Semester: IV			Term: EVEN				Course Code: 25CSDSPCC404					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
2	-	2	2	-	1	3	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course aims:

1. To understand the major components of Operating System &its functions.
2. To introduce the concept of a process and its management like transition, scheduling, etc. 3. To understand basic concepts related to Inter-process Communication (IPC) like mutual exclusion, deadlock, etc. and role of an Operating System in IPC.
4. To understand the concepts and implementation of memory management policies and virtual memory.
5. To understand functions of Operating System for storage management and device management 6. To study the need and fundamentals of special-purpose operating system with the advent of new emerging technologies.

Course Outcomes:

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

1. Understand the basic concepts related to Operating Systems.
2. Analyze and evaluate the performance of different process and disk scheduling algorithms 3. Demonstrate inter-process communication and process synchronization.
4. Analyze and evaluate various deadlock detection, avoidance and removal techniques. 5. Analyze and evaluate memory management policies in different scenarios.
6. Evaluate different file organization and access techniques

Module	Contents	Hours	Cos
I	**Introduction:** Operating System operations, Process management, Memory management, storage management, Protection and security. **System Structure:** Operating system services and interface, System calls and its types, System programs, Operating System Design and implementation, OS structure, Virtual machines, System boot. **Self-learning Topics:** Study of any three different OS. System calls with examples for different OS.	8	CO1
II	**Processes:** Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching. Thread: Definition, Various states, Benefits of threads, Types of threads, Multithreading. **Process Scheduling**: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non-pre-emptive, FCFS, SJF, SRTF, RR Scheduling. **Self-learning Topics:**Performance comparison of Scheduling Algorithms,Selection of Scheduling Algorithms for different situations, Real-time Scheduling	8	CO
III	**Inter-process Communication:** Critical Section, Race Conditions, Mutual Exclusion, The Producer\ Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dining Philosopher Problem etc. **Deadlocks:** Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, and Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery. **Self-learning Topics:** Study a real time case,study for Deadlock detection and recovery.	8	CO3
IV	**Memory Management:**Basic concept,Logical and Physical address map, Memory allocation: Contiguous Memory allocation – Fixed and variable partition–Internal and External fragmentation and Compaction; Paging: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging. **Virtual Memory**: Basics of Virtual Memory– Hardware and control structures –Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Optimal Page Replacement and Least Recently used (LRU). **Self-learning Topics:** Memory Management ,for any one Operating System, Implementation of Page Replacement Algorithms.	8	**CO4**

V	**File Management**: Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), efficiency and performance. **Disk Management:** Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting. **Self Study:** Case study on UNIX and WINDOWS Operating System.	9	**CO5**
VI	**Storage Management** **File System**: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection. Implementing file System: File-System Structure, File-System Implementation, Directory Implementation, Allocation Methods, Free- Space Management **Secondary Storage Structure:** Overview of Mass-Storage Structure, Disk Structure, Disk Scheduling, Disk Management, Swap-Space Management; RAID Structure	4	**CO6**
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Study of Linux general purpose commands	CO1
2	Basic System administrative task: Process management, Memory management, File system management, User management	CO1
3	Shell Scripts and AWK programs	CO1
4	Implementation of Scheduling algorithms (FIFO, SJF, Priority, Round Robin)	CO2
5	Implementation of classic Synchronization problems using semaphores (producer-consumer, reader-writer, dining philosophers)	CO3
6	Implementation of Bankers Problem (Deadlock avoidance)	CO4
7	Implementation of Memory management/ allocation policies (1st fit, best fit, worst fit)	CO5
8	Implementation of Page replacement algorithms (FIFO, LRU, OPTIMAL)	CO5
9	File Systems	CO6
10	Case Study on Android/ mac OS	CO1,3,5,6

Reference Books:

1. N. Chauhan, Principles of Operating Systems, 1st ed., Oxford University Press, 2014. 2. A. Tanenbaum and A. Woodhull, Operating System Design and Implementation, 3rd edPearson.
3. R. Arpaci-Dusseau and A. Arpaci-Dusseau, Operating Systems: Three Easy Pieces, CreateSpace Independent Publishing Platform, 1st ed., 2018

Text Books:

1. Abraham Silberschatz, Greg Gagne, Peter Baer Galvin, "Operating System Concepts", 8th Edition, Wiley, January 2018. 15
2. Tanenbaum, "Modern Operating System", 4th Edition, Pearson Education, 2014. 3. William Stallings, "Operating Systems: Internal and Design Principles", 8th Edition, Pearson, 2014. 4. Randal. K. Michael, "Mastering Shell Scripting", 2nd Edition, Wiley Publication, 2008.

Useful Links

1. https://www.nptel.ac.in/
2. https://swayam.gov.in/
3. https://www.youtube.com/@GateSmashers

Course Title: Employability Enhancement Program -II (Communication)												
Semester: IV			**Term: EVEN**				**Course Code: 25CSDSAEC401**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
-	-	2	-	-	1	1	-	-	-	25	-	25

Course Objectives:

1. To understand the importance of active listening in effective communication.
2. To cultivate effective inter-personal skills and employment skills for organizational development.

Course Outcomes:

After successful completion of the course, learner will be able to …

1. Understand the importance of active listening and social etiquette for effective communication.
2. Enhance written communication, official and technical skills
3. Strengthen their personal and professional relationship in career building.
4. Ace their employability Skills through personal SWOT, Group Discussion and Resume Writing

Module	Contents	Hours	Cos
I	**Listening & Social Skills:** Importance of Listening, Difference between hearing & listening, Types of Listening, Barriers of Listening, Listening (Audios/Videos), Etiquette-Social Etiquette, Dining Etiquette, Telephonic Etiquette, Email Etiquette, Reading Comprehension Skills	6	CO1
II	**Proposal & Report Writing:** Letter Writing: Permission Letter, Leave Letter, Apology Letter, Meetings – Notice, Agenda & Minutes, Introduction to Proposal Writing, Parts of a Proposal, Types of Proposal: Research, Business, What is Technical paper writing in IEEE? Types of Paper Writing: Journal, Conference Paper, Writing a Review Paper	8	CO2
III	**Interpersonal Skills:** Presentation Skills: Power Point, Demo Presentation, Managerial Skills: Time Management, Goal Setting, Decision Making, Conflict Resolution, Team Building, Leadership, Emotional Intelligence, Critical Thinking, Assertiveness, Negotiation	8	CO3
IV	**Employability Skills:** SWOT Analysis: Personal & Organizational, Verbal Aptitude Test, Group Discussion Skills: Types of GD, Do's and Don'ts, Tips for cracking a GD, Resume Writing, Interview Techniques	8	CO4
	Total	**30**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Listening Activity	CO1
2	Comprehending Unseen Passages	CO1
3	Writing Email Etiquette/Do's & Don'ts of Email Writing	CO1
4	Meeting and Documentation- Notice, Agenda & Minutes	CO2
5	Letter Writing- Permission, Leave & Apology	CO2
6	PPT Presentation on any Technical Topic (Group Activity)	CO2/CO3

7	Case Study Based GD-1	CO3
8	Case Study -2	CO3
9	SWOT Analysis: Personal	CO4
10	Resume Writing	CO4

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Evaluation and Assessment Scheme:

A. Continuous Assessment (CA):

Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All COs / LOs should be covered)

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

1. Assignment
2. Case Study
3. Debate
4. Solution for Social Problems
5. Field Visit
6. Group Project
7. Flip Classroom
8. Topic Review
9. Quiz
10. Mind Mapping
11. Any other

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

1) M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008

2) Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010

3) Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007

4) Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008

5) Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015

6) Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press,

2008

7) Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

8) Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007

9) Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008

Useful links for CCES-I:

https://youtu.be/TTARLuquJeE

https://youtu.be/jPj0Z2lb8jg

https://youtu.be/2nEvKZ4SG2c

PD & Social Etiquette

https://youtu.be/wPorhmnMDdc

https://youtu.be/n6F5icYGnSg

7Cs of Effective Communication

https://youtu.be/XuGCDRNIU-M

Letter Writing

https://youtu.be/ci47OQLFjao

https://youtu.be/uj6rlM62Bqk

Motivational Speech

https://youtu.be/xrEq-1UujOo

https://youtu.be/W7BW9gv_OkU

Reading Comprehension

https://youtu.be/3yYjYvdcCw8

Public Speaking Tips

https://youtu.be/UNGla--HOXQ

BARRIERS TO COMMUNICATION

https://youtu.be/k9KK_0zr3L

Course Title: Employability Enhancement Program -III (Industry Certification)												
Semester: IV			Term: EVEN				Course Code: 25CSDSVSE401					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
-	-	2	-	-	-	1	-	-	-	-	25	25

Introduction

As global competition continues to intensify, industries increasingly seek candidates who possess not only strong technical skills but also adaptability, problem-solving abilities, and the readiness to meet the demands of an evolving workforce. To bridge the gap between academic learning and industry expectations, SJCEM has introduced certification courses designed to equip students with industry-relevant knowledge and skills and prepare them for impactful internships. These courses provide students with practical exposure and professional competencies, enabling them to perform effectively in real-world work environments, enhance their confidence, and improve their overall employability.

Objectives:

The objectives of this course are to

1. Develop Professional Skills
2. Enhance Technical Competency
3. Cultivate Problem-Solving Abilities
4. Promote Ethical and Professional Conduct
5. Familiarize with Industry Standards and Expectations
6. Prepare for a Transition from Classroom to Workplace

Outcomes:

After completion of this course, students will be able to

1. Communicate and Collaborate Effectively
2. Acquire Job-Ready Technical Skills
3. Enhanced Critical Thinking and Problem-Solving
4. Understand Ethical and Professional Standards
5. Use Industry Tools and Standards
6. Industry Integration effectively

Certification GUIDELINES:

The general procedure for organizing certification courses is as follows:

1. Identification of Industry Partners

Industries have been identified to provide in-house certification courses in various domains. Students are regularly informed and encouraged to pursue these certification courses.

2. Selection of Certification Domain

Students can choose two domains of their interest for the certification course and express their willingness to pursue the certification.

Following combination of domains are offered in the even semesters:

	Domain 1	**Domain 2**
Track 1	SQL	.NET
Track 2	CCNA	AI-IBM
Track 3	Cyber Security	AI-IBM
Track 4	Creo	Solid Works
Track 5	Data Science	Prompt Engineering and AI
Track 6	MernStack	Flutter
Track 7	AR-VR	Game Development
Track 8	Drone	Data Analytics
Track 9	IELTS/GRE	Certificate in Social Science
Track 10	Robotic	IoT
Track 11	Blockchain Basics	Blockchain Intelligence
Track 12	AWS	MernStack

3. Allocation of Tracks

Each track can accommodate a maximum of 60 students or as per the availability of maximum seats. Allocation will be based on a first-come first-served basis. However, the institute reserves the right to reassign tracks as per the requirement.

4. Course Duration

Students have to complete the certification course, which has a minimum duration of 30 hours.

5. Oral & Practical Exam

Based on the entire syllabus, oral (20 marks) & practical/implementation (30 marks) examination will be conducted. Grades will be assigned as per the examination rules.

Note: A minimum of 90% attendance is required to award the certificate. If a student fails to meet this requirement, the student needs to re-register for the course internally or externally until successfully complete

Course Title: Foundations of Analytical Design												
Semester: IV			**Term:** Even				**Course Code: 25MDM401DAB**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	-	2	3	-	1	4	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. To introduce students to the theoretical foundations of visual perception, cognition, and design, and how these principles apply to effective data visualization.
2. To equip students with a structured workflow—from acquiring and cleaning data to prototyping and deploying visualizations—for transforming raw data into meaningful visual narratives.
3. To train students in the design and construction of key chart types (distributions, comparisons, parts-of-a-whole, spatial maps) and in thoughtful use of color, typography, and visual encoding.
4. To develop students' ability to craft compelling data stories and dashboards, and to critique visualizations (their own and peers') with a perceptual and narrative lens.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the foundational principles of human visual perception (e.g. Gestalt laws, pre attentive attributes) and how they influence design decisions in visualization.
2. Map different data types (categorical, ordinal, quantitative, spatial) to appropriate visual channels (position, size, color, shape) and justify those choices.
3. Design and develop a variety of standard and advanced visualizations (bar, line, scatter, histogram, box/violin, treemaps, choropleth, etc.) using a tool such as Tableau or equivalent.
4. Apply color and typographic best practices (including accessibility, contrast, color-blind safe palettes) to enhance readability and integrity of visualizations.
5. Compose a coherent, annotated dashboard or visual narrative from a real dataset—structuring layout, hierarchy, annotation, filters, interactivity, and flow.
6. Critically evaluate visualizations (own work and others) for clarity, misleading elements (chartjunk), cognitive load, perceptual effectiveness, and narrative strength.

Module	Content	Hours	COs
1	**Introduction to Data Visualization & Perception**		
	The "Why" of Visualization: From data to insight. Foundations of Human Perception: Gestalt Principles (Proximity, Similarity, Closure, etc.). Pre attentive Attributes: How visual properties like color, size, and orientation are processed by the brain. The Cognitive Load of Visualizations: Designing for ease of understanding. Introduction to the Data Visualization Toolkit: Charts, graphs, and maps. **Self-learning** : Explore how Gestalt principles and pre attentive attributes influence user perception in real-world data visualizations.	6	1
2	**The Data & Design Workflow**		
	The Data Pipeline: Acquisition, Cleaning, Exploration, and Visualization. Data Types and Encodings: Matching categorical, ordinal, and quantitative data to visual channels (position, length, area, color hue/saturation). Introduction to Data Wrangling with Tableau Prep/Power Query. Defining the Audience and the Story: What does the user need to know? Sketching and Low-Fidelity Prototyping for visualizations. **Self-Learning :** Examine real-world case studies on how data cleaning and wrangling impact the accuracy and effectiveness of visualization design.	6	2
3	**Visualizing Distributions & Comparisons**		
	Foundational Charts: Bar charts, Line charts, Scatter plots. **Advanced Charts for Distribution:** Histograms, Box plots, Violin plots. **Visualizing Parts of a Whole:** Pie charts (and their pitfalls), Donut charts, Stacked bar charts, Treemaps. Best Practices for Axis Labels, Titles, and Annotations. Hands-on Lab: Creating these visualizations in Tableau. **Self-learning** : Explore the advantages and limitations of different chart types (histograms, box plots, scatter plots, treemaps) in representing distributions and comparisons.	9	3
4	**Color and Typography in Data Design**		
	Color Theory for Data Visualization: Sequential, Diverging, and Categorical color schemes. Accessibility: Designing for color blindness and contrast. Tools for Choosing Color Palettes (ColorBrewer, Adobe Color). The Role of Typography: Legibility, hierarchy, and annotation. Avoiding Chartjunk and Deceptive Practices.	8	4

	Self-learning : Investigate the impact of color schemes and typography choices on readability, accessibility, and user interpretation of visualizations.		
5	**Introduction to Spatial Data Visualization**		
	Fundamentals of Geospatial Data: Points, Lines, and Polygons. Choropleth Maps: Thematic mapping by geographic regions. Symbol Maps and Proportional Symbol Maps. Dot Density Maps and Heatmaps. Introduction to GIS concepts and geocoding. Hands-on Lab: Creating maps in Tableau. **Self-learning :** Explore real-world applications of choropleth and heat maps in fields like public health, urban planning, and environmental studies.	8	5
6	**Crafting the Data Story & Critique**		
	The Narrative Structure: Setting the context, introducing conflict (the insight), and providing resolution. Annotation as a Storytelling Tool. Designing Effective Dashboards: Layout, visual hierarchy, and interactivity (filters, highlights). Creating a final portfolio piece: From a dataset to a full, annotated dashboard. Peer and Instructor-led Critique Sessions. **Self-learning :** Analyze successful data stories and dashboards from public repositories (e.g., Tableau Public) to understand the use of narrative structure, annotations, and interactivity.	8	6
	Total Hours	**45**	

Exp. No.	List of Experiments	Cos
1	Create simple bar and line charts using Tableau/Power BI to demonstrate how visualization turns data into insights.	CO1
2	Design multiple charts applying Gestalt principles (proximity, similarity, closure) and analyze perception changes.	CO1
3	Visualize the same dataset using variations in color, size, and shape to study the role of preattentive attributes.	CO1
4	Use Tableau Prep/Power Query to clean a raw dataset and prepare it for visualization.	CO2
5	Represent categorical, ordinal, and quantitative data using appropriate visual encodings and compare effectiveness.	CO2
6	Create histograms, box plots, and violin plots for a dataset to understand distribution and detect outliers.	CO2/CO3
7	Compare pie charts, donut charts, stacked bar charts, and treemaps for the same dataset and evaluate strengths and weaknesses.	CO3
8	Design charts using sequential, diverging, and categorical color schemes with appropriate typography; test accessibility.	CO3
9	Create a choropleth map and proportional symbol map using a geographic dataset in Tableau.	CO4
10	Build an interactive dashboard with multiple visualizations, annotations, and filters to narrate a data story.	
11	Annotate a visualization effectively to highlight insights and guide interpretation.	CO4
12	Conduct peer critique of a visualization/dashboard to evaluate clarity, cognitive load, and narrative strength.	

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Evaluation and Assessment Scheme:

1. **Internal Assessment Examination (IAE):**
   Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

2. **End Semester Theory Examination (ESE):**
   End Semester exam of 60 Marks will be conducted based on entire syllabus.

3. **Continuous Assessment (CA):**
   Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All COs / LOs should be covered)

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

1. Assignment
2. Case Study
3. Debate
4. Solution for Social Problems
5. Field Visit
6. Group Project
7. Flipped Classroom
8. Topic Review
9. Quiz
10. Mind Mapping
11. Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

1. Data Mining, Concepts and Techniques: 3rd edition, Jiawei Han, Micheline Kamber and Jian Pei
2. Data Analytics using R, Bharati Motwani, Wiley Publications
3. Python for Data Analysis: 3rd Edition, Wes McKinney ,Publisher(s): O'Reilly Media, Inc.

Text Books:

1. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education services Wiley Publication
2. Data Analytics using Python: Bharati Motwani, Wiley Publications.
3. Practical Statistics for Data Scientists 50+ Essential Concepts Using R and Python, O'Reilly Publications 2nd Edition
4. Practical Text Mining and statistical Analysis for non-structured text data applications,1st edition, Grey Miner, Thomas Hill.

Useful Links:

1. http://varianceexplained.org/RData/
2. https://www.kaggle.com/code/iamleonie/time-series-interpreting-acf-and-pacf
3. https://www.geeksforgeeks.org/data-visualization-using-matplotlib/

Course Title:Environmental Studies												
Semester: IV			Term: EVEN				Course Code: 25CSDSVEC401					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
1	–	--	--	–	--	–	--	--	--	G	--	G

Course Objectives

The course aims to:

1. Develop an understanding of the environment, ecosystems, and their importance to human life.
2. Create awareness about natural resources and their sustainable utilization.
3. Understand various forms of environmental pollution, their causes, effects, and control measures.
4. Familiarize students with biodiversity, conservation strategies, and environmental management.
5. Introduce students to climate change, global environmental issues, and sustainable development.
6. Develop environmental awareness, responsibility, and participation in environmental protection.

Course Outcomes

After successful completion of the course, students will be able to:

- CO1: Explain the basic concepts of environment, ecology, ecosystems, and their interrelationships.
- CO2: Identify different natural resources and analyze methods for their conservation and sustainable utilization.
- CO3: Analyze the causes, effects, and control measures of different types of environmental pollution and waste.
- CO4: Explain the importance of biodiversity and apply appropriate strategies for biodiversity conservation.
- CO5: Analyze major global environmental issues such as climate change, global warming, ozone depletion, and environmental degradation.
- CO6: Apply the principles of sustainable development and environmental ethics to promote responsible environmental practices.

Course Title: Internship I												
Semester: IV			Term: EVEN				Course Code: 25CSDSOJT401					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
--	–	--	–	–	--	01	--	--	--	–	25	25

Introduction

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program helps fresh pass–outs in gaining professional know-how and benefits corporate sectors. The internship also enhances the student's employability skills passing out from Technical Institutions..

Objectives:

1. Integration of workshop with workplace in physical and/or hybrid model.
2. Developing research aptitude in emerging technologies
3. Enhance entrepreneurial capabilities and professional competency
4. Development of decision-making and teamwork skills
5. Cultivate a sense of Social Imagery and Citizenship Responsibility

Outcomes: After completion of this course, students will be able to

1. Apply practical skills effectively in physical and hybrid workplace settings.
2. Conduct and communicate research on emerging technologies.
3. Demonstrate creative problem-solving and an entrepreneurial mindset.
4. Meet industry standards with strong communication and technical skills.
5. Collaborate effectively and make informed decisions within teams.

INTERNSHIP GUIDELINES:

- The students should apply for internships of their choice with the permission of the Institute.
- The internship duration ranges from 4 to 6 weeks and is scheduled during the summer vacation period for students
- Industry will confirm the training slots and the number of seats allocated for internships via confirmation letter/ email.
- Students on joining Training at the concerned Industry / Organization, submit the Joining Report/Letters / Email.

- Students undergo industrial training at the concerned Industry / Organization.
- Training and placement team will visit the industry and evaluate(s) the performance of students regularly and evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
- Students will submit training report after completion of internship.
- Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- It will be evaluated on the basis of the following criteria:
    - ❖ Regularity in maintenance of the diary.
    - ❖ Project/Case study/Completion of assigned task by industry undertaken during the internship
    - ❖ Employer feedback
- Training Certificate to be obtained from industry followed by the presentation in the department.

Bachelor of Technology

In

Computer Science & Engineering

(Data Science)

Third Year

Semester – V

SJCEM: R–24C

Effective from Academic Year

2026-27

Program Structure for Third Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)

Semester V

SCHEME: SJCEMR–24 Scheme C

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
24CSDSPCC501C	PCC	Fundamentals of Data Science	3	-	2	3	-	1	4
24CSDSPCC502C	PCC	Artificial Intelligence	2	-	2	2	-	1	3
24CSDSPEC501XC	PEC	Program Elective - I	3	-	2	3	-	1	4
24CSDSPEC502XC	PEC	Program Elective - II	3	-	-	3	-	-	3
24MDM501XC	MDM	Multidisciplinary Minor	3	-	2	3	-	1	4
24OE501XC	OE	Open Elective I	3	-	-	3	-	-	3
24CSDSVSE501C	VSEC	Employability Enhancement Program -IV (Data Security lab)	-	-	2	-	-	1	1
Total			**17**	**0**	**10**	**17**	**0**	**5**	**22**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/PR	Total
24CSDSPCC501C	PCC	Fundamentals of Data Science	20	20	60	25	25	150
24CSDSPCC502C	PCC	Artificial Intelligence	20	20	60	25	-	125
24CSDSPEC501XC	PEC	Program Elective - I	20	20	60	25	-	150
24CSDSPEC502XC	PEC	Program Elective - II	20	20	60	-	-	100
24MDM501XC	MDM	Multidisciplinary Minor	20	20	60	25	-	125
24OE501XC	OE	Open Elective I	20	20	60	-	-	100
24CSDSVSE501C	VSEC	Employability Enhancement Program -IV (Data Security lab)	-	-	-	25	-	25
Total			**120**	**120**	**360**	**125**	**25**	**750**

Program Electives Courses

Program Electives Courses (PEC)				
	PEC 1		PEC 2	
Semester	**Track 1– DevOps and Cloud Computing**	**Track 2 – Soft and Quantum Computing**	**Track 3– Cyber Security and Ethical Hacking**	**Track 4 – Business Intelligence Developer**
Sem V	Software Engineering and Project Management	Advance Operating System	Cryptography & System Security	Advanced DBMS and SQL for Business Intelligence
Sem VI	DeVops Core Technologies	Distributed and Parallel Computing	Information Security	Data Warehousing and Mining
Sem VII	Cloud Computing	Soft Computing	Intrusion Detection Systems (IDS)	Knowledge Management and Business Intelligence
Sem VII	Cloud Security	Quantum Computing	Ethical Hacking & Penetration Testing	Business Intelligence tools and applications

Semester	**Program Elective I**			
	Track 01		**Track 02**	
	DevOps and Cloud Computing		**Soft and Quantum Computing**	
Sem V	24CSDSPEC5011C	Software Engineering and Project Management	24CSDSPEC5012C	Advance Operating System

Semester	**Program Elective II**			
	Track 03		**Track 04**	
	Cyber Security and Ethical Hacking		**Business Intelligence Developer**	
Sem V	24CSDSPEC5021C	Cryptography & System Security	24CSDSPEC5022C	Advanced DBMS and SQL for Business Intelligence

Open Elective I Courses

Semester	**Track 01**		**Track 02**	
	Entrepreneurship		**Research Methodology**	
	Code	**Subject**	**Code**	**Subject**
V	24OE5011C	Design Thinking	24OE5012C	Research Methodology

Semester	**Track 03**		**Track 04**	
	Foreign Language		**Business Management**	
	Code	**Subject**	**Code**	**Subject**
V	24OE50131C	Foreign Language I - Japanese	24OE5014C	Basics of Marketing Management
	24OE50132C	Foreign Language I – German		

Syllabus

for

Third Year

Computer Science & Engineering (Data Science)

Semester – V

SJCEM : R–24C

(With Effect from 2026-27)

Course Title: Fundamentals of Data Science												
Semester: V			Term: Odd			Course Code: 24CSDSPCC501C						
Teaching Scheme						Evaluation Scheme						
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	--	2	3	--	1	4	20	20	60	25	25	150
Sustainable Development Goals Mapped: 4, 8, 9, 11, 16, 17												

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. Understand the fundamental concepts of Data Science, Big Data, and diverse data types.
2. Apply the Data Science Process for data acquisition, preparation, and exploration.
3. Explain the principles of learning from data for analytical problem solving.
4. Analyze techniques for handling and processing large datasets.
5. Examine fundamental text analytics methods for extracting insights from textual data.
6. Utilize visualization techniques to effectively communicate analytical findings.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Identify data types, data sources, and applications of Data Science in real-world domains.
2. Perform data collection, cleaning, transformation, and exploratory analysis using the Data Science Process.
3. Explain supervised, unsupervised, and semi-supervised learning paradigms for data-driven applications.
4. Apply appropriate tools and techniques for analyzing large datasets and case studies.
5. Analyze textual data using fundamental text mining and text analytics techniques.
6. Develop visualizations and dashboards to communicate data-driven insights effectively.

Module	Content	Hours	COs	RBT Level
I	**Data Science Concepts and Data Types** Introduction to Data Science and Big Data, applications of data science in various domains, data-driven decision making, data lifecycle, characteristics of Big Data, types of data, structured and unstructured data, natural language data, machine-generated data, graph and network data, multimedia data (audio, image, and video), streaming data, data sources, challenges in handling different data types, and real-world examples of data science applications. **Self-Learning:** Open Data Repositories and Public Datasets for Data Science.	8	1	L2
II	**Data Science Process and Data Preparation** Overview of the Data Science Process, defining research goals and objectives, problem formulation, project planning, data collection and retrieval, data quality assessment, data cleaning and preprocessing, handling missing values and inconsistencies, data integration, data transformation, exploratory data analysis, basic statistical measures, data visualization techniques, pattern identification, and preparation of datasets for analysis. **Self-Learning Topic:** Data Cleaning Techniques Using Spreadsheet and Python Tools.	7	2	L3
III	**Introduction to Learning from Data** Concept of learning from data, applications in data science, overview of predictive analytics, role of learning techniques in the data science workflow, introduction to Python-based analytical tools, feature selection concepts, training and testing datasets, model validation concepts, prediction of new observations, fundamentals of supervised learning, fundamentals of unsupervised learning, semi-supervised learning, and simple real-world examples of classification and clustering. **Self-Learning Topic:** Exploring Beginner-Friendly Machine Learning Applications.	8	3	L2
IV	**Data Handling and Analytical Case Studies** Challenges in handling large datasets, efficient data storage and processing techniques, selecting suitable algorithms and data structures, analytical tool selection, programming practices for data analysis, efficient use of computing resources, introduction to predictive analytics through case studies, recommender system	8	4	L4

	concepts, and application of the data science process to real-world problems. **Self-Learning Topic:** Introduction to Cloud-Based Data Analytics Platforms.			
V	**Text Analytics Fundamentals** Introduction to text mining and text analytics, applications of text analytics, text preprocessing, tokenization, bag-of-words representation, stemming and lemmatization, basic text classification concepts, introduction to Natural Language Processing tools, analysis of textual datasets, and application of the data science process to text data. **Self-Learning Topic:** Chatbots and Conversational AI: A Basic Overview.	7	5	L4
VI	**Data Visualization and Communication** Importance of data visualization, principles of effective visual communication, common visualization techniques, charts and graphs for data analysis, exploratory and explanatory visualization, interactive data visualization concepts, dashboard fundamentals, dashboard development tools, presentation of analytical findings, storytelling with data, and communicating insights to decision-makers. **Self-Learning Topic:** Business Intelligence Dashboards and Data Storytelling.	7	6	L3
Total		**45**		

Sr No.	List of Experiment	COs
1.	Data Collection and Dataset Exploration using Public Datasets	CO1
2.	Data Types and Data Structures using Python and Pandas	CO1
3.	Data Cleaning and Preprocessing of Real-World Datasets	CO2
4.	Data Transformation and Feature Engineering Techniques	CO2
5.	Exploratory Data Analysis (EDA) using Statistical Measures	CO2

6.	Correlation Analysis and Pattern Identification in Datasets	CO2
7.	Implementation of a Simple Classification Problem	CO3
8.	Implementation of a Simple Clustering Problem	CO3
9.	Text Data Preprocessing: Tokenization, Stemming, and Lemmatization	CO5
10.	Text Analytics using Bag-of-Words and Word Frequency Analysis	CO5
11.	Data Visualization using Charts, Graphs, and Plots	CO6
12.	Development of an Interactive Dashboard for Data Visualization	CO6

Reference Books:

1. An Introduction to Statistical Learning with Applications in Python, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani and Jonathan Taylor
2. Introduction to Data Mining: 2nd Edition, Pang-Ning Tan, Michael Steinbach, Anuj Karpatne and Vipin Kumar
3. Fundamentals of Data Visualization, Claus O. Wilke

Textbooks:

1. Data Science for Business, Foster Provost and Tom Fawcett
2. Doing Data Science: Straight Talk from the Frontline, Cathy O'Neil and Rachel Schutt
3. Data Science from Scratch: 2nd Edition, Joel Grus
4. Practical Statistics for Data Scientists: 2nd Edition, Peter Bruce, Andrew Bruce and Peter Gedeck
5. Python for Data Analysis: 3rd Edition, Wes McKinney

Useful Links:

1. **Data Science Methodology**, Coursera
   https://www.coursera.org/learn/data-science-methodology
2. **Data Science A-Z: Hands-On Exercises & ChatGPT Prize [2026]**, Udemy
   https://www.udemy.com/course/datascience
3. **Python for Data Science and Machine Learning Bootcamp**, Udemy
   https://www.udemy.com/course/python-for-data-science-and-machine-learning-bootcamp

4. **Data Science for Beginners**, Microsoft Learn
https://learn.microsoft.com/en-us/training/paths/data-science
5. **Introduction to Data Science**, edX
https://www.edx.org/learn/data-science
6. **Data Analysis with Python**, freeCodeCamp
https://www.freecodecamp.org/learn/data-analysis-with-python

Course Title: Artificial Intelligence												
Semester: V			**Term: Odd**				**Course Code: 24CSDSPCC502C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
2	**-**	**2**	**2**	**-**	**1**	**3**	**20**	**20**	**60**	**25**	**--**	**125**
Sustainable Development Goals Mapped: 4, 8, 9, 11, 16, 17												

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. Understand the foundations, concepts, and applications of Artificial Intelligence.
2. Analyze intelligent agents, agent architectures, and environment characteristics.
3. Apply AI-based problem-solving and search techniques.
4. Apply knowledge representation, reasoning, perception, and learning concepts.
5. Examine probabilistic reasoning techniques for decision making under uncertainty.
6. Evaluate the capabilities, limitations, and societal implications of intelligent systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Explain the fundamentals of AI, its perspectives, evolution, opportunities, challenges, and ethical considerations.
2. Analyze intelligent agents, agent architectures, and the characteristics of different AI environments.
3. Apply search and problem-solving techniques to develop AI-based solutions.
4. Apply knowledge representation, reasoning, perception, and learning techniques to develop intelligent systems.
5. Analyze probabilistic reasoning techniques for decision making under uncertainty.
6. Evaluate the capabilities, limitations, ethical issues, and societal impact of intelligent systems. Course Outcomes:

Module	Contents	Hours	COs	RBT Level
I	**Introduction to Artificial Intelligence** Fundamentals of Artificial Intelligence and its significance, AI perspectives including acting humanly, thinking humanly, acting rationally, and thinking rationally, evolution and milestones in AI development. Applications of AI across various domains, current trends and state of AI, opportunities and challenges in AI adoption, and ethical, social, and responsible AI considerations. **Self-learning Topics:** Ethical Frameworks, Continuous Learning Human-in-the-Loop Approaches	5	CO1	L2
II	**Intelligent Agents** Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents. Types of Agents: Simple Reflex, Model Based, Goal Based, Utility Based Agent. Environment Types: Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent. Performance Measure, Environment, Actuators and Sensors (PEAS) Framework for Intelligent Agents **Self-learning Topics:** Genetic Representation of Agents, Fitness Evaluation	5	CO2	L3
III	**Solving Problems by Searching** AI Problem Solving and Search Strategy Evaluation. Uninformed search techniques: Breadth First Search, Depth First Search, Uniform Cost Search and Iterative Deepening Search, heuristic functions and admissible heuristics, Informed search techniques: Greedy Best First Search and A* Search. Local search using Hill Climbing, game playing and adversarial search, Mini-Max algorithm, and Alpha-Beta pruning. **Self-learning Topics:** Metaheuristic Algorithms for Problem Solving	5	CO3	L3
IV	**Knowledge Representation and Reasoning** Introduction to knowledge and knowledge representation, issues and properties of knowledge representation systems, propositional logic including syntax, semantics, logical connectives and truth tables, predicate logic fundamentals, quantifiers and inference rules, reasoning using forward	5	CO4	L3

	chaining and backward chaining, and introduction to logic programming using PROLOG. **Self-Learning Topic:** Advanced applications of Propositional and First-Order Predicate Logic in intelligent systems.			
V	**Reasoning Under Uncertainty** Fundamentals of uncertainty in Artificial Intelligence, representation and handling of uncertain knowledge, random variables and probability concepts, prior and posterior probabilities, probabilistic inference using joint probability distributions, Bayes' theorem and its applications, Bayesian belief networks, construction of belief networks, and reasoning under uncertainty using probabilistic models. **Self-learningTopics:** Bayesian Optimization	5	CO5	L4
VI	**Learning, Planning and Expert Systems** Introduction to AI planning and planning problems, learning in Artificial Intelligence, learning agents, concepts of supervised, unsupervised, semi-supervised and reinforcement learning, overview of expert systems, components of expert systems including knowledge base, inference engine, working memory and user interface, knowledge acquisition, and applications of expert systems in real-world domains. **Self-Learning Topic:** Transfer Learning, Generative Adversarial Networks (GANs), and Development Tools for Expert Systems.	5	CO6	L4
	Total	30		

Sr No.	List of Experiment	COs
1.	Design and Analysis of PEAS for Real-World Intelligent Agents	CO2
2.	Classification of Agent Environments and Agent Types for Given Scenarios	CO2
3.	Implementation of a Simple Reflex Agent and Goal-Based Agent	CO2
4.	Implementation of Breadth First Search (BFS) and Depth First Search (DFS)	CO3
5.	Implementation of Uniform Cost Search and Iterative Deepening Search	CO3

6.	Implementation of Greedy Best First Search and A* Search Algorithms	CO3
7.	Implementation of Mini-Max Algorithm with Alpha-Beta Pruning	CO3
8.	Implementation of Forward Chaining and Backward Chaining Techniques	CO3
9.	Development of Simple PROLOG Programs for Knowledge Representation	CO4
10.	Computation of Prior and Posterior Probabilities and Bayesian Inference	CO5
11.	Implementation of a Basic Learning Model and Design of a Simple Rule-Based Expert System	CO 5
12.	Case study of any existing successful AI system	CO6

Reference Books:

1. Ivan Bratko, PROLOG Programming for Artificial Intelligence, Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall
3. Saroj Kaushik, Artificial Intelligence, Cengage Learning
4. Davis E. Goldberg, Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989.
5. Patrick Henry Winston, Artificial Intelligence‖, Addison-Wesley, Third Edition
6. N. P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press.

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight Artificial Intelligence Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008
3. George F Luger Artificial Intelligence‖ Low Price Edition, Pearson Education., Fourth edition

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc22_cs56/preview
2. https://nptel.ac.in/courses/106105077
3. http://www.classcentral.com/course/independent-elements-of-ai-12469

Course Title: Software Engineering and Project Management												
Semester: V			Term: Odd				Course Code: 24CSDSPEC5021B					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	-	125

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment, TW: Term Work

Course Objectives: The course aims:

1. To provide the knowledge of software engineering discipline.
2. To understand requirements and analyze them.
3. To do planning and apply scheduling.
4. To apply analysis, and develop software solutions.
5. To demonstrate and evaluate real time projects with respect to software engineering principles and Apply testing and assure quality in software solution.
6. To understand the need of project management and project management life cycle.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand and use basic knowledge in software engineering.
2. Identify requirements, analyze and prepare models.
3. Plan, schedule and track the progress of the projects.
4. Design & develop the software solutions for the growth of society.
5. Apply testing and assure quality in software solutions.
6. Generate project schedules and can construct, design and develop network diagrams for different type of Projects.

Module	Contents	Hours	COs
I	**Introduction to Software Engineering** Nature of Software, Software Engineering, Software Process, Capability Maturity Model (CMM) Generic Process Model, Prescriptive Process Models: The Waterfall Model, V-model, Incremental Process Models, Evolutionary Process Models, Concurrent Models, Agile process, Agility Principles, Extreme Programming (XP), Scrum, Kanban model **Self-Learning Topics:** Software development life cycle, Software Requirement specification	9	CO1
II	**Requirements Analysis and Cost Estimation** Software Requirements: Functional & non-functional – user-system requirement engineering process – feasibility studies – elicitation – validation & management – software prototyping – S/W documentation – Analysis and modelling Requirement Elicitation, Software requirement specification (SRS) 3Ps (people, product and process) Process and Project metrics Software Project Estimation: LOC, FP, Empirical Estimation Models - COCOMO II Model. **Self-Learning Topics:** Elicitation Techniques, cost estimation	7	CO2
III	**Design Engineering** Design Process & quality, Design Concepts, The design Model, Pattern- based Software Design. Architectural Design: Design Decisions, Views, Patterns, Application Architectures, Modeling Component level Design: component, Designing class based components, conducting component- level design, User Interface Design: The golden rules, Interface Design steps & Analysis, Design Evaluation **Self-Learning Topics:** Design Engineering, Design Process	8	CO3
IV	**Software Risk, Configuration Management** Risk Identification, Risk Assessment, Risk Projection, RMMM Software Configuration management, SCM repositories, SCM process Software Quality Assurance Task and Plan, Metrics, Software Reliability, Formal Technical Review (FTR), Walkthrough. **Self-Learning Topics:** Resources allocation, Project Risk	6	CO4
V	**Software Testing and Maintenance** Testing: Software Quality, Testing: Strategic Approach, Strategic Issues- Testing: Strategies for Conventional Software, Object oriented software, Web Apps Validating Testing -	6	CO5

	System Testing - Art of Debugging. Maintenance : Software Maintenance-Software Supportability-Reengineering - Business Process Reengineering - Software Reengineering - Reverse Engineering- Restructuring - Forward Engineering. **Self-Learning Topics:** Impact analysis, monitoring		
VI	**IT Project Management and Project Scheduling** Introduction, 4 P's, W5HH Principle, Need for Project Management, Project Life cycle and ITPM, Project Feasibility, RFP, PMBOK. Knowledge areas, Business Case, Project Planning, Project Charter and Project Scope. Project Scheduling: Defining a Task Set for the Software Project, Timeline charts WBS, Developing the Project Schedule, Network Diagrams (AON, AOA), CPM and PERT, Gantt Chart , Tracking the Schedule, Earned Value Analysis **Self-Learning Topics:** Project character and scope ,Risk management	9	CO6
	Total	**45**	

Exp. No.	List of Experiments	COs
1.	To prepare a Problem Statement for the mini project.	CO1
2.	To select and apply two traditional process models for selected projects.	CO2
3.	To apply agile process model for selected projects.	CO2
4.	To develop requirements specification and prepare Software Requirement Specification (SRS) document in IEEE format for a mini project	CO3
5.	To perform structured data flow analysis using Data Flow Diagram.	CO3
6.	To estimate the cost of a project using software metrics (LOC and FP analysis).	CO4
7.	To schedule the project using CPM/PERT.	CO5
8.	To track the project using Gantt chart.	CO5
9.	To write test cases for white box testing.	CO5
10.	To write test cases for black box testing.	CO5

11.	To prepare RMMM Plan.	CO6
12.	To perform Version control using Subversion.	CO6

Reference Books:

1. Software Engineering : A Precise Approach, Pankaj Jalote, Wiley India
2. Ian Sommerville, Software Engineering, 9th edition Pearson Education ISBN-13: 978-0- 13- 703515-1, ISBN-10: 0-13-703515-2
3. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa.

Text Books:

1. Roger S. Pressman, Software Engineering: A practitioner's approach, McGraw Hill
2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India
3. John M. Nicholas, Project Management for Business and Technology, Education.

Useful Links:

1. https://onlinecourses.swayam2.ac.in/cec21cs21/preview
2. https://nptel.ac.in/courses/106101061
3. http://www.nptelvideos.com/video.php?id=911&c=9 4

Course Title: Advanced Operating System													
Semester: V			Term: Odd				Course Code: 24CSDSPEC5012C						
Teaching Scheme							Evaluation Scheme						
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total	
Th	Tu	Pr	Th	Tu	Pr								
3	--	2	3	--	1	4	20	20	60	25	25	150	

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

The course aims:

1. To understand the structure and functionality of modern operating systems.
2. To learn virtualization technologies and resource management techniques.
3. To analyze the principles of parallel and distributed computing systems.
4. To understand distributed objects, middleware, and Internet computing frameworks.
5. To study fault tolerance, failures, and recovery mechanisms in distributed environments.
6. To explore real-time, multimedia, and security aspects of modern computing systems.

Course Outcomes:

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

1. Explain the architecture and services of operating systems.
2. Apply virtualization concepts for efficient resource utilization.
3. Analyze the design and operation of parallel and distributed systems.
4. Illustrate the role of distributed objects, middleware, and Internet computing technologies.
5. Evaluate failure handling and recovery techniques in distributed environments.
6. Assess real-time, multimedia, and security requirements in modern computing systems.

Module	Contents	Hours	COs
I	**Operating System Fundamentals and Structure (7 Hours)** Introduction to operating systems, functions and services of operating systems, operating system structures and architectures, system calls, kernel design concepts, process and thread management, CPU scheduling techniques, memory management fundamentals, and case studies of modern operating systems.	7	CO1
II	**Virtualization and Resource Management** Concepts of virtualization, hardware virtualization, operating system virtualization, application virtualization, virtual machines and hypervisors, container-based virtualization, resource allocation and isolation, virtualization in cloud computing, performance considerations, and applications of virtualization technologies.	7	CO2
III	**Parallel and Distributed Systems** Fundamentals of parallel computing, multiprocessor and multicore architectures, characteristics and goals of distributed systems, communication models in distributed environments, distributed system architectures, synchronization and coordination mechanisms, distributed file systems, and applications of parallel and distributed computing	8	CO3
IV	**Distributed Objects, Middleware, and Internet Computing** Distributed object systems, remote procedure calls (RPC), remote method invocation (RMI), middleware concepts and services, service-oriented architecture (SOA), web services, microservices architecture, Internet computing models, and cloud-based Internet applications.	8	CO6
V	**Distributed Subsystems, Failures, and Recovery** Distributed subsystem design principles, logical clocks and event ordering, consistency and replication models, fault models in distributed systems, failure detection techniques, checkpointing and recovery mechanisms, reliability, availability, and fault tolerance in distributed computing environments.	7	CO4
VI	**Real-Time, Multimedia, and Security Systems (8 Hours)**	8	CO5

	Introduction to real-time operating systems, real-time scheduling techniques, multimedia systems and their resource requirements, multimedia synchronization and scheduling, security threats in operating and distributed systems, authentication mechanisms, access control models, cryptographic techniques, and security in distributed and Internet computing environments.		
	Total	**45**	

Exp. No.	Experiment Title	CO Mapping
1	Study of Operating System Components and Architecture	CO1
2	Demonstration of Process Creation and Process States in Linux/Windows	CO1
3	Study of CPU Scheduling Algorithms using Simulation Tools	CO1
4	Installation and Configuration of a Virtual Machine using VirtualBox/VMware	CO2
5	Creation and Management of Multiple Virtual Machines	CO2
6	Study of Container-Based Virtualization using Docker	CO2
7	Demonstration of Parallel Processing using Multithreading Programs	CO3
8	Implementation of Inter-Process Communication (IPC) Mechanisms	CO3
9	Study of Distributed System Architecture and Communication Models	CO3
10	Demonstration of Remote Procedure Call (RPC) or Remote Method Invocation (RMI)	CO4
11	Study of Middleware Services and Web Service Communication	CO4
12	Exploration of Internet Computing Platforms and Cloud Services	CO4
13	Simulation of Fault Detection and Recovery in Distributed Systems	CO5
14	Study of Checkpointing and Recovery Mechanisms in Distributed Systems	CO5
15	Demonstration of Real-Time Scheduling and Basic Security Mechanisms in Operating Systems	CO6

Text Books

1. Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Wiley.
2. Modern OperatOperating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Wiley.ing Systems, Andrew S. Tanenbaum, Herbert Bos, Pearson Education.
3. Distributed Systems: Principles and Paradigms, Andrew S. Tanenbaum, Maarten Van Steen, Pearson Education.
4. Distributed Systems: Concepts and Design, George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Pearson Education.

References

1. Operating Systems: Internals and Design Principles, William Stallings, Pearson Education.
2. Distributed Computing: Principles, Algorithms, and Systems, Cambridge University Press.
3. Real-Time Systems, Jane W. S. Liu, Pearson Education.
4. Computer Security: Principles and Practice, Pearson Education.

Online Learning Resources / Video Lectures

1. NPTEL – Operating Systems
    - NPTEL Operating Systems Course
2. NPTEL – Distributed Systems
    - NPTEL Distributed Systems Course
3. MIT OpenCourseWare – Operating System Engineering
    - MIT OCW Operating System Engineering
4. Stanford University – Distributed Systems (Video Lectures)
    - Stanford Distributed Systems Lectures

Course Title: Cryptography and System Security												
Semester: VI			**Term: Even**				**Course Code: 24CSDSPEC5021C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**-**	**-**	**3**	**-**	**-**	**3**	**20**	**20**	**60**	**-**	**-**	**100**

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course aims:

1. To introduce cryptographic fundamentals and number theory.
2. To explain symmetric, hash-based, and public-key cryptography.
3. To familiarize students with authentication and PKI.
4. To introduce secure communication protocols and standards.
5. To develop skills in using cryptographic tools.
6. To enable the design of secure applications.

Course Outcomes:

1. Explain information security goals, classical cryptography, finite fields, and number theory.
2. Apply encryption and decryption techniques for confidentiality and authentication.
3. Evaluate message authentication and integrity verification mechanisms using cryptographic hashes.
4. Apply digital signature algorithms to ensure authentication and secure communication.
5. Analyze network attacks and evaluate security protocols such as SSL, IPSec, and PGP.
6. Design secure applications using cryptographic and authentication mechanisms.

Module	Contents	Hours	COs
I	**Introduction & Number Theory** Services, Mechanisms and attacks-the OSI security architecture Network security model-Classical Encryption techniques (Symmetric cipher model, mono-alphabetic and poly-alphabetic substitution techniques: Vigenère cipher, play fair cipher, Hill cipher, transposition techniques: keyed and keyless transposition ciphers, steganography) **Self-Learning Topics:** Prime number, hash function	8	CO1
II	**Block Ciphers & Public Key Cryptography** Data Encryption Standard-Block cipher principles-block cipher modes of operation Advanced Encryption Standard (AES)-Triple DES Blowfish-RC5 algorithm. Public key cryptography: Principles of public key cryptosystems: The RSA algorithm, The knapsack algorithm, El Gamal Algorithm. Key management – Diffie Hellman Key exchange **Self-Learning Topics:** Block Cipher Modes of Operation, data encryption standard	8	CO2
III	**Cryptographic Hashes, Message Digests and Digital Certificates** Authentication requirement – Authentication function, Types of Authentication, MAC – Hash function – Security of hash function and MAC –MD5 – SHA – HMAC – CMAC, Digital Certificate: X.509, PKI **Self-Learning Topics:** Fast computation, Collision Resistances	8	CO3
IV	**Digital signature schemes and authentication Protocols** Digital signature and authentication protocols: Needham Schroeder Authentication protocol, Digital Signature Schemes – RSA, EI Gamal and Schnorr, DSS **Self-Learning Topics:** Digital signature, Token-based authentication	7	CO6
V	**System Security**	7	CO4

	Authentication, Authorization Operating System Security: Memory and Address Protection, File Protection Mechanism, User Authentication. Linux and Windows: Vulnerabilities, File System Security Database Security: Database Security Requirements, Reliability and Integrity. **Self-Learning Topics:** Sensitive Data, Inference Attacks, Multilevel Database Security		
VI	**Web security** Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Web Browser Attacks, Web Bugs, Clickjacking, Cross Site Request Forgery, Session Hijacking and Management, Phishing Technique, DNS Attack, Secure Electronic Transaction, Email Attacks, Firewalls, Penetration Testing **Self-Learning Topics:** Cross-Site Request Forgery, Security Misconfigurations	7	CO5
	Total	**45**	

Exp. No.	**List of Experiments**	**COs**
1.	Design and Implementation of a product cipher using Substitution and Transposition ciphers	CO1
2.	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal.	CO1
3.	Implementation of Diffie Hellman Key exchange algorithm	CO2
4.	For varying message sizes, test integrity of message using MD-5, SHA-1, and analyse the performance of the two protocols. Use crypt APIs.	CO3
5.	Exploring wireless security tools like Kismet, NetStumbler etc.	CO5
6.	Study the use of network reconnaissance tools like WHOIS, dig, traceroute, nslookup to gather information about networks and domain registrars.	CO4, 6

7.	Study of packet sniffer tools Wireshark :- 1. Observer performance in promiscuous as well as non-promiscuous mode. 2. Show the packets can be traced based on different filters.	CO1, 3
8.	Download and install Nmap. Use it with different options to scan open ports, perform OS fingerprinting, do a ping scan, tcp port scan, udp port scan, etc. .	CO1, 3
9.	Detect ARP spoofing using Nmap and/or open source tool ARPWATCH and Wireshark	CO1, 6
10.	Use the NESSUS/ISO Kaali Linux tool to scan the network for vulnerabilities	CO5

Reference Books:

1. Web Application Hackers Handbook by Wiley.
2. Computer Security, Dieter Gollman, Third Edition, Wiley
3. CCNA Security Study Guide, Tim Boyle, Wiley
4. Introduction to Computer Security, Matt Bishop, Pearson.
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif , O'Reilly
6. Cryptography and Network Security, Atul Kahate, Tata Mc Graw Hill

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education.
2. Security in Computing, Charles P. Pfleeger, Fifth Edition
3. Network Security and Cryptography, Bernard Menezes, Cengage Learning.
4. Network Security Bible, Eric Cole, Second Edition, Wiley
5. Mark Stamp's Information Security Principles and Practice, Wiley

Useful Links:

1. https://nptel.ac.in/courses/106105031
2. https://onlinecourses.nptel.ac.in/noc22_cs03/preview
3. https://www.coursera.org/learn/basic-cryptography-and-crypto-api

Course Title: Design Thinking													
Semester: V			Term: ODD				Course Code: 24OE5011C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/ PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination ESE:
End Semester Examination
CA: Continuous Assessment, TW: Term Work

Course Objectives:

1. To introduce a learner to the principles of Design Thinking
2. To familiarize a learner with the process (stages) of Design Thinking
3. To expose a learner to various case studies of Design Thinking

Course Outcomes:

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

1. To compare traditional approach to problem solving with the Design Thinking approach and discuss the principles along with the process of Design Thinking
2. To define a user persona using Empathy Mapping
3. To frame a problem statement using various Design Thinking tools
4. To select best idea among the ideas generated through various Design Thinking tools
5. To create prototypes using engineering principles
6. To test the prototypes and gather feedback for refining the prototype

Module	Contents	Hours	COs
I	**Introduction to Design Thinking** Definition, comparison of traditional approach with Design Thinking, process (stages) of Design Thinking, case studies	6	CO1
II	**Creating User Persona** Interview technique, user observation technique, creation of empathy map	8	CO2
III	**Defining problem statement** Cause and effect, mind mapping and journey maps technique	8	CO3
IV	**Ideation** Brain storming, Bench marking and prioritizing technique	8	CO4
V	**Prototype generation** Rules of prototype generation, Low and high-fidelity prototypes, Prototyping techniques - Paper, Digital and 3D prototyping	8	CO5
VI	**Testing the prototype** Evaluation techniques: Interviews, User observation, Wireframing, A/B Testing	7	CO6
	Total	**45**	

Sr. No.	Suggested Activities List	COs
1.	Conducting user interviews and observations for a specific product or system to identify user pain points. Prepare an empathy map.	CO1
2.	Developing detailed user personas based on their empathy research.	CO2
3.	Synthesizing the findings from user research to define a clear problem statement in engineering terms.	CO3
4.	Performing a brainstorming session within the group using mind mapping techniques to generate creative solutions to the defined problem.	CO4

5.	Creating a prototype for selected idea using engineering principles. Prototype could be a physical model, electronic circuits, web or mobile app or a combination of these.	CO5
6.	Testing the prototype with the users and gathering feedback to create refined prototype.	CO6

Reference Books:

1. Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School, Idris Mootee, Wiley, 2013
2. Change by Design, Tim Brown, Harper Business, 2009

Text Books:

1. Design Thinking: Methodology Book, Emrah Yayichi, 2016
2. Handbook of Design Thinking: Christian Mueller-Roterberg, 2018

Useful Links:

1. Empathy map: https://www.nngroup.com/articles/empathy-mapping/
2. Prototyping: https://staragile.com/blog/prototype-in-design-thinking
3. Design Thinking case studies:
   https://voltagecontrol.com/blog/8-great-design-thinking-examples/
   https://dyworks.in/design-thinking-case-studies/

Course Title: Research Methodology												
Semester: V			Term: ODD				Course Code: 24OE5012C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/ PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. Understand the fundamental concepts of research including constructs, hypotheses, propositions,
2. Differentiate among various types of research and apply appropriate research.
3. Design effective
4. Apply the stages of the scientific research process from problem identification to report writing.
5. Formulate a relevant and feasible research problem considering key practical factors such as data availability and interpretation.
6. Evaluate research outcomes critically, test validity, and address ethical issues while presenting actionable recommendations.

Course Outcomes:

1. Understand fundamental research concepts such as constructs, hypotheses, postulates.
2. Identify and differentiate various types of research (e.g., basic, applied, analytical, empirical)
3. Develop an appropriate research and sample design, identifying stages and techniques, and recognize potential sampling errors.
4. Apply the scientific research process, from selecting a research problem to preparing the final report, including data collection, analysis, and hypothesis testing
5. Formulate a relevant and feasible research problem
6. Evaluate research outcomes by testing validity, addressing ethical issues, and proposing practical recommendations based on findings.

Module	Contents (All Modules are hands on only)	Hours	COs
I	**Module 1: Introduction and Basic Research Concepts** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences, Objectives of Research, Issues and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	10	1
II	**Module 2: Types of Research** Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	8	2
III	**Module 3: Research Design and Sample Design** Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	8	3
IV	**Module 4: Research Methodology** Meaning of Research Methodology ,Stages in Scientific Research Process: Identification and Selection of Research Problem, Formulation of Research Problem, Review of Literature, Formulation of Hypothesis, Formulation of research Design, Sample Design , Data Collection, Data= Analysis, Hypothesis testing and Interpretation of Data, Preparation of Research Report	6	4
V	**Module 5: Formulating Research Problem** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	8	5
VI	**Module 6: Outcome of Research** Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	5	6
	Total	**45**	

Reference Books:

1. Uma Sekaran & Roger Bougie, *Research Methods for Business: A Skill Building Approach*, Wiley.
2. Donald R. Cooper & Pamela S. Schindler, *Business Research Methods*, McGraw Hill.
3. Zikmund, Babin, Carr & Griffin, *Business Research Methods*, Cengage Learning.

Textbooks:

1. C.R. Kothari & Gaurav Garg, *Research Methodology: Methods and Techniques*, New Age International Publishers.
2. Ranjit Kumar, *Research Methodology: A Step-by-Step Guide for Beginners*, SAGE Publications.

Course Title: Foreign Language – I (German)												
Semester: V			**Term: Odd**				**Course Code: 24OE50131C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**--**	**--**	**3**	**--**	**--**	**3**	**20**	**20**	**60**	**--**	**--**	**100**

Sustainable Development Goals Mapped: 4 , 11

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To enable students to communicate basic information in German through greetings, introductions, and simple conversations.
2. To develop foundational grammar skills including verb conjugation, articles, pronouns, and sentence structure.
3. To build essential vocabulary for everyday situations, hobbies, places, family, and professions.
4. To introduce students to German culture and geography while enhancing their reading, writing, listening, and speaking abilities.

Course Outcomes: Learner will be able to…

1. To introduce themselves and others, use the German alphabet, and engage in basic conversations related to profession and origin.
2. Apply fundamental grammar rules, including verb conjugations and personal pronouns, to form meaningful sentences in present tense.
3. Use appropriate vocabulary and sentence structures to talk about hobbies, countries, languages, and leisure activities.
4. Describe places, housing types, and give directions using relevant vocabulary and composite words.
5. Express daily routines and events in present and past tenses using separable verbs, question forms, and time expressions.
6. Interact effectively in real-life situations using modal verbs, prepositions, negations, and vocabulary related to places, family, and professions

Module	Contents	Hours	COs
I	Introduction to German Language Sichbegrüßen (Greetings),Sichvorstellen (Self-introduction) Das Alphabet & Deutsche Buchstabiertafel (German Alphabet & Spelling),Beruf und Herkunftangeben (Professions & Origin) Wer bin ich? (Who am I?),Anderevorstellen (Introducing Others),Telefonieren (Telephoning),Rechnen (Basic Calculations)	08	1
II	Grammar Basics and Daily Expressions KonjugationPräsens: trinken / kommen / sein,Wiespätist es? /Wie viel Uhr istes?,DiePersonalpronomen,Formelloderinformell – du oder Sie?,Begrüßung und Verabschiedung,Verben – arbeiten / machen / sein Kurssprache: schreiben / lesen / hören / sprechen / sehenmarkieren / ergänzen / unterstreichen / kreuzen,Artikel: ein/eine/ein – kein/keine/kein – der/die/das	08	2
III	Vocabulary Building and Communication Singular/Plural – Nomen schreiben, lernen,DasWörterbuchAdjektive,WasistIhrHobby?,Länder in EuropaWährungen,Sprachen:Muttersprache/Fremdsprache,Un regelmäßigeVerben – sprechen / lesen / essen / sehen Was machen/tun Sie in der Freizeit?	08	3
IV	Cultural Awareness and Descriptions Die Landkarte von Europa,Sehenswürdigkeiten in Indien und Europa,UnsereHeimat,Häuser und WohnungstypenDas Arbeitszimmer, Schlafzimmer, Küche, Balkonetc.Einfamilienhaus, Altbauwohnung, Studentenwohnheim etc. Die Wohnung – Richtungen,Kompositabilden – Wörterkombinieren	07	4

V	Grammar Deep Dive and Routine Activities Es gibt…,Subjekt/Objekt - Nominativ / AkkusativVerben: haben, schlafen, finden (Konjugation + Akkusativ),Personalpronomen&Possessivartikel,Wochentage / Wochenende,Präsens / Präteritum: sein / waren, haben / hattenDer Tagesablauf / Mein Alltag,TrennbareVerben,Fragen: Ja/Nein-Fragen, Wann...? Wie lange...?,Die Jahreszeiten / Der Feiertag	07	5
VI	Practical Usage and Modal Verbs Präpositionen: auf / unter / vor / hinter / im / in / an / über / zwischen / neben,Negation: nicht / nein / nie,Zahlen: Kardinalzahlen / Ordinalzahlen,Wobekommt man was? (Places & Common Phrases),in der Schule, imSupermarkt, am Bahnhof, in der Bibliothek, etc.,DieFamilie: Beschreibung, Familienbaum, Berufe,Modalverben: können, müssen, möchten, wollen, sollen, dürfen	07	6
	Total	**45**	

Reference Books:

1. Schritte international Neu A1.1, Daniela Niebisch, Sylvette Penning-Hiemstra, Franz Specht, Hueber Verlag, 2023
2. The Everything Learning German Book, Ed Swick, Adams Media, 2022 German Made Simple: Learn to Speak and Understand German Quickly and Easily, Arnold Leitner, Crown Publishing Group, 2021
3. Living Language German, Complete Edition, Living Language Staff, Penguin Random House, 2021

Text Books:

1. Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Klett Sprachen Verlag, 2024
2. Menschen A1 Kursbuch, Angela Pude and Franz Specht, Hueber Verlag, 2024
3. Berliner Platz Neu 1, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, Langenscheidt Publishing Group, 2024

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc20_hs41/preview
2. https://onlinecourses.nptel.ac.in/noc21_hs30/preview

Course Title: Foreign Language - I (Japanese)

Semester: V	Term: ODD	Course Code:24OE50132C

Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Oral/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	–	–	3	–	–	3	20	20	60	–	–	100

Sustainable Development Goals Mapped: 4 , 11

IAE: Internal Assessment Examination

ESE: End Semester Examination

Course Objectives:

1. Develop basic Japanese communication skills through everyday conversations and classroom activities.
2. Learn Japanese scripts, vocabulary, particles, and sentence structures.
3. Apply grammar concepts such as verb tenses, counters, pronouns, and particles correctly.
4. Improve listening, speaking, reading, and writing skills through practice and revision.
5. Build confidence in using elementary Japanese in practical situations.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand Japanese scripts, greetings, basic vocabulary, and self-introduction expressions.
2. Read and write Hiragana and Katakana and use common classroom phrases correctly.
3. Construct simple Japanese sentences using basic particles and vocabulary.
4. Use family vocabulary, counters, pronouns, and date expressions appropriately.
5. Apply time expressions, days, and particles in sentence formation.
6. Use basic verb tense forms and particles accurately in simple communication.

Module	Contents	Hours	COs
I	**Introduction to Japanese Language** Introduction to Japanese language, Japanese scripts, Hiragana, greetings and basic phrases, suffixes related to nationality, language, and country. **Self-Learning:** Hiragana writing practice, greetings conversation, nationality vocabulary exercises, basic phrase reading	7	CO1
II	**Scripts and phrases** Katakana, classroom phrases, vocabulary building, word formation using Hiragana and Katakana, numbers (1–10), quizzes, dictation, and phrase-based activities. **Self-Learning:** Katakana writing practice, classroom phrase activities, number practice, dictation exercises	8	CO2
III	**Sentence structure & particle.** Basic sentence structures, sentence formation, conversational reading, particles (ka, mo, wa, no), numbers (11–50), suffixes for age, month, and year, and revision. **Self-Learning:** Sentence formation practice, particle usage exercises, conversational reading, number writing	8	CO3
IV	**Family and Counters** Vocabulary development, dates, family-related vocabulary, counters for people and objects, pronouns (kore, sore, are / kono, sono, ano), and sentence formation using pronouns. **Self-Learning:** Family vocabulary practice, pronoun usage exercises, date writing, counters practice	8	CO4

V	**Date and time & particle** Revision, sentence formation, days of the week, suffixes for hours and minutes, particles indicating time for actions, verb-based vocabulary, and sentence construction using verbs. **Self-Learning:** Days and time expression practice, verb sentence formation, particle usage activities, speaking exercises	8	CO5
VI	**Verb tenses & particle III** Verb tenses including present tense, past tense, non-past negative tense, and past negative tense; vocabulary enhancement; particles (を)wo(で) de). **Self-Learning:** Verb tense exercises, vocabulary building, sentence construction using particles を and で, paragraph writing	6	CO6
	Total	**45**	

Reference Books (R): Not applicable.

Text Books(T): Not applicable

Online References: Not applicable

Course Title: Basics of Marketing Management												
Semester: V			**Term: ODD**				**Course Code: 24OE5014C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**-**	**-**	**3**	**-**	**-**	**3**	**20**	**20**	**60**	**-**	**-**	**100**
Sustainable Development Goals Mapped: 4 , 11												

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. To introduce basic concepts and functions of marketing.
2. To help students understand consumer behavior and market segmentation.
3. To familiarize students with product, pricing, promotion, and distribution strategies.
4. To provide an understanding of modern marketing trends including digital and green marketing.
5. To enable engineering students to apply marketing principles in technology-driven environments.

Course Outcomes:

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

1. Define key marketing terms and explain the role of marketing in organizations...
2. Analyze consumer behavior and segment markets effectively
3. Apply the marketing mix (4Ps) in real-world scenarios.
4. Evaluate marketing strategies using SWOT and competitor analysis.
5. Identify and explain emerging marketing practices such as digital, green, and social marketing.
6. Integrate basic marketing knowledge into engineering projects and innovations

Module	Contents	Hours	COs
I	**Introduction to Marketing** Definition, nature, scope, and importance of marketing Core marketing concepts: Needs, Wants, Demand, Value, Exchange Evolution of marketing: Production to Relationship orientation Role of marketing in business and society **Self-learning Topic:** Case Study Analysis – How Apple Uses Marketing to Create Customer Value	**06**	CO1
II	**Understanding the Market and Consumer Behavior** Marketing environment: Micro and Macro Buyer decision process – stages and influencing factors Market segmentation: Bases and strategies Targeting and Positioning (STP) **Self-learning Topic:** Consumer Behavior Models (e.g., AIDA, Maslow's Hierarchy) and Their Real-World Applications	08	CO2
III	**Marketing Mix - Product and Price** Product: Levels, types, lifecycle, new product development Branding, Packaging, and Labeling Pricing: Objectives, strategies, and methods Factors affecting pricing decisions **Self-learning Topic:** Skimming vs. Penetration Pricing – Strategies Used by Tech Startups	08	CO3
IV	**Marketing Mix - Place and Promotion** Distribution channels: Types and functions Retailing, Wholesaling, and Logistics Promotion mix: Advertising, Sales Promotion, Public Relations, Direct Marketing, Personal Selling Integrated Marketing Communication (IMC) **Self-learning Topic:** Role of Influencer Marketing in Brand Promotion	08	**CO3**

V	**Strategic Marketing and Modern Trends** SWOT analysis and marketing planning BCG Matrix, Ansoff Matrix Digital Marketing: SEO, SEM, Social Media Marketing, Email Marketing E-commerce and m-commerce strategies **Self-learning Topic:** Google Ads vs. Social Media Ads – ROI Comparison and Strategy Design	**08**	**CO4, CO5**
VI	**Social Responsibility and Applications of Marketing** Green marketing and sustainability Ethical issues in marketing Rural marketing in India Applying marketing principles to engineering innovations/ startups **Self-learning Topic:** Marketing Strategies for Rural India – Case of Patanjali or Amul	07	**CO5, CO6**
	Total	**45**	

Suggested Activities and Mini Project:

- Case study analysis on marketing strategies of tech companies
- Group presentation on digital marketing tools
- Survey-based project on consumer behavior for a product
- Role-play for product launching and branding
- Design a basic marketing plan for an engineering project/startup

Reference Books:

1. S.A. Sherlekar, Marketing Management, Himalaya Publishing.
2. Grewal & Levy, Marketing, McGraw-Hill Education.
3. Tracy L. Tuten, Principles of Marketing for a Digital Age, SAGE Publications.

Text Books:

1. Philip Kotler, Marketing Management, Pearson Education.
2. Ramaswamy & Namakumari, Marketing Management: Global Perspective Indian Context, Macmilla

Course Title: Employability Enhancement Program -IV (Data Security lab)												
Semester: V			Term: Odd				Course Code:					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
-	-	2	-	-	1	1	-	-	-	25	-	25

Course Objectives :

1. To understand the fundamental concepts of data security, privacy, and information protection techniques.
2. To implement cryptographic algorithms such as encryption, hashing, and digital signatures for securing data.
3. To develop practical skills in implementing authentication, authorization, and secure access control mechanisms.
4. To apply privacy-preserving techniques such as data anonymization, k-anonymity, and differential privacy for secure data publishing and sharing.
5. To implement secure storage mechanisms for protecting sensitive datasets using encryption and other security techniques.
6. To design and evaluate intelligent security solutions using machine learning techniques for intrusion detection and cyber threat analysis.

Course Outcome

After successful completion of the course, students will be able to:

1. Apply data anonymization techniques to protect sensitive information while preserving data utility.
2. Implement cryptographic techniques including AES, SHA-256, hash functions, and digital signatures to ensure data confidentiality, integrity, and authenticity.
3. Develop authentication and Role-Based Access Control (RBAC) mechanisms for secure access to information systems.
4. Implement privacy-preserving data publishing and sharing techniques using k-anonymity and differential privacy.
5. Design secure data storage solutions using encryption and data protection mechanisms.
6. Develop machine learning-based intrusion detection systems to identify and mitigate security threats.

Sr No.	List of Experiment
1	To implement data anonymization techniques for protecting sensitive information in datasets.
2	To encrypt and decrypt dataset contents using the AES algorithm.
3	To implement secure password hashing using the SHA-256 algorithm.
4	To verify data integrity using cryptographic hash functions.
5	To implement Role-Based Access Control (RBAC) for secure data access.
6	To implement digital signatures for dataset authentication and verification.
7	To implement k-anonymity for privacy-preserving data publishing.
8	To apply differential privacy techniques for secure data sharing.
9	To implement secure storage of datasets using encryption techniques.
10	To develop an intrusion detection system using machine learning algorithms.
11	To develop a phishing email detection system using machine learning.
12	To detect fraudulent credit card transactions using anomaly detection techniques.

Bachelor of Technology

In

Computer Science & Engineering (Data Science)

Third Year
Semester – VI

SJCEM: R–25

Effective from Academic Year

2026-27

Program Structure for Second Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)

Semester VI

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
25CSDSPCC601C	PCC	Big Data Analytics	3	-	2	3	-	1	4
25CSDSPCC602C	PCC	Machine Learning	2	-	2	2	-	1	3
25CSDSPEC601XC	PEC	Program Elective - III	3	-	2	3	-	1	4
25CSDSPEC602XC	PEC	Program Elective - IV	3	-	-	3	-	-	3
25MDM601XC	MDM	Multidisciplinary Minor	-	-	4	-	-	2	2
25CSDSVSE601C	VSEC	Employability Enhancement Program -V (Industry Certification)	-	-	2	-	-	1	1
25CSDSVSE602C	VSEC	AI Ethics for DS	2	-	-	2	-	-	2
25CSDSPRJ601C	PRJ	Major Project Phase - I	-	-	4	-	-	**2**	**2**
25CSDSOJT601C	OJT	Internship II	-	-	3	-	-	1	1
		Total	**13**	**0**	**19**	**13**	**0**	**9**	**22**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/ PR	Total
25CSDSPCC601C	PCC	Big Data Analytics	20	20	60	25	25	150
25CSDSPCC602C	PCC	Machine Learning	20	20	60	25	25	150
25CSDSPEC601XC	PEC	Program Elective - III	20	20	60	25	25	150
25CSDSPEC602XC	PEC	Program Elective - IV	20	20	60	-	-	100
25MDM601XC	MDM	Multidisciplinary Minor	-	-	-	50	-	50
25CSDSVSE601C	VSEC	Employability Enhancement Program - V (Industry Certification)	-	-	-	-	25	25
25CSDSVSE602C	VSEC	AI Ethics for DS	10	10	30	-	-	50
25CSDSPRJ601C	PRJ	Major Project Phase - I	-	-	-	50	-	50
25CSDSOJT601C	OJT	Internship II	-	-	-	-	25	25
		Total	**90**	**90**	**270**	**175**	**125**	**750**

Syllabus

for

Third Year

Computer Science & Engineering (Data Science)

Semester – VI

SJCEM: R–25

(With Effect from 2026-27)

Course Title: Big Data Analytics												
Semester: VI			Term: EVEN				Course Code: 25CSDSPCC601C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed

1. To provide an overview of an exciting growing field of big data analytics
2. To introduce programming skills to build simple solutions using big data technologies such as MapReduce and scripting for NoSQL, and the ability to write parallel algorithms for multiprocessor execution
3. To teach the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems in decision support.
5. To provide an indication of the current research approaches that is likely to provide a basis for tomorrow's solutions.

Course Outcomes:

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

1. Understand the key issues in big data management and its associated applications for business decisions and strategy.
2. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Map reduce and NoSQL in big data analytics.
3. Collect, manage, store, query and analyze various forms of Big Data.
4. Interpret business models and scientific computing paradigms,and apply software tools for big data analytics.
5. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
6. Solve Complex real world problems in various applications like recommender systems, social media applications, health and medical systems, etc.

Module	Contents	Hours	Cos

I	**Introduction to Big Data and Hadoop** Introduction to Big Data, Big Data Characteristics, Types of Big Data, Traditional versus Big Data Business Approach, Case Study of Big Data Solutions, Concept of Hadoop, Core Hadoop Components, Hadoop Ecosystem. **Self-learning Topics:** Recent Trends in Big Data Technologies, Hadoop Distributions, Big Data Applications.	7	CO1
II	**Hadoop HDFS and MapReduce** Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File System Organization, MapReduce: Map Tasks, Grouping by Key, Reduce Tasks, Combiners, Details of MapReduce Execution, Coping with Node Failures, Algorithms Using MapReduce: Matrix-Vector Multiplication, Relational Algebra Operations, Computing Selections, Computing Projections, Union, Intersection, and Difference using MapReduce, Hadoop Limitations. **Self-learning Topics:** YARN Architecture, Hadoop Cluster Setup, Performance Optimization in MapReduce.	8	CO2
III	**NoSQL** Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data Architecture Patterns: Key-Value Stores, Graph Stores, Column Family (Bigtable) Stores, Document Stores, Variations of NoSQL Architectural Patterns, NoSQL Case Study, NoSQL Solutions for Big Data, Types of Big Data Problems, Analyzing Big Data with a Shared-Nothing Architecture, Choosing Distribution Models: Master-Slave versus Peer-to-Peer, NoSQL Systems for Handling Big Data Problems. **Self-learning Topics:** Comparison of NoSQL Databases (MongoDB, Cassandra, HBase, Redis), CAP Theorem, ACID versus BASE Properties.	8	CO3
IV	**Mining Data Streams** The Stream Data Model, Data Stream Management System (DSMS), Examples of Stream Sources, Stream Queries, Issues in Stream Processing, Sampling Data Techniques in a Stream, Filtering Streams: Bloom Filter and its Analysis, Counting Distinct Elements in a Stream, Count-Distinct Problem, Flajolet-Martin Algorithm, Combining Estimates, Space Requirements, Counting Ones in a Window, Cost of Exact Counts, Datar-Gionis-Indyk-Motwani (DGIM) Algorithm,	7	CO4

	Query Answering in the DGIM Algorithm, Decaying Windows. **Self-learning Topics:** Stream Processing Frameworks (Apache Storm, Spark Streaming, Flink), Count-Min Sketch, Real-Time Analytics Applications.		
V	**Real-Time Big Data Models** Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Case Study: Product Recommendation, Social Networks as Graphs, Clustering of Social Network Graphs, Direct Discovery of Communities in a Social Graph. **Self-learning Topics:** Hybrid Recommendation Systems, Graph Analytics, Real-Time Recommendation Engines.	8	CO5
VI	**Data Analytics with R** Exploring Basic Features of R, Exploring R GUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and Using Objects, Interacting with Users, Handling Data in R Workspace, Executing Scripts, Creating Plots, Accessing Help and Documentation in R, Reading Datasets and Exporting Data from R, Manipulating and Processing Data in R, Using Functions Instead of Scripts, Built-in Functions in R, Data Visualization: Types and Applications. **Self-learning Topics:** Advanced Data Visualization with ggplot2, Data Manipulation using dplyr, Introduction to Statistical Analysis and Machine Learning in R.	7	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS. -Programming exercises on Hadoop	CO1
2	Use of Sqoop tool to transfer data between Hadoop and relational database servers. a. Sqoop - Installation.	CO1

	b. To execute basic commands of Hadoop eco system component Sqoop.	
3	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands	CO3
4	Experiment on Hadoop Map-Reduce: -Write a program to implement a word count program using MapReduce.	CO2
5	Experiment on Hadoop Map-Reduce: -Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc	CO2
6	Create HIVE Database and Descriptive analytics-basic statistics.	CO2
7	Data Stream Algorithms (any one): - Implementing DGIM algorithm using any Programming Language - Implement Bloom Filter using any programming language Implement Flajolet Martin algorithm using any programming language	CO4
8	Social Network Analysis using R (for example: Community Detection Algorithm)	CO5
9	Data Visualization using Hive/PIG/R/Tableau/	CO6
10	Exploratory Data Analysis using Spark/ Pyspark.	CO3
11	Mini Project: One real life large data application to be implemented (Use standard Da- tasets available on the web). -Streaming data analysis – use flume for data capture, HIVE/PYSpark for analysis of twitter data, chat data, weblog analysis etc. - Recommendation System (for example: Health Care System, Stock Market Predic- tion, Movie Recommendation, etc.) SpatioTemporal DataAnalytics	CO1,CO2, CO3,CO4, CO5,CO6

Reference Books

1. Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics‖,Wiley
2. Chuck Lam, ―Hadoop inAction‖, Dreamtech Press
3. Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners‖,Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010
6. Ronen Feldman and James Sanger, ―The Text Mining Handbook: Advanced

Approaches in Analyzing Unstructured Data‖, Cambridge University Press, 2006.

7. Vojislav Kecman, ―Learning and Soft Computing‖, MITPress, 2010.

Textbooks:

1. Cre Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge UniversityPress
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan Mcary and Ann Kelly ―Making Sense of NoSQL‖ – A guide for managers and the rest of us, Manning Press.
4. DT Editorial Services, "Big Data Black Book", Dreamtech Press.
5. EMC Education Services,"Data Science and Big Data Analytics",Wiley.

Useful Links

1. https://hadoop.apache.org/
2. https://spark.apache.org/
3. https://www.mongodb.com/docs/
4. https://www.r-project.org/

Course Title: Machine Learning												
Semester: VI			Term: EVEN				Course Code: 25CSDSPCC602C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
2	-	2	2	-	1	3	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives: The course aims

1. To introduce the basic concepts and techniques of Machine Learning.
2. To acquire in depth understanding of various supervised and unsupervised algorithms
3. To be able to apply various ensemble techniques for combining ML models
4. To demonstrate dimensionality reduction techniques.

Course Outcomes:

At the end of the course students will be able:

1. To acquire fundamental knowledge of developing machine learning models.
2. To select, apply and evaluate an appropriate machine learning model for the given
3. To demonstrate ensemble techniques to combine predictions from different models.
4. To demonstrate the dimensionality reduction techniques.

Module	Contents	Hours	Cos
I	**Introduction to Machine Learning** Machine Learning, Types of Machine Learning, Issues in Machine Learning, Applications of Machine Learning, Steps in Developing a Machine Learning Application, Training Error, Generalization Error, Overfitting, Underfitting, Bias-Variance Trade-off. **Self-learning Topics:** Fundamentals of Machine Learning, Neural Network Learning.	5	CO1
II	**Learning with Regression and Trees** Learning with Regression: Linear Regression, Multivariate Linear Regression, Logistic Regression, Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART), Performance Metrics: Confusion Matrix, Kappa Statistics, Sensitivity, Specificity, Precision, Recall, F-Measure, ROC Curve. **Self-learning Topics:** Decision Trees, Regression, Classification.	10	CO2
III	**Ensemble Learning** Understanding Ensemble Learning, K-Fold Cross Validation, Boosting, Decision Stumping, XGBoost, Bagging, Subagging, Random Forest, Comparison with Boosting, Different Ways to Combine Classifiers. **Self-learning Topics:** Role of Classifiers, Validation.	07	CO3
IV	**Learning with Classification** Support Vector Machine (SVM), Constrained Optimization, Optimal Decision Boundary, Margins and Support Vectors, SVM as a Constrained Optimization Problem, Quadratic Programming, SVM for Linear and Nonlinear Classification, Basics of Kernel Trick, Support Vector Regression (SVR), Multiclass Classification. **Self-learning Topics:** Key Concepts of Machine Learning and Related Algorithms.	09	CO4
V	**Learning with Clustering** Introduction to Clustering, Overview of Distance Metrics, Major Clustering Approaches, Graph-Based Clustering: Clustering with	08	CO5

	Minimum Spanning Tree (MST), Model-Based Clustering: Expectation Maximization (EM) Algorithm, Density-Based Clustering: DBSCAN. **Self-learning Topics:** Clustering, Graph, Minimum Spanning Tree (MST).		
VI	**Dimensionality Reduction** Dimensionality Reduction Techniques, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Singular Value Decomposition (SVD). **Self-learning Topics:** Linear Analysis, Reduction Techniques.	06	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	To implement Linear Regression.	CO1, CO2
2	To implement Logistic Regression.	CO2
3	To implement Ensemble learning (bagging/boosting)	CO2
4	To implement multivariate Linear Regression.	CO2
5	To implement SVM	CO2
6	To implement PCA/SVD/LDA	CO2
7	To implement Graph Based Clustering	CO3
8	To implement DB Scan	CO3
9	To implement CART	CO3
10	To implement LDA	CO3

Reference Books:

1. Han Kamber, ―Data Mining Concepts and Techniques‖, Morgan Kaufmann Publishers
2. Margaret. H. Dunham, ―Data Mining Introductory and Advanced Topics, Pearson Education
3. Kevin P. Murphy , Machine Learning ― A Probabilistic Perspective‖
4. Samir Roy and Chakraborty, ―Introduction to soft computing‖, Pearson Edition.
5. Richard Duda, Peter Hart, David G. Stork, ―Pattern Classification‖, Second Edition, Wiley Pub-lications.

Text Books:

1. Peter Harrington, ―Machine Learning n Action‖, DreamTech Press
2. Ethem Alpaydın, ―Introduction to Machine Learning‖, MIT Press
3. Tom M. Mitchell, ―Machine Learning‖ McGraw Hill
4. Stephen Marsland, ―Machine Learning An Algorithmic Perspective‖, CRC Press

Useful Links

1. Data sets for Machine Learning algorithms: https://www.kaggle.com/datasets
2. Machine Learning repository- https://archive.ics.uci.edu/ml/index.php
3. Machine Learning from Coursera
4. https://towardsdatascience.com/machine-learning/home
5. https://onlinecourses.nptel.ac.in/noc21_cs85/preview

Course Title: Modern Operating System												
Semester: VI			Term: EVEN				Course Code:25CSDSPEC6011C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed to:

1. To understand the role and functions of various system software components in the development and execution of application programs.
2. To study the design and implementation of system programs including assemblers, macro processors, linkers, loaders, and compilers.
3. To analyze different phases of program translation, linking, loading, and execution in modern computing systems.
4. To develop the ability to apply system software concepts for designing efficient language processors and program execution environments.

Course Outcomes:

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

1. Explain the concepts, functions, and components of system software and their role in program development and execution.
2. Design and implement assemblers and macro processors using appropriate data structures and algorithms.
3. Analyze the working principles of linkers and loaders for efficient program linking, relocation, and loading.
4. Apply lexical analysis and parsing techniques in the design and implementation of compiler front-end components.
5. Analyze syntax-directed translation, intermediate code generation, code optimization, and runtime environment for compiler construction.
6. Design and evaluate compiler components to develop efficient language processing systems for real-world programming languages.

Module	Contents	Hours	COs
I	**Introduction to Advanced Operating Systems:** Functions of Operating Systems, Design Approaches (Layered, Kernel-based, Virtual Machine), Types of Advanced Operating Systems: Network Operating System (NOS), Distributed Operating System (DOS), Multiprocessor OS, Mobile OS, Real-Time OS, Cloud OS. **Self-learning Topics:** Evolution of Operating Systems, Linux and Windows Kernel Architecture.	6	CO1
II	**UNIX Kernel and File Management:** System Structure, User Perspective, UNIX Architecture, Buffer Cache, Buffer Pool, Reading and Writing Buffers, File Representation, Inodes, Directory Structure, Path Conversion to Inode, Superblock, Inode Assignment, Disk Block Allocation. **Self-learning Topics:** Linux File Systems (ext4, XFS), Journaling File Systems.	8	CO2
III	**UNIX Process and Memory Management:** Process Structure, Kernel Data Structures, U-area, Process Table, Process States and Transitions, Process Context, Context Switching, Memory Layout, Regions, Page Tables, Virtual-to-Physical Address Mapping. **Self-learning Topics:** Virtual Memory Optimization, Memory Protection Mechanisms.	4	CO2
IV	**Distributed Operating System Concepts:** Goals of Distributed Operating Systems, Distributed Computing Models, Hardware and Software Concepts, DOS Architecture, Design Issues: Transparency, Flexibility, Scalability, Reliability, Performance, Fault Tolerance. **Self-learning Topics:** Distributed File Systems, Cloud-based Distributed Systems.	8	CO3

V	**Multiprocessor Operating Systems:** Introduction, Multiprocessor Architectures, Design Issues, Threads, Process Synchronization (Test-and-Set, Swap Instruction), Process Waiting, Processor Scheduling, Co-scheduling, Smart Scheduling, Affinity-based Scheduling. **Self-learning Topics:** Multicore Scheduling, NUMA Architecture.	8	CO4
VI	**Real-Time Operating Systems and Mobile Operating Systems:** Characteristics and Classification of RTOS, Clock-driven Cyclic Scheduling, Event-driven Scheduling, Earliest Deadline First (EDF), Rate Monotonic Scheduling (RMS), Mobile OS Architecture, Android OS, iOS, Virtual Operating Systems, Cloud Operating Systems, Design Issues. **Self-learning Topics:** Embedded Operating Systems, Wearable Device Operating Systems, Kubernetes-based Cloud OS.	11	CO5, CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	COs
1	Study of Linux/UNIX operating system architecture, kernel components, and basic shell commands.	CO1
2	Implement process creation and management using system calls (`fork()`, `exec()`, `wait()`, `exit()`) in Linux.	CO2
3	Implement Inter-Process Communication (IPC) using Pipes, Shared Memory, Message Queues, or Semaphores.	CO3
4	Simulate process synchronization using Mutexes and Semaphores for Producer–Consumer and Reader–Writer problems.	CO3
5	Study and implement file management operations in Linux (file creation, permissions, inode information, directory management).	CO2
6	Simulate distributed system concepts such as Remote Procedure Call (RPC) or Client–Server communication using Socket Programming.	CO4
7	Implement multithreading using POSIX Threads (Pthreads) and analyze thread synchronization. .	CO5

8	Simulate processor scheduling algorithms (FCFS, Round Robin, Priority, Affinity Scheduling) and compare their performance.	CO5
9	Study and simulate Real-Time Scheduling Algorithms such as Earliest Deadline First (EDF) and Rate Monotonic Scheduling (RMS).	CO6
10	Study virtualization and cloud operating systems by creating and managing Virtual Machines using VirtualBox/VMware or containers using Docker.	CO6

Reference Books:

1. Rajib Mall, Real-Time Systems: Theory and Practice, 1st Edition, Pearson Education India, 2006.
2. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, Operating System Concepts, 10th Edition, Wiley.
3. Andrew S. Tanenbaum and Herbert Bos, Modern Operating Systems, 5th Edition, Pearson.
4. D. M. Dhamdhere, Operating Systems – A Concept Based Approach, McGraw-Hill Education.

Text Books:

1. Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, 2nd Edition, Pearson Education, 2016.
2. William Stallings, Operating Systems: Internals and Design Principles, 8th Edition, Prentice Hall, 2014.

Useful Links

1. GeeksforGeeks – Operating Systems
   https://www.geeksforgeeks.org/operating-systems/
2. TutorialsPoint – Operating System
   https://www.tutorialspoint.com/operating_system/
3. Operating Systems: Three Easy Pieces (OSTEP)
   https://pages.cs.wisc.edu/~remzi/OSTEP/
4. The Linux Kernel Documentation
   https://docs.kernel.org/

Course Title: Distributed and Parallel Computing												
Semester: VI			Term: EVEN				Course Code: 25CSDSPEC6012C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed to:

1. To introduce the fundamental concepts and architecture of parallel and distributed computing systems.
2. To understand various parallel programming models, including multithreaded programming and Message Passing Interface (MPI).
3. To study the design, implementation, and performance analysis of parallel and distributed computing systems.
4. To familiarize students with GPU computing and its applications in high-performance computing.
5. To develop knowledge of cloud computing concepts and their role in distributed and scalable computing environments.

Course Outcomes:

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

1. Explain the architecture, characteristics, and programming models of parallel and distributed computing systems.
2. Develop parallel computing solutions using multithreading, OpenMP, and Message Passing Interface (MPI).
3. Design and implement distributed applications using inter-process communication and distributed system concepts.
4. Apply GPU computing techniques and cloud computing technologies to solve computationally intensive problems.

5. Analyze the performance, scalability, synchronization, and fault tolerance of parallel and distributed computing systems.
6. Evaluate and recommend appropriate parallel, distributed, and cloud-based computing solutions for real-world applications.

Module	Contents	Hours	Cos
I	**Introduction to Parallel Processing Architecture:** Introduction to Parallel Processing, Parallelism in Sequential Machines, Abstract Model of Parallel Computer, Multiprocessor Architecture, Pipelining, Array Processors, Flynn's Taxonomy, Instruction-Level Support for Parallel Programming, Multiprocessor Caches and Cache Coherence, Non-Uniform Memory Access (NUMA). **Self-learning Topics:** SIMD and Vector Processors, Modern Multicore Architectures, Parallel Computing Applications.	8	CO1
II	**Parallel Programming:** Data Dependency Analysis: Types of Dependencies, Loop and Array Dependence, Loop Dependence Analysis, Shared Memory Programming, Process Creation, Mutual Exclusion, Principles of Message Passing Programming, Send and Receive Operations, MPI (Message Passing Interface), Topologies and Communicators, Collective Communication, OpenMP Programming Model, Dense Matrix Algorithms, Matrix Multiplication, Solving Linear Equations. **Performance Measures:** Execution Time, Speedup, Efficiency, Cost, Scalability, Granularity, Amdahl's Law, Gustafson's Law, Performance Bottlenecks. **Self-learning Topics:** Hybrid MPI-OpenMP Programming, Parallel Sorting Algorithms.	8	CO2
III	**GPU Architecture and Programming:** GPU Architecture, Parallel Algorithm Design, Data Parallelism, CUDA Programming Model, CUDA Kernel, Thread Organization, Memory Hierarchy, Heterogeneous Programming, Introduction to CUDA Programming, Multi-GPU Computing. **Self-learning Topics:** NVIDIA CUDA Toolkit, OpenCL Programming, GPU Performance Optimization.	8	CO3
IV	**Introduction to Distributed Computing:** Definition, Goals and Characteristics of Distributed Computing, Distributed Computing Models, Software Concepts, Multithreading, Clock Synchronization, Physical and Logical Clocks, Election Algorithms, Distributed Mutual Exclusion, Distributed	8	CO4

	Transactions, Deadlocks, Comparison between Parallel and Distributed Architectures. **Self-learning Topics:** Distributed Operating Systems, Consensus Algorithms (Paxos, Raft).		
V	**Communication in Distributed Systems:** Message Passing, Message Buffering, Message Formats, Multi-Datagram Messaging, Group Communication, Remote Procedure Call (RPC), Parameter Passing, Remote Method Invocation (RMI), Distributed Objects, Static and Dynamic RMI, Java RMI, Message-Oriented Communication, Persistent and Transient Communication Models. **Self-learning Topics:** gRPC Framework, Apache Kafka, RESTful Distributed Services.	9	CO5
VI	**Cloud Computing and Virtualization:** Introduction to Cloud Computing, Cloud Components, NIST Cloud Model, Cloud Deployment Models, Cloud Service Models (IaaS, PaaS, SaaS), Cloud Architecture, Advantages and Limitations of Cloud Computing, Virtualization, Hypervisors (Type I & Type II), CPU, Memory and I/O Virtualization, KVM, Xen, VMware, Hyper-V, Amazon Web Services (EC2, S3, EBS). **Self-learning Topics:** Docker, Kubernetes, Serverless Computing, Microsoft Azure and Google Cloud Platform.	4	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	Basics of MPI (Message Passing Interface)	CO1
2	Implementation of advanced MPI Programs.	CO1
3	Basics of OpenMP API.	CO1
4	Shared Memory Programming using OpenMP API.	CO1
5	Setting up CUDA Development Environment.	CO2
6	Programming in CUDA a. Multiplication b. Parallel Sort	CO2
7	Creating distributed applications using RPC / RMI.	CO3
8	Implementation of Election Algorithms.	CO4

9	Implementation of Mutual Exclusion Algorithms.	CO4
10	Implementation of SaaS, PaaS and IaaS using AWS.	CO5
11	Basics Programs using Go Language.	CO6
12	Concurrent Programming using Go routines.	CO6
13	Concurrent Programming using Go channels.	CO6
14	Basics Programs using Julia Language.	CO6
15	Concurrent Programming using Julia.	CO6
16	Implementation of Julia Ecosystem.	CO6

Reference Books:

1. Pradeep K. Sinha, "Distributed Operating Systems", 1 st Edition, Prentice Hall of India Private Limited, 2012.
2. Georg Hager and Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers", Chapman & Hall / CRC Computational Science series, 2011.
3. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", 1 st Edition, McGraw-Hill International Editions, Computer Science Series, 2008.
4. Kai Hwang and Zhiwei Xu, "Scalable Parallel Computing: Technology, Architecture, Programming", McGraw Hill, 1998.
5. Laurence T. Yang and MinyiGuo, "High- Performance Computing: Paradigm and Infrastructure", Wiley, 2006.

Textbooks:

1. M. Sasikumar, Dinesh Shikhare and P. Ravi Prakash, "Introduction to Parallel Processing", 2nd Edition, PHI, 2014.
2. Sunita Mahajan and Seema Shah, "Distributed Computing", 2nd Edition, Oxford, 2010.
3. Andrew S. Tanenbaum and Maarten van Steen, "Distributed Systems: Principles and Paradigms", 3 rd Edition, Prentice Hall of India Private Limited, 2017.
4. Ananth Grama, Anshul Gupta, George Karypis and Vipin Kumar, "Introduction to Parallel Computing", 2nd Edition, Pearson Education, 2007.
5. Kai Hwang and Naresh Jotwani, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", 2 nd Edition, McGraw Hill, 2010.
6. Edward Kandrot and Jason Sanders, "CUDA by Example – An Introduction to General Purpose GPU Programming", Addison-Wesley Professional, 2010.
7. Benedict R. Gaster, Lee Howes, David R Kaeli, Perhaad Mistry and Dana Schaa, "Heterogeneous Computing with OpenCL", 2nd Edition, Elsevier, 2013.

Useful Links

1. https://computing.llnl.gov/tutorials/parallel_comp/
2. http://www.cs.swarthmore.edu/~newhall/unixlinks.html#nw
3. https://www.cs.swarthmore.edu/~newhall/cs87/references.html
4. https://golang.org/doc/tutorial/

Course Title: Information Security												
Semester: VI			Term: EVEN			Course Code: 25CSDSPEC6021C						
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed to:

1. To understand the fundamental concepts of cryptography, network security, and secure communication systems.
2. To study encryption techniques, cryptographic algorithms, hashing, message authentication, and public key cryptography.
3. To analyze authentication protocols, Public Key Infrastructure (PKI), and security protocols such as Kerberos, IPsec, SSL/TLS, and secure email.
4. To apply cryptographic techniques and network security principles to design, implement, and evaluate secure communication systems and applications.

Course Outcomes:

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

1. Explain the fundamental concepts of information security, security goals, cryptographic services, attacks, and classical encryption techniques.
2. Apply symmetric key, asymmetric key, and public key cryptographic algorithms for secure encryption, decryption, authentication, and key exchange.
3. Analyze cryptographic hash functions, message authentication codes (MAC), digital signatures, authentication protocols, and Public Key Infrastructure (PKI) for secure communication.
4. Evaluate network security threats, TCP/IP vulnerabilities, and implement appropriate security mechanisms including firewalls, IDS/IPS, SSL/TLS, IPsec, and secure email systems.
5. Identify and mitigate web application security vulnerabilities based on the OWASP Top 10, including SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), and

Server-Side Request Forgery (SSRF).

6. Examine emerging security technologies including Artificial Intelligence, Machine Learning, and Blockchain-based security mechanisms to analyze modern cyber threats and develop secure systems.

Module	Contents	Hours	Cos
I	**Introduction and Classical Cryptography:** Security Goals, Security Services, Security Mechanisms, Types of Security Attacks, Classical Encryption Techniques, Symmetric Cipher Model, Mono-alphabetic and Poly-alphabetic Substitution Ciphers (Caesar, Vigenère, Playfair, Affine, Hill Cipher), Transposition Techniques (Keyed and Keyless), Steganography. **Self-learning Topics:** Caesar Cipher, Rail Fence Cipher, Modern Applications of Steganography.	7	CO1
II	**Block Ciphers and Public Key Cryptography:** Block Cipher Principles, Modes of Operation (ECB, CBC, CFB, OFB, CTR), DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Public Key Cryptography, RSA Algorithm, Diffie-Hellman Key Exchange, Man-in-the-Middle Attack, Elliptic Curve Cryptography (ECC). **Self-learning Topics:** Hybrid Cryptography, Post-Quantum Cryptography.	8	CO2
III	**Cryptographic Hashing and Digital Signatures:** Authentication Requirements, Authentication Functions, Types of Authentication, Message Authentication Code (MAC), Cryptographic Hash Functions, MD5, SHA Family, Digital Signatures, Needham-Schroeder Authentication Protocol, RSA Digital Signature, Digital Certificates (X.509), Public Key Infrastructure (PKI). **Self-learning Topics:** SHA-3, Certificate Authorities, Blockchain Hashing.	8	CO3
IV	**Network Security and Security Applications:** TCP/IP Vulnerabilities, Packet Sniffing, ARP Spoofing, Port Scanning, IP Spoofing, TCP SYN Flood, DNS Spoofing, Denial of Service (DoS) and Distributed DoS (DDoS), Firewalls, Intrusion Detection Systems (HIDS, NIDS), Honeypots, Kerberos, SSL, TLS, IPsec (AH & ESP), Secure Email (PGP, S/MIME), Key Management. **Self-learning Topics:** Zero Trust Security, VPN Technologies,	7	CO4

	Next-Generation Firewalls.		
V	**OWASP Top 10 Web Security Risks:** Introduction to OWASP, OWASP Top 10 (2013, 2017, 2021), SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Server-Side Request Forgery (SSRF), Secure Coding Practices and Vulnerability Mitigation Techniques. **Self-learning Topics:** OWASP ZAP Tool, Secure Software Development Lifecycle (SSDLC).	8	CO5
VI	**Emerging Technologies in Cybersecurity:** Artificial Intelligence and Machine Learning in Security, Intrusion Detection using AI/ML, Anomaly Detection, Fraud Detection, Adversarial Attacks on AI Systems, Blockchain-based Security Applications, Case Studies on AI-enabled Security Systems. **Self-learning Topics:** Explainable AI (XAI) for Security, Zero Trust Architecture, AI-powered Security Operations (SOC).	7	CO6
	Total	**15**	

Reference Books:

1. Bernard Menezes, Cryptography and Network Security, 1st Edition, Cengage Learning, 2010.
2. Atul Kahate, Cryptography and Network Security, 2nd Edition, Tata McGraw-Hill, 2008.
3. Charles P. Pfleeger and Shari Lawrence Pfleeger, Security in Computing, 5th Edition, Pearson Education, 2015.
4. Nina Godbole, Information System Security, 2nd Edition, Wiley India, 2017.
5. William Stallings, Network Security Essentials: Applications and Standards, Pearson Education.

Text Books:

1. Mark Stamp and Deven Shah, Information Security: Principles and Practice, 2nd Edition, Cengage Learning, 2011.
2. Behrouz A. Forouzan, Cryptography and Network Security, 2nd Edition, Tata McGraw-Hill, 2008.
3. William Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Pearson Education, 2013.

Useful Links

1. Cryptography and Network Security: https://nptel.ac.in/courses/106105031/
2. OWASP TOP 10: https://www.owasp.org/index.php/Top_10_2013
3. Cryptography and System Security
   https://www.udemy.com/course/cryptography-and-system-security/

4. Ethical Hacking for Beginners: BurpSuite, NMap and SNORT
   https://www.udemy.com/course/ethicalhackingforbeg/
5. AI for Cybersecurity & Bug Bounty Hunting
   https://www.udemy.com/course/ai-for-cybersecurity-bug-bounty-hunting/

Course Title:Data Warehousing and Mining												
Semester: VI			**Term: EVEN**				**Course Code: 25CSDSPEC6022C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	-	-	3	-	-	3	10	10	30	25	-	75

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

The course is aimed:

1. To identify the significance of Data Warehousing and Mining.
2. To analyze data, choose relevant models and algorithms for respective applications.
3. To study web data mining.
4. To develop research interest towards advances in data mining.

Course Outcomes:

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

7. Understand data warehouse fundamentals and design data warehouse with dimensional modelling and apply OLAP operations.
8. Understand data mining principles and perform Data preprocessing and Visualization.
9. Identify appropriate data mining algorithms to solve real world problems.
10. Compare and evaluate different data mining techniques like classification, prediction, clustering and association rule mining
11. Describe complex information and social networks with respect to web mining.

Module	Contents	Hours	Cos
I	**Data Warehousing Fundamentals** Introduction to Data Warehouse, Data Warehouse Architecture, Data Warehouse versus Data Marts, E-R Modeling versus Dimensional Modeling, Information Package Diagram, Data Warehouse Schemas: Star Schema, Snowflake Schema, Factless Fact Table, Fact Constellation Schema, Updates to Dimension Tables, Major Steps in ETL Process, OLTP versus OLAP, OLAP Operations: Slice, Dice, Rollup, Drilldown, and Pivot. **Self-learning Topics:** Data Warehouse Implementation Tools, Data Warehouse Security and Metadata Management.	9	CO1
II	**Introduction to Data Mining, Data Exploration and Data Pre-processing** Introduction to Data Mining, Data Mining Task Primitives, Data Mining Architecture, KDD Process, Issues in Data Mining, Applications of Data Mining, Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Pre-processing: Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization, and Concept Hierarchy Generation. **Self-learning Topics:** Data Mining Tools, Data Quality Assessment, Feature Selection Techniques.	9	CO 2
III	**Classification** Basic Concepts, Decision Tree Induction, Naïve Bayesian Classification, Accuracy and Error Measures, Evaluating the Accuracy of a Classifier: Holdout and Random Subsampling, Cross Validation, Bootstrap. **Self-learning Topics:** Rule-Based Classification, k-Nearest Neighbor (k-NN) Classification, Ensemble Methods.	**7**	CO3
IV	**Clustering** Types of Data in Cluster Analysis, Partitioning Methods: k-Means and k-Medoids, Hierarchical Methods: Agglomerative and Divisive Clustering. **Self-learning Topics:** Density-Based Clustering (DBSCAN), Grid-Based Clustering, Cluster Evaluation Methods.	**7**	CO4

V	**Mining Frequent Patterns and Associations** Market Basket Analysis, Frequent Itemsets, Closed Itemsets, Association Rules, Frequent Pattern Mining, Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without Candidate Generation, Introduction to Mining Multilevel Association Rules, and Mining Multidimensional Association Rules. **Self-learning Topics:** FP-Growth Algorithm, Constraint-Based Association Rule Mining, Applications of Association Rule Mining.	**7**	CO5
VI	**Web Mining** Introduction to Web Mining, Web Content Mining: Crawlers, Harvest System, Virtual Web View, Personalization, Web Structure Mining: PageRank, HITS (CLEVER), Web Usage Mining. **Self-learning Topics:** Web Opinion Mining, Social Network Analysis, Web Mining Applications.	6	CO6
	Total	**45**	

List of Tutorials

Sr. No.	Topic	Hours.	COs
1	One case study on building Data warehouse/Data Mart	1	CO1
2	Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema)	1	CO1
3	Implementation of all dimension table and fact table based on experiment 1 case study	1	CO1
4	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot based on experiment 1 case study	1	CO1
5	Implementation of Bayesian algorithm 5 Implementation of Data Discretization (any one) & Visualization (any one)	1	CO1
6	Perform data Pre-processing task and demonstrate Classification, Clustering, Association algorithm on data sets using data mining tool (WEKA/R tool)	1	CO2
7	Implementation of Clustering algorithm (K-means/K-medoids)	1	CO2
8	Implementation of any one Hierarchical Clustering method	1	CO2

9	Implementation of Association Rule Mining algorithm (Apriori)	1	CO2
10	Implementation of Page rank/HITS algorithm	1	CO2
	Total Hours	**14**	

Reference Books:

1. Reema Theraja, "Data warehousing", Oxford University Press 2009.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Publisher 2 nd edition.
3. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining", Morgan Kaufmann 3 rd edition.

Text Books:

1. Paulraj Ponniah, " Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 2 nd edition.
3. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2. https://www.coursera.org/specializations/data-mining

Course Title: Tools for Data Analytics												
Semester: VI			**Term:** Even				**Course Code: 24MDM601DAB**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
-	-	4	-	-	2	2	-	-	-	50	-	50

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. Introduce learners to the modern data landscape and the principles of data acquisition, modelling, and analytical SQL.
2. Develop competence in designing and implementing data models (fact-dimension schemas) for analytical purposes.
3. Enable learners to apply advanced SQL techniques including joins, subqueries, and window functions for extracting insights.
4. Integrate UX design processes—from user research to high-fidelity prototyping—to create effective data-driven interfaces.

Course Outcomes:

2. Design and implement relational and dimensional data models (e.g., Star Schema) suitable for analytical systems.
3. Develop and optimize SQL queries using joins, subqueries, and window functions for complex data analysis.
4. Apply UX research methods to identify user needs, create personas, and design user journeys for data-driven solutions.
5. Build low- and high-fidelity prototypes using Figma and conduct usability testing and heuristic evaluations.
6. Integrate cloud data warehouses (Google BigQuery) with BI tools (Tableau or Power BI) to create interactive dashboards.
7. Perform advanced data visualization and geospatial analytics using parameters, LOD expressions, and GeoJSON integration.

Sr No.	List of Experiment	COs
1	Instructor-led demo of a cloud console (e.g., Google Cloud Console). Create a project and activate BigQuery	CO5
2	Exploring Big Data: Load a large public dataset (e.g., NYC Taxi trips, Wikipedia pageviews) into BigQuery. Run simple COUNT and SELECT * queries to experience 'Volume.'	CO1 CO5
3	Discussion & Documentation: In groups, analyze a streaming data source (e.g., Twitter API demo) and a semi-structured dataset (e.g., JSON) to document 'Velocity' and 'Variety.'	CO1 CO5
4	Case Study Analysis: Deconstruct a known business process (e.g., retail sales) into Facts (transactions) and Dimensions (products, customers, time).	CO1
5	Practical Data Modeling: Using a SQL client, create a simple Star Schema in BigQuery with a fact table and multiple dimension tables.	CO1
6	ETL / ELT Simulation: Write and run SQL scripts to INSERT and UPDATE data into your newly created tables, understanding the 'Transform' and 'Load' process	CO1 CO2
7	Deep Dive on JOIN s: Hands-on writing INNER, LEFT, RIGHT, and FULL OUTER joins on the Star Schema created in Week 2.	CO2
8	Sub query Practice: Solve analytical problems using correlated and non-correlated sub queries.	CO2
9	Performance Lab: Compare the execution time and data scanned of a poorly written query vs. an optimized one.	CO2
10	Conceptual Foundation: Instructor-led explanation of OVER(), PARTITION BY, and ORDER BY clauses	CO2
11	Hands-on Practice: Write queries using ROW_NUMBER(), RANK(), SUM() OVER(), LAG(), and LEAD().	CO2
12	Mini-Project: Analyze a time-series dataset to find month-over-month growth rates and top-N performers	CO2 CO6
13	Configuration: Connect Tableau/Power BI to BigQuery	CO5
14	Layout Lab: Design a mobile-friendly version of key dashboard views.	CO4 CO5 CO6
15	Each team presents their final dashboard followed by Q&A.	CO5 CO6
16	Final Submission: Portfolio entry with Figma link, dashboard link, and UX research dossier	CO3 CO4 CO5 CO6

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B.End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

C. Continuous Assessment (CA):
Continuous Assessment should consist of the following

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

7. Assignment
8. Case Study
9. Debate
10. Solution for Social Problems
11. Field Visit
12. Group Project
13. Flipped Classroom
14. Topic Review
15. Quiz
16. Mind Mapping
17. Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

4. The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling (3rd Edition)
5. Practical Tableau: 100 Tips, Tutorials, and Strategies (2nd Edition)Don't Make Me Think, Revisited: A Common Sense Approach to Web Usability
6. Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy.

Text Books:

5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data

6. Storytelling with Data: A Data Visualization Guide for Business Professionals

7. Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python (2nd Edition)

Useful Links:

5. https://cloud.google.com/bigquery/docs
6. https://mode.com/sql-tutorial/
7. https://help.figma.com/hc/en-us
8. https://www.nngroup.com/articles/usability-testing-101/
9. https://public.tableau.com/en-us/s/resources
10. https://learn.microsoft.com/en-us/power-bi/
11. https://developers.google.com/maps/documentation
12. https://datasociety.net/

Course Title: Employability Enhancement Program - V (Industry Certification)												
Semester: VI			Term: EVEN				Course Code:24CSDSVSE601C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
--	-	02	--	01	--	01	--	--	--	–	25	25

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:
At the end of the course, students will be able to:

1. Develop industry-relevant technical and professional skills through preparation for recognized industry certification.
2. Understand and apply current tools, technologies, standards, and best practices relevant to the Computer Science and Data Science domain.
3. Enhance problem-solving, analytical, communication, and professional skills required in the workplace.
4. Prepare effectively for industry certification examinations through structured learning, practice, and assessment.
5. Bridge the gap between academic knowledge and industry requirements by demonstrating practical competency.

Course Outcomes:
At the end of the course, students will be able to:

1. Demonstrate knowledge of concepts and technologies covered by the selected industry certification.
2. Apply industry-standard tools, techniques, and methodologies to solve domain-specific problems.
3. Analyze and solve practical problems using appropriate technical and analytical skills.
4. Demonstrate professional competencies such as communication, teamwork, problem-solving, and self-learning.
5. Successfully prepare for and demonstrate competency in a relevant industry certification examination.

List of Tutorials:

Tut. No.	List of Tutorials	Hours	COs
	Speaking Skills		
1.	Role Play	01	CO1
2.	Poster Presentation (Group): Assignment 5	01	CO1
3.	Interviewing an influential person with Geo tag photo or video: Assignment 8	01	CO2
4.	Story Telling with moral/value	01	CO1
5.	Impromptu	01	CO3
	Reading Skills		
6.	Summarization unseen passage Assignment 2	01	--
7.	Book Review Presentation: Assignment 4	01	CO1
8.	Reading Newspaper Article	01	--
	Writing Skills		
9.	Vocabulary Building: Crossword	01	CO3
10.	One Word Substitution, Collocation, Phrases & Idioms - Assignment 1	01	CO3
11.	Expansion of an Idea- Assignment 3	01	CO3
12.	Behavioral Ethics: Ethical Code of Conduct: Assignment 6	01	CO4
13.	Dress & Appearance: Assignment 7	01	CO1
14.	Paragraph Writing	01	--
15.	Dialogue Writing (Formal)	01	--
	Total	**15**	

Examination Scheme:

Continuous Assessment (CA): **25 Marks**

Assignment + Attendance = 05 + 05=10 Marks

Poster Presentation & interviewing an Influential person = 05 + 05 = 10 marks Book Review & Role Play= 2.5 + 2.5 = 05 Marks

Assessment: There is internal assessment only

Reference Books:

1. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
2. Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
3. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
4. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008
5. Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
6. Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
7. Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
8. Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008
9. Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

Text Books:

5. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008

Useful Links:

Speaking Skills

https://youtu.be/iNxl16ZkM-A?si=_smlyYEtxvHBD40S

https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI

https://youtu.be/ftwVrEF_OlQ?si=sYiKRfg_xX1erVf6

https://youtu.be/TKfwenWIHhk?si=xn8GDiZIBYKB14M4

https://youtu.be/pbhK_OhMgA4?si=DeROjEtA6V_w5dL

https://youtu.be/a2dTNAryZ8g?si=6tA9U-ZAX4wQBi_x

https://youtu.be/QBnGmmBAgyc?si=JGm-TpmrslhE-ZB8

https://youtu.be/EhgKvPWn9Vc?si=vboPgmmIyyVqsrcI

https://youtu.be/z9F68dJSbOE?si=VVMrBOeNnc5XNln8

Reading Skills

https://youtu.be/KadZ3KYzM0I?si=XRmUOk2O8UmoMfEK

https://youtu.be/kCthrwUz68w?si=L4U4TJjuO72Us_dD

https://youtu.be/tpHp8oEHANQ?si=R-YOMfSa5LIuyXMR

Writing Skills

https://youtu.be/Zx-JcXsbUqQ?si=ysfXU8ZR4UM3U22P

https://youtu.be/5o_oph2vhGM?si=_4D6h8ZMiYSe0ZV4

Course Title: AI Ethics for DS												
Semester: VI			Term: EVEN				Course Code:25CSDSVSE602C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
2	-	-	2	–	--	2	10	10	30	–	–	50

IAE: Internal Assessment Examination
ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

After successful completion of this course, learners will be able to:

1. Understand the fundamental principles of ethics and responsible Artificial Intelligence in Data Science.
2. Analyze ethical issues related to data collection, privacy, fairness, transparency, and accountability in AI systems.
3. Evaluate the societal, legal, and regulatory implications of AI-driven decision-making.
4. Apply ethical frameworks to identify and mitigate bias in machine learning and data-driven applications.
5. Explore governance, trust, and responsible AI practices for the development and deployment of AI solutions.

Course Outcomes:

On successful completion of this course, learners will be able to:

1. Explain the ethical principles, challenges, and societal impact of Artificial Intelligence and Data Science.
2. Analyze ethical issues related to data privacy, ownership, consent, and responsible data management.
3. Evaluate fairness, bias, transparency, explainability, and accountability in AI and machine learning models.
4. Apply ethical frameworks to assess AI-based decision-making systems across different domains.
5. Examine AI governance, regulations, and responsible AI practices for real-world applications.
6. Recommend ethical guidelines for designing trustworthy AI and Data Science solutions.

Module	Contents	Hours	Cos
I	**Introduction to AI and Ethical Implications** Overview of Artificial Intelligence (AI), Generative AI versus Predictive AI, Ethical Concerns in AI Development, Societal Impacts of AI, Ethical Decision-Making Frameworks in AI Systems. **Self-learning Topics:** History of AI, Responsible AI Principles, AI Ethics Guidelines.	**7**	CO1
II	**Ethics of Data in AI** Privacy Issues, Data Ownership, Consent in Data Usage, Differential Privacy, Transparency in Data Collection, Ethical Data Handling. **Self-learning Topics:** Data Protection Regulations (GDPR, DPDP Act), Data Anonymization Techniques, Privacy-Preserving Machine Learning.	**7**	CO2
III	**Predictive AI Models and Their Implications** Introduction to Supervised Learning, Predictive Analytics, Algorithmic Bias, Fairness in Predictive Modelling, Consequences of Biased Predictions in Decision-Making. **Self-learning Topics:** Unsupervised Learning, Explainable AI (XAI), Bias Mitigation Techniques.	8	CO3
IV	**Generative AI and Ethical Challenges** Introduction to Generative AI, Foundation Models, Large Language Models (LLMs), Generative Adversarial Networks (GANs), Diffusion Models, Ethical Issues in Generative AI, Deepfakes, Hallucinations, Copyright and Intellectual Property Concerns, Responsible Use of Generative AI. **Self-learning Topics:** Prompt Engineering, AI Safety, Responsible Content Generation.	8	CO4
V	**Ethics of Algorithmic Decision-Making** Ethics of Predictive AI in Finance, Criminal Justice, and Employment, Fairness, Transparency, Accountability of Algorithmic Decisions, Explainability in AI Systems.	**7**	CO5

	Self-learning Topics: AI Auditing, Human-in-the-Loop Systems, Case Studies on Algorithmic Fairness.		
VI	**Future Directions and Governance of AI** Ethical Implications of Emerging AI Technologies, Global Governance of AI, AI Regulation, Transparency, Ethical AI Standards, Interdisciplinary Collaboration in AI Ethics. **Self-learning Topics:** AI Policies and Regulations, International AI Governance Frameworks, Sustainable AI.	8	CO6
	Total	**45**	

Reference Books:

1. Negnevitsky, M. (2005). Artificial Intelligence: A Guide to Intelligent Systems. Addison Wesley.
2. Kearns, M., & Roth, A. (2019). The Ethical Algorithm: The Science of Socially Aware Algorithm Design. Oxford University Press.
3. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press.
4. O'Neil, C. (2016). Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy. Crown Publishing.
5. Anderson, M., & Anderson, S. L. (Eds.). (2011). Machine Ethics. Cambridge University Press.
6. Coeckelbergh, M. (2020). AI Ethics. MIT Press.
7. Müller, V. C. (Ed.). (2020). Ethics of Artificial Intelligence and Robotics. Springer.

Text Books:

1. AI Ethics (2023) by Paula Boddington. Springer.
2. The Ethics of Artificial Intelligence: Principles, Challenges, and Opportunities (2023) by Luciano Floridi. OUP .

Useful Links:

1. https://www.nist.gov/itl/ai-risk-management-framework?utm
2. https://airc.nist.gov/?utm_source=chatgpt.com
3. https://oecd.ai/en/ai-principles

Course Title: Internship II												
Semester: VI			Term: EVEN				Course Code: 25CSDSOJT601					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
--	–	--	–	–	--	01	--	--	--	–	25	25

Introduction

The rise in global competition has prompted organizations to devise strategies to have a talented and innovative workforce to gain a competitive edge. Developing an internship policy is an impactful strategy for creating a future talent pool for the industry. The internship (a form of experiential learning) program helps fresh pass–outs in gaining professional know-how and benefits corporate sectors. The internship also enhances the student's employability skills passing out from Technical Institutions..

Objectives:

1. Integration of workshop with workplace in physical and/or hybrid model.
2. Developing research aptitude in emerging technologies
3. Enhance entrepreneurial capabilities and professional competency
4. Development of decision-making and teamwork skills
5. Cultivate a sense of Social Imagery and Citizenship Responsibility

Outcomes: After completion of this course, students will be able to

1. Apply practical skills effectively in physical and hybrid workplace settings.
2. Conduct and communicate research on emerging technologies.
3. Demonstrate creative problem-solving and an entrepreneurial mindset.
4. Meet industry standards with strong communication and technical skills.
5. Collaborate effectively and make informed decisions within teams.

INTERNSHIP GUIDELINES:

- The students should apply for internships of their choice with the permission of the Institute.
- The internship duration ranges from 4 to 6 weeks and is scheduled during the summer vacation period for students
- Industry will confirm the training slots and the number of seats allocated for internships via confirmation letter/ email.
- Students on joining Training at the concerned Industry / Organization, submit the Joining

Report/Letters / Email.

- Students undergo industrial training at the concerned Industry / Organization.
- Training and placement team will visit the industry and evaluate(s) the performance of students regularly and evaluation Report of the students is submitted in department office/TPO with the consent of Industry persons/ Trainers.
- Students will submit training report after completion of internship.
- Student's Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
- It will be evaluated on the basis of the following criteria:
  - ❖ Regularity in maintenance of the diary.
  - ❖ Project/Case study/Completion of assigned task by industry undertaken during the internship
  - ❖ Employer feedback
- Training Certificate to be obtained from industry followed by the presentation in the department.

AE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

6. Introduce learners to the modern data landscape and the principles of data acquisition, modelling, and analytical SQL.
7. Develop competence in designing and implementing data models (fact-dimension schemas) for analytical purposes.
8. Enable learners to apply advanced SQL techniques including joins, subqueries, and window functions for extracting insights.
9. Integrate UX design processes—from user research to high-fidelity prototyping—to create effective data-driven interfaces.

Course Outcomes:

8. Design and implement relational and dimensional data models (e.g., Star Schema) suitable for analytical systems.
9. Develop and optimize SQL queries using joins, subqueries, and window functions for complex data analysis.
10. Apply UX research methods to identify user needs, create personas, and design user journeys for data-driven solutions.
11. Build low- and high-fidelity prototypes using Figma and conduct usability testing and heuristic evaluations.

12. Integrate cloud data warehouses (Google BigQuery) with BI tools (Tableau or Power BI) to create interactive dashboards.

13. Perform advanced data visualization and geospatial analytics using parameters, LOD expressions, and GeoJSON integration.

Bachelor of Technology

In

Computer Science & Engineering

(Data Science)

Final Year
Semester – VII

SJCEM : R–24C

Effective from Academic Year 2026-27

Program Structure for Final Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)
Semester VII
SCHEME: SJCEMR–24 Scheme C

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
24CSDSPCC701C	PCC	Big Data Analytics	3	-	2	3	-	1	4
24CSDSPCC702C	PCC	Deep Learning	2	-	2	2	-	1	3
24CSDSPEC701XC	PEC	Program Elective – V	3	-	2	3	-	1	4
24CSDSPEC702XC	PEC	Program Elective – VI	3	-	-	3	-	-	3
24OE701XC	OE	Open Elective III	3	-	-	3	-	-	3
24CSDSAEC701C	AEC	Employability Enhancement Program -VI (Communication)	-	-	2	-	-	1	1
24CSDSPRJ701C	PRJ	Capstone Project	-	-	4	-	-	2	2
Total			**14**	**0**	**12**	**14**	**0**	**6**	**20**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/PR	Total
24CSDSPCC701C	PCC	Big Data Analytics	20	20	60	25	25	150
24CSDSPCC702C	PCC	Deep Learning	20	20	60	25	-	125
24CSDSPEC701XC	PEC	Program Elective - V	20	20	60	25	-	125
24CSDSPEC702XC	PEC	Program Elective - VI	20	20	60	-	-	100
24OE701XC	OE	Open Elective III	20	20	60	-	-	100
24CSDSAEC701C	AEC	Employability Enhancement Program -VI (Communication)	-	-	-	25	-	25
24CSDSPRJ701C	PRJ	Capstone Project	-	-	-	25	50	75
Total			**100**	**100**	**300**	**125**	**75**	**700**

Semester VII

Program Electives Courses

Program Elective	Track 01		Track 02	
	Intelligence Systems		Advanced Algorithms and Systems	
Program Elective V	24CSDSPEC7011C	Applied Data Science	24CSDSPEC7012C	Advanced Computer Network
Program Elective VI	24CSDSPEC7021C	Game Theory	24CSDSPEC7022C	IoT and Edge Computing

Program Elective	Track 03		Track 04	
	Soft and Quantum Computing		Vision Technology	
Program Elective V	24CSDSPEC7013C	Soft Computing	24CSDSPEC7014 C	Metaverse with AR/VR
Program Elective VI	24CSDSPEC7023C	Quantum Computing	24CSDSPEC7024 C	User Experience Design with VR

Open Elective III Courses

Semester	Track 01		Track 02	
	Entrepreneurship		Research Methodology	
	Code	Subject	Code	Subject
VII	24OE7011C	Finance and Accounting	24OE7012C	Intellectual Property Rights

Semester	Track 03		Track 04	
	Foreign Language		Business Management	
	Code	Subject	Code	Subject
VII	24OE70131C	Foreign Language III - Japanese 2	24OE7014C	Basics of HR Management
	24OE70132C	Foreign Language III – German 2		

Syllabus

for

Final Year

Computer Science & Engineering (Data Science)

Semester – VII

SJCEM : R–24C

(With Effect from 2026-27)

Course Title: Big Data Analytics												
Semester: VII			**Term: Odd**				**Course Code: 24CSDSPCC701C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**-**	**2**	**3**	**-**	**1**	**4**	**20**	**20**	**60**	**25**	**25**	**150**

Sustainable Development Goals Mapped: 4, 8, 9, 11, 12, 13

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To provide an overview of the big data platforms, its use cases and Hadoop ecosystem.
2. To introduce programming skills to build simple solutions using big data technologies such as MapReduce, Scripting for No SQL and R
3. To learn the fundamental techniques and principles in achieving big data analytics with scalability and streaming capability.
4. To enable students to have skills that will help them to solve complex real-world problems for decision support.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Understand the building blocks of Big Data Analytics.
2. Apply fundamental enabling techniques like Hadoop and MapReduce in solving real world problems
3. Understand different NoSQL systems and how it handles big data.
4. Apply advanced techniques for emerging applications like stream analytics.
5. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications, etc.
6. Apply statistical computing techniques and graphics for analyzing big data.

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Module	Course Content	Hours	COs	RBT Level
1	**Introduction to Big Data and Hadoop** Introduction to Big Data - Big Data characteristics and Types of Big Data. Traditional vs. Big Data business approach. Case Concept of Hadoop, Core Hadoop Components; Hadoop Ecosystem. **Self learning**:- Study of Big Data applications in Healthcare, Banking and E-Commerce .	06	1	L2
2	**Hadoop HDFS and MapReduce** Distributed File Systems: Physical Organization of Compute Nodes, Large-Scale File-System Organization. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union ,Intersection, and Difference by MapReduce. **Self learning**:- Apache Spark framework and comparison with MapReduce .	10	2	L4
3	**NoSQL** Introduction to NoSQL, NoSQL Business Drivers NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Columnfamily (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study NoSQL solution for big data, Understanding the types of big data problems; Analysing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems. **Self learning**:-Study of MongoDB and Cassandra architecture	7	3	L3
4	**Mining Data Streams** The Stream Data Model: A Data-Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data techniques in a Stream Filtering Streams: Bloom Filter with Analysis. Counting Distinct Elements in a Stream, Count-Distinct Problem, Flageolet-Martin Algorithm, Combining Estimates, Space Requirements Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm, Decaying Windows.	8	4	L4

	Self learning:-Real-time stream processing using Apache Kafka			
5	**Real-Time Big Data Models** A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering Case Study: Product Recommendation Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities in a social graph. **Self learning:-** Sentiment Analysis and Recommendation Systems	8	5	L5
6	**Data Analytics with R** Exploring Basic features of R, Exploring RGUI, Exploring RStudio, Handling Basic Expressions in R, Variables in R, Working with Vectors, Storing and Calculating Values in R, Creating and using Objects, Interacting with users,Handling data in R workspace, Executing Scripts, Creating Plots,Accessing help and documentation in R Reading datasets and Exporting data from R, Manipulating and Processing Data in R, Using functions instead of script, built-in functions in R Data Visualization: Types, Applications **Self learning:-**Data Visualization using Tableau/Power BI and advanced plotting in R	6	6	L3
Total		**45**		

Sr No.	List of Experiment	COs
1	Study of Big Data characteristics, Hadoop architecture and Hadoop ecosystem.	1
2	Installation and configuration of Hadoop in pseudo distributed mode.	1
3	Perform basic HDFS operations such as file creation, upload, download and replication.	2
4	Write and execute a simple MapReduce program for word count application.	2
5	Implement MapReduce program for matrix multiplication or data aggregation.	3
6	Study and implementation of NoSQL database using MongoDB/Cassandra.	3
7	Perform CRUD operations using NoSQL database.	4
8	Implement Bloom Filter algorithm for stream filtering.	4

9	Implement Flajolet-Martin Algorithm for counting distinct elements in data streams.	5
10	Study and implementation of recommendation system using collaborative filtering.	5
11	Study of R programming basics: vectors, matrices, data frames and functions.	6
12	Data visualization in R using plots, histograms, bar charts and scatter plots.	6

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

C. Continuous Assessment (CA):

Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All COsshould be covered)

Attendance (Theory & Practical): 05 m33arks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

- ➢ Assignment
- ➢ Case Study
- ➢ Debate
- ➢ Solution for Social Problems
- ➢ Field Visit
- ➢ Group Project
- ➢ Flipped Classroom
- ➢ Topic Review
- ➢ Quiz
- ➢ Mind Mapping
- ➢ Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

1. Bill Franks , ―Taming The Big Data Tidal Wave: Finding Opportunities In HugeData StreamsWithAdvancedAnalytics‖,Wiley.
2. Chuck Lam, ―Hadoop inAction‖, Dreamtech Press
3. Jared Dean, ―Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners, Wiley India Private Limited, 2014.
4. Jiawei Han and Micheline Kamber, ―Data Mining: Concepts and Techniques‖, Morgan Kaufmann Publishers, 3rd ed, 2010.
5. Lior Rokach and Oded Maimon, ―Data Mining and Knowledge Discovery Handbook‖, Springer, 2nd edition,2010.
6. Vojislav Kecman, ―Learning and Soft Computing‖, MITPress, 2010.

Text Books:

1. Cre Anand Rajaraman and Jeff Ullman ―Mining of Massive Datasets‖, Cambridge University Press.
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dream tech Press.
3. DT Editorial Services, ―Big Data Black Book‖, Dreamtech Press

Useful Links:

- https://nptel.ac.in/courses/106104189
- https://www.coursera.org/specializations/big-data#courses
- https://www.digimat.in/nptel/courses/video/106106169/L01.html

Course Title: Deep Learning												
Semester: VII			**Term: Odd**				**Course Code: 24CSDSPCC702C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
2	**-**	**2**	**2**	**-**	**1**	**3**	**20**	**20**	**60**	**25**	**-**	**125**

Sustainable Development Goals Mapped: 3,4,9

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To learn the fundamentals of Neural Network.
2. To gain an in-depth understanding of training Deep Neural Networks.
3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks.
4. Students should be familiar with the recent trends in Deep Learning.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Understand fundamental neural network concepts and architectures and apply for real-world applications.
2. Analyse training, optimization, and regularization techniques in deep neural networks
3. Apply autoencoder models and their variants for unsupervised learning and practical applications such as image compression.
4. Analyse convolutional neural network operations and architectures, including modern models, for supervised learning tasks.
5. Analyse and evaluate recurrent neural network models, including LSTM and GRU, for sequence learning tasks and handling temporal dependencies.
6. Apply and analyse generative adversarial network (GAN) architectures for image generation and related real-world applications.

Module	Course Content	Hours	COs	RBT Level
I	**Fundamentals of Neural Network** History of Deep Learning, Deep Learning Success Stories, Neural Network Architecture, Components of Neural Network. Multilayer Perceptron (MLPs), Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Deep Networks**:** Three Classes of Deep Learning Basic Terminologies of Deep Learning. **Self-Learning Topic:** Applications of Neural Networks	4	1	L2
II	**Training, Optimization and Regularization of Deep Neural Network** Introduction to Feedforward Deep Neural Networks – Multi-Layer Feedforward Neural Networks (MLPs) and Learning Factors. Activation Functions and Loss Functions – Sigmoid, Tanh, ReLU, Softmax, and Cross-Entropy Loss. Learning with Backpropagation – Backpropagation Algorithm and Weight Updates. Optimization Techniques – Gradient Descent, AdaGrad, RMSProp. Regularization and Generalization – Overfitting, Bias–Variance Trade-off, and Regularization Methods. **Self-Learning Topic:** Advanced Optimization Algorithms, Regularization Techniques	6	2	L4
III	**Autoencoders: Unsupervised Learning** Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders. Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders. Application of Autoencoders: Image Compression. **Self-Learning Topic:** Structure of Autoencoders, Application of Autoencoder: Image Denoising	5	3	L3

IV	**Convolutional Neural Networks (CNN): Supervised Learning** Convolution operation, Padding, Stride, Relation between input, output and filter size. CNN architecture: Convolution layer, Pooling Layer, Weight Sharing in CNN, Fully Connected NN vs CNN, Variants of basic Convolution function, Multichannel convolution operation, 2D convolution. **Self-Learning Topic:** Modern Deep Learning Architectures: LeNET	5	4	L4
V	**Recurrent Neural Networks (RNN)** Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Limitation of " vanilla RNN" Vanishing and Exploding Gradients, Truncated BTT. Long Short Term Memory(LSTM): Selective Read, Selective write, Selective Forget, Gated Recurrent Unit (GRU). **Self-Learning Topic:** RNN Architectures, Applications of RNNs.	6	5	L5
VI	**Recent Trends and Applications** Generative Adversarial Network (GAN): Architecture. Applications: Image Generation, DeepFake. **Self-Learning Topic:** Discriminator Architecture, Training Dynamics.	4	6	L3
Total		**30**		

Sr No.	List of Experiment	COs
1	Implement Multilayer Perceptron algorithm to simulate XOR gate.	1
2	To explore python libraries for deep learning e.g. Theano, TensorFlow etc.	1
3	Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD	2

	f. Adam Learning GD	
4	Implement a backpropagation algorithm to train a DNN with at least 2 hidden layers.	2
5	Design the architecture and implement the autoencoder model for Image Compression.	3
6	Design the architecture and implement the autoencoder model for Image denoising.	3
7	Design and implement a CNN model for digit recognition application.	4
8	Design and implement a CNN model for image classification.	4
9	Design and implement LSTM model for handwriting recognition, speech recognition, machine translation, speech activity detection, robot control, video games, time series forecasting etc.	5
10	Design and implement GRU for any real life applications, chat bots etc.	5
11	Case Study: Generative Adversarial Network (GAN): Architecture	6
12	Case Study: GAN Applications: Image Generation, DeepFake	6

Evaluation and Assessment Scheme:

D. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

E. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

F. Continuous Assessment (CA):

Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All Cos should be covered)

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

- ➢ Assignment
- ➢ Case Study
- ➢ Debate
- ➢ Solution for Social Problems
- ➢ Field Visit
- ➢ Group Project

- ➢ Flipped Classroom
- ➢ Topic Review
- ➢ Quiz
- ➢ Mind Mapping
- ➢ Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

D. Oral & Practical Exam

Based on the entire syllabus, oral (10 marks) & practical/implementation (15 marks) examination will be conducted.

Reference Books:

a. Deep Learning from Scratch: Building with Python from First Principles- Seth Weidman by O'Reilley.
b. François Chollet. Deep learning with Python (Vol. 361). 2018 New York: Manning.
c. Douwe Osinga. Deep Learning Cookbook, O'REILLY, SPD Publishers, Delhi.
d. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc.
e. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville. Deep Learning, MIT Press Ltd, 2016.
2. Li Deng and Dong Yu, Deep Learning Methods and Applications, Publishers Inc.
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. JM Zurada Introduction to Artificial Neural Systems, Jaico Publishing House.
5. M. J. Kochenderfer, Tim A. Wheeler. Algorithms for Optimization, MIT Press.

Useful Links:

- ■ http://www.cse.iitm.ac.in/~miteshk/CS6910.html
- ■ https://nptel.ac.in/courses/106/106/106106184/
- ■ https://www.deeplearningbook.org/

Course Title: Applied Data Science												
Semester: VII			**Term: Odd**				**Course Code: 24CSDSPEC7011C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
3	**-**	**2**	**3**	**-**	**1**	**4**	**20**	**20**	**60**	**25**	**-**	**125**
Sustainable Development Goals Mapped: 4, 8, 9, 11, 12, 13												

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To introduce students to the basic concepts of data science.
2. To acquire an in-depth understanding of data exploration and data visualization.
3. To be familiar with various anomaly detection techniques.
4. To understand the data science techniques for different applications.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Apply the data science process for data-driven problem solving.
2. Perform data exploration and visualization to derive meaningful insights.
3. Apply anomaly detection techniques to identify unusual patterns in datasets.
4. Analyze and implement time-series forecasting models for predictive analytics.
5. Evaluate forecasting results and interpret temporal data trends for decision-making.
6. Apply data science techniques and tools to solve real-world applications.

Module	Course Content	Hours	COs	RBT Level
1	**Modern Data Science and Intelligent Analytics** Data Science lifecycle and process models, motivation for Data Science techniques: data volume, variety, velocity, dimensionality, and complexity. Data science tasks and real-world applications, data acquisition and preprocessing, feature engineering, overview of predictive and prescriptive modeling, comparison of Data Science, Data Analytics, Business Analytics, and Artificial Intelligence. Introduction to Big Data ecosystems, cloud-based data science platforms, MLOps concepts, and responsible data science practices. **Self-Learning Topic:** Data-Centric AI and MLOps for Scalable	7	1	L2,L3
2	**Data Exploration** Types of data, Properties of data, Descriptive Statistics: Univariate Exploration: Measure of Central Tendency, Measure of Spread, Symmetry, Skewness: Karl Pearson Coefficient of skewness, Bowley's Coefficient, Kurtosis Multivariate Exploration: Central Data Point, Correlation, Different forms of correlation, Karl Pearson Correlation Coefficient for bivariate distribution, Inferential Statistics: Overview of Various forms of distributions: Normal, Poisson, Test Hypothesis, Central limit theorem, Confidence Interval, Z-test, t-test, Type-I, Type-II Errors, ANOVA **Self-Learning Topic:** Bayesian Data Analysis	8	2	L2,L3
3	**Methodology and Data Visualization** Methodology: Overview of model building, Cross Validation, K fold cross validation, leave-1 out, Bootstrapping Data Visualization Univariate Visualization: Histogram, Quartile, Distribution Chart Multivariate Visualization: Scatter Plot, Scatter Matrix, Bubble chart, Density Chart Roadmap for Data Exploration **Self-Learning Topic**: Interactive Dashboard Design	8	3	L3

4	**Anomaly Detection** Outliers, Causes of Outliers, Anomaly detection techniques, Outlier Detection using Statistics Outlier Detection using Distance based method, Outlier detection using density-based methods, SMOTE **Self-Learning Topic:** Autoencoders and GANs	7	4	L3,L4
5	**Time Series Forecasting** Taxonomy of Time Series Forecasting methods, Time Series Decomposition. Smoothening Methods: Average method, Moving Average smoothing, Time series analysis using linear regression, ARIMA Model, Performance Evaluation: Mean Absolute Error, Root Mean Square Error, Mean Absolute Percentage Error, Mean Absolute Scaled Error **Self-Learning Topic:** Deep Learning Models for TSF	8	5	L3,L4
6	**Applications of Data Science** Predictive Modelling: House price prediction, Fraud Detection Clustering: Customer Segmentation. Time series forecasting: Weather Forecasting Recommendation engines: Product recommendation, Explainable AI (XAI) **Self-Learning Topic:** Responsible Data Science Applications	7	6	L4,L5
Total		**45**		

Sr No.	List of Experiment	COs
1	To study the fundamentals of Data Science, understand the Data Science Process, explore the motivation behind using Data Science techniques, and differentiate between Data Science and Data Analytics.	1
2	To analyse a dataset using univariate and multivariate statistical techniques by calculating measures of central tendency, measures of spread, skewness, kurtosis, and correlation.	2
3	Study of Inferential Statistics: Probability Distributions and Hypothesis Testing	2
4	Explore data visualization techniques.	3
5	Implement and explore performance evaluation metrics for Data Models (Supervised/Unsupervised Learning)	3

6	To understand the process of model building and evaluate machine learning models using Cross Validation techniques such as K-Fold Cross Validation.	3
7	Use SMOTE technique to generate synthetic data. (to solve the problem of class imbalance)	4
8	Outlier detection using distance based/density-based method.	4
9	Implement time series forecasting using Average Method, Moving Average Smoothing.	5
10	To study and implement various smoothing methods for time series forecasting using Linear Regression/ARIMA Model/evaluate their performance using forecasting error metrics.	5
11	Illustrate data science lifecycle for selected case study 1. Customer Segmentation 2. Fraud Detection	6
12	Illustrate data science lifecycle for selected case study House Price prediction 4. Product Recommendation	6

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

C. Continuous Assessment (CA):

Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All Cos should be covered)

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

1. Assignment
2. Case Study
3. Debate
4. Solution for Social Problems
5. Field Visit

6. Group Project
7. Flipped Classroom
8. Topic Review
9. Quiz
10. Mind Mapping
11. Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

1. S.C. Gupta, V. K. Kapoor ―Fundamentals of Mathematical Statistics‖, S. Chand and Sons, New Delhi.
2. B. L. Agrawal. ―Basic Statistics‖, New Age Publications, Delhi.

Text Books:

1. Vijay Kotu, Bala Deshpande. ―Data Science Concepts and Practice‖, Elsevier, M.K. Publishers.
2. Dr. P. N. Arora, Sumeet Arora, S. Arora, Ameet Arora, ―Comprehensive Statistical Methods‖, S.Chand Publications, New Delhi.

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc22_cs32/preview
2. https://onlinecourses.nptel.ac.in/noc21_cs69/preview

Course Title: Game Theory													
Semester: VII			**Term: Odd**				**Course Code: 24CSDSPEC7021C**						
Teaching Scheme							**Evaluation Scheme**						
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**Or/Pr/ Tut.**	**Total**	
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**								
3	**-**	**-**	**3**	**-**	**-**	**3**	**20**	**20**	**60**	**-**	**-**	**100**	

Sustainable Development Goals Mapped: 4,8,9,10,16

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To introduce the student to the notion of a game, its solutions concepts, and other basic notions and tools of game theory, and the main applications for which they are appropriate, including electronic trading markets.
2. To formalize the notion of strategic thinking and rational choice by using the tools of game theory, and to provide insights into using game theory in modelling applications.
3. To draw the connections between game theory, computer science, and economics, especially emphasizing the computational issues.
4. To apply game theory in searching, auctioning and trading.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Analyse and discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.
2. Analyse and evaluate real-world situations using Nash Equilibrium by identifying key strategic aspects and applying appropriate game theoretic concepts.
3. Apply and analyse Bayesian game concepts to model real-world applications and implement virtual business scenarios using game theory.
4. Understand and apply the working principles of non-cooperative games in relevant scenarios.
5. Explain and analyze mechanisms for aggregating preferences in decision-making scenarios.
6. Analyse and evaluate the working principles of repeated games in strategic decision-making scenarios.

Module	Course Content	Hours	COs	RBT Level
1	**Fundamentals of Game Theory** Making rational choices: basics of Games – strategy – preferences – payoffs – Mathematical basics – Game theory – Rational Choice – Basic solution concepts-non-cooperative versus cooperative games – Basic computational issues finding equilibria and learning in games Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets). Merkle Tree. **Self-learning Topic:** Probability Distributions, Statistical Inference	7	1	L2
2	**Games with Perfect Information** Strategic games – prisoner's dilemma, matching pennies - Nash equilibria – theory and illustrations – Cournot's and Bertrand models of oligopoly – auctions – mixed strategy equilibrium– zero-sum games – Extensive Games with Perfect Information – repeated games (prisoner's dilemma) – subgame perfect Nash equilibrium; computational issues. **Self-learning Topic:** Game Theory, Classical Games	8	2	L4
3	**Games with Imperfect Information** Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions – Information aspects – Illustrations – Extensive Games with Imperfect – Information – Strategies – Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining. **Self-learning Topic:** Strategic Interactions, Sequential Decision-Making	7	3	L3
4	**Non-Cooperative Game Theory** Non-cooperative Game Theory – Self-interested agents – Games in normal form – Analysing games: from optimality to equilibrium Computing Solution Concepts of Normal Form Games – Computing Nash equilibria of two- player, zero-sum games –Computing Nash equilibria of two-player, general sum games Identifying dominated strategies. **Self-learning Topic:** Strategic Form Games, Extensive Form Games	8	4	L3
5	**Mechanism Design Aggregating Preferences** Social Choice – Formal Model – Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents:	7	5	L4

	Mechanism Design – Mechanism design with unrestricted preferences – Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science –Google's sponsored search – eBay auctions – K-armed bandits. **Self-learning Topic:** Preference Aggregation Mechanisms, Bayesian Games			
6	**Repeated Games** Blockchain applications, Tools and case studies Repeated games: The Prisoner's Dilemma , The main idea ,Preferences ,Infinitely repeated games, Strategies ,SomeNash equilibria of the infinitely repeated Prisoner's Dilemma , Nash equilibrium payoffs of the infinitely repeated Prisoner's Dilemma when the players are patient ,Subgame perfect equilibria and the one-deviation property. **Self-learning Topic:** Strategies in Repeated Games, Learning in Repeated Games	8	6	L5
Total		**45**		

Evaluation and Assessment Scheme:

- **Internal Assessment Examination (IAE):**

  Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

- **End Semester Theory Examination (ESE):**

  End Semester exam of 60 Marks will be conducted based on entire syllabus.

Reference Books:

1. M. Machler, E. Solan, S. Zamir, Game Theory, Cambridge University Press, 2013.
2. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), Algorithmic Game Theory. Cambridge University Press, 2007.
3. Dixit and S. Skeath, Games of Strategy, Second Edition. W Norton & Co Inc, 2004.
4. Yoav Shoham, Kevin Leyton-Brown, Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations, Cambridge University Press 2008.

Text Books:

1. An Introduction to Game Theory by Martin J. Osborne
2. M. J. Osborne, An Introduction to Game Theory. Oxford University Press, 2004

Useful Links:

- https://nptel.ac.in/courses/110104063
- https://onlinecourses.nptel.ac.in/noc19_ge32/preview

Course Title: Soft Computing												
Semester: VII			Term: Odd			Course Code: 24CSDSPEC7013C						
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	25	-	125
Sustainable Development Goals Mapped: 4, 8, 9, 10, 12												

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. Artificial Intelligence, Various types of production systems, characteristics of production systems.
2. Neural Networks, architecture, functions and various algorithms involved.
3. Fuzzy Logic, Various fuzzy systems and their functions.
4. Genetic algorithms, its applications and advances.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Learn about soft computing techniques and their application.
2. Analyze various neural network architectures.
3. Understand perceptrons and counter propagation networks.
4. Understand Counter Propagation Network.
5. Define the fuzzy systems.
6. Analyze the genetic algorithms and their applications.

Module	Content	Hours	COs	RBT Level
I	**Soft Computing** Introduction to soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing. Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Prepositional and predicate logic, monotonic and non monotonic reasoning, forward Reasoning, backward reasoning, **Self-Learning Topic:** Weak & Strong Slot & filler structures,	7	1	L2
II	**Neural Network** Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, Difference b/w ANN and human brain, characteristic and applications of ANN, single layer network.	8	2	L2
III	**Perceptron** Perceptron training algorithm, Linear separability , Widrow & Hebb's learning rule/Delta rule, ADALINE, MADALINE, AI v/s ANN. Introduction of MLP, different activation functions, Error back propagation algorithm, derivation of BBPA, momentum, limitation, characteristics and application of EBPA.	8	3	L3
IV	**Counter propagation network** Architecture , functioning & characteristics of counter Propagation network, Hop field/ Recurrent network, configuration, stability constraints, associative memory, and characteristics, limitations and applications. Hopfield v/s Boltzman machine. Adaptive Resonance Theory: Architecture, classifications, Implementation and training. Associative Memory.	7	4	L4
V	**Fuzzy Logic** Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions.	7	5	L5

	Fuzzy rule base system : Fuzzy propositions, formation, decomposition & aggregation of fuzzy Rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making & Applications of fuzzy logic.			
VI	**Genetic algorithm** Fundamental, basic concepts, working principle, encoding, fitness function, reproduction, Genetic modeling: Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator ,Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & other traditional methods.	8	6	L5
Total		**45**		

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

C. Continuous Assessment (CA):

Continuous Assessment should consist of the following

Experiments / Tutorials (8 to 10): 10 marks (All Cos should be covered)

Attendance (Theory & Practical): 05 marks

Teacher Assessment Examination (TAE): 10 Marks

List of Teacher Assessment Examination (TAE):

1. Assignment
2. Case Study
3. Debate
4. Solution for Social Problems
5. Field Visit
6. Group Project
7. Flipped Classroom
8. Topic Review
9. Quiz

10. Mind Mapping
11. Any other.

Note: Number of activities to be conducted under TAE would be as per the subject need.

Reference Books:

1. Bart Kosko, Neural Network & Fuzzy System, PHI Publication, 1st Edition, 2009
2. Rich E, Knight K, Artificial Intelligence, TMH, 3rd Edition, 2012.

Text Books:

❖ S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, Wiley Publications, 2nd Edition, 2011.

Useful Links:

1.www.myreaders.info/html/soft_computing.html

Course Title: Quantum Computing												
Semester: VII			Term: Odd			Course Code: 24CSDSPEC7022C						
Teaching Scheme							Evaluation Scheme:					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	--	--	3	--	--	3	20	20	60	--	--	100

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To understand basics of quantum computing
2. To understand mathematics required for quantum computing
3. To understand building blocks of quantum computing and design algorithms
4. To understand quantum hardware principles and tools for quantum computing.

Course Outcomes:

After successful completion of the course, the learner will be able to …

1. Understand basic concepts of quantum computing
2. Illustrate building blocks of quantum computing through architecture and programming models.
3. Appraise various mathematical models required for quantum computing
4. Discuss various quantum hardware building principles.
5. Identify the various quantum algorithms
6. Describe usage of tools for quantum computing.

Module	Contents	Hours	COs	RBT Level
I	**Introduction to Quantum Computing** Motivation for studying Quantum Computing, Origin of Quantum Computing, Quantum Computer vs. Classical Computer, Introduction to Quantum Mechanics, Overview of Major Concepts in Quantum Computing, Qubits and Multi-Qubit States, Bloch Sphere Representation, Quantum Superposition, Quantum Entanglement, Major Players in the Industry (IBM, Microsoft, Rigetti, D-Wave, etc.) **Self- Learning Topic:** NISQ Era, Fault-Tolerant Quantum Computing	07	CO1	L2
II	**Mathematical Foundations for Quantum Computing** Matrix Algebra, Basis Vectors and Orthogonality, Inner Product and Hilbert Spaces, Matrices and Tensors, Unitary Operators and Projectors, Dirac Notation, Eigenvalues and Eigenvectors, Group Theory **Self- Learning Topic:** Lie Algebra Applications in Quantum Computing	05	CO2	L3
III	**Building Blocks for Quantum Program** Architecture of a Quantum Computing Platform, Details of Qubit System of Information Representation. Bloch Sphere Multi-Qubit States, Quantum Superposition of Qubits (Valid and Invalid Superposition), Quantum Entanglement, Useful States from Quantum Algorithmic Perspective (e.g., Bell State), Operations on Qubits: Measuring and Transforming Using Gates, Quantum Logic Gates and Circuits, No-Cloning Theorem and Quantum Teleportation. Programming Model for a Quantum Computing Program, Steps Performed on Classical Computer, Steps Performed on Quantum Computer, Moving Data Between Bits and Qubits **Self- Learning Topic:** Variational Quantum Circuits	05	CO3	L3

IV	**Quantum Algorithms and Error Correction** Quantum Algorithms, Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch–Jozsa Algorithm, Quantum Error Correction Using Repetition Code, Error Correction Codes, 3-Qubit Codes, Shor's 9-Qubit Error Correction Code. **Self- Learning Topic:** Hybrid Quantum-Classical Algorithms	05	CO4	L4
V	**Quantum Hardware** Ion Trap Qubits, The DiVincenzo Criteria, Lagrangian and Hamiltonian Dynamics in a Nutshell, Dynamics of a Translating Rotor, Quantum Mechanics of a Free Rotor, A Poor Person's Atomic Model, Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates, The Cirac–Zoller Mechanism, Quantum Theory of Simple Harmonic Motion, A Phonon–Qubit Pair Hamiltonian, Light-Induced Rotor–Phonon Interactions, Trapped Ion Qubits, Mølmer–Sørenson Coupling, Cavity Quantum Electrodynamics (cQED), Eigenstates of the Jaynes–Cummings Hamiltonian, Circuit QED (cirQED), Quantum LC Circuits, Artificial Atoms Superconducting Qubits, Quantum Computing with Spins, Quantum Inverter Realized with Two Exchange-Coupled Spins in Quantum Dots, A 2-Qubit Spintronic Universal Quantum Gate. **Self- Learning Topic:** Topological Quantum Computing	5	CO5	L4
VI	**OSS Toolkits for Implementing Quantum Programs** IBM Quantum Experience, Microsoft Q, Rigetti PyQuil (QPU/QVM), Quantum Cloud Platforms **Self- Learning Topic:** Developing Quantum Applications using Qiskit Runtime	03	CO6	L5
	Total	**30**		

Textbooks

1. Michael A. Nielsen, *Quantum Computation and Quantum Information*, Cambridge University Press.
2. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
3. Qiskit Textbook: https://qiskit.org/textbook-beta/
4. Vladimir Silva, *Practical Quantum Computing for Developers*, 2018.

References

1. Bernard Zygelman, A First Introduction to Quantum Computing and Information, 2018.
2. Supriyo Bandyopadhyay and Marc Cahay, Introduction to Spintronics, CRC Press, 2008.
3. Lars Jaeger, The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies.
4. Giuliano Gladioli La Guardia, Quantum Error Correction Codes, Springer, 2021

Digital References:

1. https://onlinecourses.nptel.ac.in/noc21_cs103/preview
2. https://www.coursera.org/courses?query=quantum%20computing
3. https://www.cl.cam.ac.uk/teaching/1617/QuantComp/

Course Title: Finance and Accounting												
Semester: VII			Term: Odd			Course Code: 24OE7011C						
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

Sustainable Development Goals Mapped: 1, 4, 8, 10, 16

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1 Understand the basic concepts of managerial economics, demand analysis, and elasticity of demand.

2 Apply break-even analysis and pricing strategies in business decision-making.

3 Analyze business organizations, economic policies, and cost accounting methods.

4 Evaluate accounting procedures and preparation of financial statements.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the concepts and scope of managerial economics and demand analysis.
2. Analyze elasticity of demand and apply demand forecasting methods.
3. Apply break-even analysis and pricing strategies for business decisions.
4. Evaluate business organizations and the impact of economic policies.
5. Prepare cost sheets using cost accounting techniques.
6. Prepare financial statements using accounting principles and procedures.

Module	Content	Hours	COs	RBT Level
1	**Introduction to managerial economics** Definition, nature and scope of managerial economics, demand analysis, demand determinants, law of demand and its exceptions	7	1	2
2	**Elasticity of Demand** Definition types measurement and significance of elasticity of demand. Factors governing demand forecasting, methods of demand forecasting (survey methods, statistical methods, expert opinion method, test marketing, controlled experiment, and judgmental approach to demand forecasting)	8	2	4
3	**Break even analysis and pricing strategies** Break even analysis-determination of breakeven point (simple problems) - managerial significance and limitations of BEA. Objectives and policies of pricing-methods of pricing: cost plus pricing, sealed bid pricing, going rate pricing, market skimming pricing, penetration pricing, two part pricing, block pricing, bundling pricing, peak load pricing, cross subsidization.)	8	3	3
4	**Business and New economic policy** Characteristics of business , features and evaluation of forms of business organization based on ownership, nature of the economy, structure of the economy, economic policies, new economic policy 1991, economic conditions	7	4	5
5	**Cost accounting Introduction-** Classification of costs –methods of costing – techniques of costing – preparation of cost sheet.	7	5	4
6	**Accountancy** Accounting principles, procedure-double entry system-journal-ledger, trail balance –cash book- preparation of trading, profit and loss account-balance sheet.	8	6	5
	Total	**45**		

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

Textbooks:

1. Management Economics and Financial Analysis, Aryasri, 4/e, TMH, 2009.
2. Managerial Economics, Varshney & Maheswari, Sultan Chand, 2009.

Reference books:

1. Agarwal AN," Indian Economy "Wiley Eastern Ltd,New Delhi
2. Jain and Narang "Accounting part-1"Kalyani publishers
3. Arora,M.N."Cost Accounting", Vikas publications
4. Ashwatappa. K "Business Environment"

e-Resources and Digital Material:

1. http://nptel.ac.in/courses/110105067/
2. http://nptel.ac.in/courses/110107073/

Course Title: Intellectual Property Rights												
Semester: VII			Term: Odd			Course Code: 24OE7012C						
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

Sustainable Development Goals Mapped: 4, 8, 9, 16

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To understand the fundamentals and importance of Intellectual Property Rights (IPR).
2. To learn various types of IPR such as patents, copyrights, trademarks, and designs.
3. To understand procedures related to registration, protection, and infringement of IPR.
4. To gain knowledge of IT Act 2000, cyber laws, and digital security concepts.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Explain the basics of IPR, TRIPS, and WTO.
2. Describe patent and copyright registration, rights, and infringement.
3. Analyze copyright protection and software piracy issues.
4. Examine trademarks, domain names, and legal remedies
5. Apply concepts of industrial design and layout protection.
6. Evaluate provisions of IT Act 2000 and cybercrimes

Module	Content	Hours	COs	RBT Level
1	**INTRODUCTION TO IPR:** Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights Introduction to TRIPS and WTO. Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	8	1	2
2	**PATENT RIGHTS AND COPY RIGHTS**— Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. – 6 hours	8	2	3
3	**COPY RIGHT**—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	8	3	4
4	**TRADE MARKS**— Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. Domain Names on cyber space.	7	4	4
5	**DESIGN**- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	7	5	3
6	**BASIC TENENTS OF INFORMATION TECHNOLOGY ACT-2000 –** IT Act - Introduction E- Commerce and legal provisions E- Governance and legal provisions Digital signature and Electronic Signature. Cybercrimes,	7	6	5

Text books:

1 N.K. Acharya, *Textbook on Intellectual Property Rights*, Asia Law House, 2017.

2 Deborah E. Bouchoux, *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, 2013.

3 P. Narayanan, *Intellectual Property Law*, Eastern Law House, 2017.

Reference books:

1 W.R. Cornish, *Intellectual Property Rights*, Universal Book Traders, 2010.

2 V.K. Ahuja, *Law Relating to Intellectual Property Rights*, LexisNexis, 2017.

3 S.K. Roy Chaudhary & H.K. Saharay, *The Law of Trademark, Copyright, Patents and Designs*, Eastern Law House, 2011.

4 Farooq Ahmad, *Cyber Law in India*, Pioneer Books, 2015.

5 Vakul Sharma, *Information Technology Law and Practice*, Universal Law Publishing, 2011.

e-Resources and Digital Material:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/ntr25_ed87
2. https://nptel.ac.in/courses/109106137

Course Title: Foreign Language - III (Japanese-2)													
Semester: VII			Term: Even				Course Code: 24OE70131C						
Teaching Scheme							Evaluation Scheme						
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total	
Th	Tu	Pr	Th	Tu	Pr								
3	-	-	3	-	-	3	20	20	60	-	-	100	

Sustainable Development Goals Mapped: 4 , 11

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. Demonstrate basic Japanese communication skills for daily conversations and interactions.
2. Explain fundamental Japanese grammar, vocabulary, particles, and sentence structures.
3. Apply verb forms, adjectives, and common expressions in practical communication situations.
4. Develop listening, speaking, reading, and writing skills through structured practice activities.
5. Communicate effectively in elementary Japanese within familiar real-life contexts.

Course Outcomes:

After successful completion of the course students will be able to:

1. Apply self-introduction patterns, basic verb tenses, particles, suffixes, and counters in elementary Japanese communication.
2. Use vocabulary and grammar related to time, dates, and daily activities in simple conversations and written expressions.
3. Construct sentences using transitive verbs, particles, and invitation sentence patterns accurately.
4. Differentiate between *i-adjectives* and *na-adjectives* and use them appropriately in communication.
5. Formulate sentences using various tense forms of *i-adjectives* in spoken and written Japanese.
6. Describe existence, positions, and locations using suitable particles and expressions in Japanese.

Module	Course Contents	Hours	COs
I	**Introduction and revision family** Self-introduction, verb tenses, particles, suffixes, family chart, counters for people and objects, and revision activities. **Self-Learning:** Self-introduction practice, family tree preparation, counters practice, paragraph writing	6	CO1
II	**Time & Activities** Suffixes related to time and dates, vocabulary development, particles (no, de, to), expressions for likes and dislikes, introduction to Kanji, five basic Kanji characters, and expressions indicating wants/desires. **Self-Learning:** Daily routine writing, Kanji practice, likes/dislikes conversations, time expressions	8	CO2
III	**Transitive Verbs and Usage** Introduction to transitive verbs, usage of particle *wo*, grammar patterns for inviting someone, vocabulary enrichment, hobbies, introduction to five Kanji characters, and revision. **Self-Learning:** Sentence formation with transitive verbs, invitation dialogues, hobbies vocabulary, Kanji practice	8	CO3
IV	**Adjectives and usage.** *i*-ending adjectives, *na*-ending adjectives, appropriate usage of adjectives, tense forms of *na*-adjectives and nouns, daily-use vocabulary, and introduction to five Kanji characters. **Self-Learning:** Describing people and objects, adjective usage practice, picture description, Kanji writing	8	CO4
V	**Tenses of *i*-Ending Adjectives** Vocabulary enhancement, present negative, past negative, and past positive forms of *i*-ending adjectives, sentence structures using all tense forms, asking questions, adverbs, and sentence formation using adverbs. **Self-Learning:** Adjective tense exercises, descriptive paragraph writing, adverb usage, question-answer practice	8	CO5

VI	**Existence, Positions and Location** New adjectives, positions of living and non-living objects, particles (*ni*, *ga*), directions, introduction to five Kanji characters, and IAE–2 revision. **Self-Learning:** Location-based conversations, direction practice, object position description, Kanji revision	7	CO6
	Total	**45**	

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

Course Title: Foreign Language – III (German-2)												
Semester: VII			Term: Odd				Course Code: 24OE50132C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	Theory				Practical	Total
Th	Tu	Pr	Th	Tu	Pr		IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	
3	--	--	3	--	--	3	20	20	60	--	--	100

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

1. To develop students' ability to communicate confidently in German through day-to-day conversations, role plays, and practical situations.
2. To strengthen intermediate German grammar skills, including cases (Nominativ, Akkusativ, Dativ), separable verbs, conjunctions, past tense forms, sentence connectors, and question formation.
3. To enable students to describe daily schedules, routines, and activities using appropriate vocabulary and time expressions.
4. To enhance reading comprehension skills through German passages, dialogues, advertisements, emails, and simple articles.

Course Outcomes:

Learner will be able to

1. Communicate effectively in German for everyday situations related to travel, shopping, health, and workplace interactions.
2. Apply intermediate German grammar, including cases, modal verbs, separable verbs, and past tense forms.
3. Describe past experiences, future plans, and personal opinions using appropriate tenses.
4. Interpret short German texts, emails, advertisements, and articles.
5. Compose simple paragraphs, emails, invitations, and descriptions in German.
6. Demonstrate conversational skills in common real-life situations.

Module	Contents	Hours	COs
I	**Intermediate Grammar and Sentence Structure** Numbers,Time ,Opposites, Akkusativ & Dativ Case (*Nominativ / Akkusativ / Dativ*),Dativ Verbs: *helfen, danken, gefallen*,Wechselpräpositionen (*in, an, auf, unter, vor, hinter, zwischen*),wer-wen-wem-was Frage	08	1
II	**Communication in Daily Life** Dativ mit Präpositionen,Ja-Nein-Doch,Wegbeschreibung und Orientierung,In der Stadt / Verkehrsmittel,Am Bahnhof / Am Flughafen,Dialoge im Alltag,E-Mails und kurze Nachrichten schreiben	07	2
III	**Vocabulary Building and Communication** **Tagesablauf & Uhrzeit** Daily routine vocabulary,Sequencing activities,Time expressions,Akkusativ Prespositions **Kleidung & Einkaufen** Colors, sizes, prices,clothes vocabulary,Dialogue in shops gefallen + dative,möchten , mögen verbs,Food & drinks Vocabulary,Ordering food,Preferences and quantities.	08	3
IV	**Communication** **Gesundheit & Beim Arzt** Body parts,Symptoms and advice,Imperative basics **Wohnung & Möbel** Rooms and furniture vocabulary,Articles and plural forms **Meine Heimat** Short paragraphs and descriptions,Conjuctions (ADUSO),Sentence connectors: und, aber, denn	07	4

V	**Grammar Deep Dive and Routine Activities** Perfekt -haben / sein + Partizip II,Regular and irregular verbs **Zeitangaben & Reihenfolge** zuerst, dann, danach, später,am Morgen, am Abend **Wetter und Jahreszeiten** Weather expressions,Seasonal activities	07	5
VI	**Practical Usage of Grammar** **Einkaufen und Dienstleistungen** Shops, offices, stations, pharmacies,Requests and polite questions,Wo-Wohin Frage ,House Vocabulary & Conversation,asking & giving directions,Fruits & Vegetables & Market Conversatio,Demonstrative Articles,Possesive Articles (Akkusativ-Dativ)	08	6
	Total	**45**	

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

Text Books:

1. Netzwerk A1, Stefanie Dengler, Paul Rusch, Helen Schmitz, Tanja Sieber, Klett Sprachen Verlag, 2024
2. Menschen A1 Kursbuch, Angela Pude and Franz Specht, Hueber Verlag, 2024
3. Berliner Platz Neu 1, Christiane Lemcke, Lutz Rohrmann, Theo Scherling, Langenscheidt Publishing Group, 2024

Reference Books:

1. Schritte international Neu A1.1, Daniela Niebisch, Sylvette Penning-Hiemstra, Franz Specht, Hueber Verlag, 2023
2. The Everything Learning German Book, Ed Swick, Adams Media, 2022 German Made Simple: Learn to Speak and Understand German Quickly and Easily, Arnold Leitner, Crown Publishing Group, 2021
3. Living Language German, Complete Edition, Living Language Staff, Penguin Random House, 2021

Links for online NPTEL/SWAYAM courses:

1. https://onlinecourses.nptel.ac.in/noc20_hs41/preview
2. https://onlinecourses.nptel.ac.in/noc21_hs30/preview

Course Title: Basics of HR Management												
Semester: VII			Term: Odd				Course Code: 24OE7014C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

Sustainable Development Goals Mapped: 1, 4, 8, 10, 16

IAE: Internal Assessment Examination

ESE: End Semester Examination

CA: Continuous Assessment

Course Objectives:

- ➢ Understand the basic concepts and functions of Human Resource Management.
- ➢ Analyze job analysis, HR planning, recruitment, and selection processes.
- ➢ Apply training and performance appraisal methods for employee development.
- ➢ Evaluate labour welfare, social security, and employee discipline practices.

Course Outcomes:

Upon successful completion of the course, students will be able to:

1. Understand the concepts, functions, and importance of Human Resource Management.
2. Analyze job analysis and human resource planning processes.
3. Apply recruitment, selection, and employee placement procedures.
4. Evaluate training and development methods for employee growth.
5. Analyze the process and methods of performance appraisal.
6. Evaluate labour welfare, social security, and employee discipline practices.

Module	Content	Hours	COs	RBT Level
I	**Human Resource Management:** Introduction, meaning, nature, scope of HRM - Importance and Evolution of the concept of HRM - Major functions of HRM - Principles of HRM	7	1	2
II	**Job Analysis:** Meaning, process of Job Analysis, methods of collecting job analysis data, Job Description and Job Specification, Role Analysis. Human Resource Planning: Objectives, Importance and process of Human Resource Planning, Effective HRP.	8	2	4
III	**Recruitment:** Definition, Constraints and Challenges, Sources and Methods of Recruitment, New Approaches to recruitment. Selection: Definition and Process of Selection. Placement: Meaning, Induction/Orientation, Internal Mobility, Transfer, Promotion, Demotion and Employee Separation.	8	3	3
IV	**Training and development**: Training v/s development, Training v/s Education, Systematic Approach to Training, Training Methods.	7	4	5
V	**Performance Appraisal:** Concept of Performance Appraisal, the Performance Appraisal Process, Methods of Performance Appraisal.	7	5	4
VI	**Social Security & Labour Welfare:** Workers' Participation in Management: Levels of Management participation, Methods/ Schemes of Workers' participation in Management. Social security in India, Scope, Types of Social security and welfare programmes, non-monetary welfare measure. Employee Discipline:	8	6	5

	Characteristics of a sound disciplinary system, Common causes of indiscipline in an organisation, Disciplinary procedure, Ways of handling grievances.			
	Total	**45**		

Evaluation and Assessment Scheme:

A. Internal Assessment Examination (IAE):

Assessment consists of two class tests, each 20 marks. The IAE 1 will cover any three Course Outcomes (COs) and IAE 2 will cover the remaining three Course Outcomes (COs). Each test will have a duration of one hour.

B. End Semester Theory Examination (ESE):

End Semester exam of 60 Marks will be conducted based on entire syllabus.

Text & Reference Books:

- Human Resource Management, Pathania, Batra, Pathak, Kalyani Publishers
- Human Resource Management, Durai, Pearson
- Human Resource Management, VSP Rao, Excel Books
- Human Resource Management, Khanka, S. Chand
- Human Resource Management Text & Cases, Ashwathappa
- Personnel & Human Resource Management, P. Subba Rao, HPH

Useful Links:

https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_mg21

http://www.digimat.in/nptel/courses/video/110105069/L01.html

Course Title: Employability Enhancement Program-VI (Communication)													
Semester: VII			Term: Odd				Course Code: 24CSDSAEC701C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	Or/Pr/Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
--	--	02	--	--	01	01	--	--	--	25	--	25

Sustainable Development goals: 4, 8

Course Objectives:

1. To apply required interpersonal skills so as to face challenges at the global level.
2. To equip students with relevant employment skills for their career advancement.

Course Outcomes:

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

1. Exhibit emotional intelligence by recognizing and responding appropriately to the emotions and perspectives of individuals from various cultural backgrounds.
2. Develop a comprehensive set of employability skills, including critical thinking, problem-solving, and adaptability, to navigate the evolving job market.

Tut No.	List of Tutorials	Hours	CO
	Listening Skills		
1	IELTS Listening	**1**	**1**
2	Grooming, Dress and Appearance	**1**	**1**
	Speaking Skills		
3	Self-Introduction	**1**	**1**
4	Technical Presentation (External Evaluator)	**1**	**1**
5	Impromptu Speech	**1**	**1**
6	Group Discussion	**1**	**2**
7	Mock Interview (Panel/Online)	**2**	**2**
	Reading Skills		
8	Book Review	**2**	**2**
9	Crossword & News/Editorial Reading	**1**	**2**

Writing Skills			
10	Proficiency Test	**1**	**2**
11	Resume Writing	**1**	**2**
12	Official Correspondence: Inquiry & Reply, Complaint & Adjustment	**1**	**2**

Reference Books:

2. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, 2008
3. Gadyalji Vaishali K, Communication Skills, Nandu Publications, 2010
4. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2007
5. Rai Urmila & Rai S.M, Business Communication, Himalaya Publishing House, 2008
6. Raman Meenakshi & Sharma Sangeeta, Technical Communication Principles and Practice, Oxford University Press, 2015
7. Raman Meenakshi & Singh Prakash, Business Communication, Oxford University Press, 2008
8. Locker O Kitty & Kaczmarek Kyo Stephen, Business Communication Building Critical Skills, McGraw Hill Education Private Limited, 2007
9. Chaturvedi P D & Chaturvedi Mukesh, Business Communication Concepts, Cases and Applications, Pearson Education, 2008

Text Books:

- Luthans Fred, Organizational Behavior An Evidence-Based Approach, McGraw Hill Education Private Limited, 2013

Useful Links:

- https://youtu.be/k9NMWDqun5A?si=HKOdK5PtKy6HvkBk
- https://youtu.be/waOIjlaTSo8?si=iHiCOT-KQRoJvFE3
- https://youtu.be/FfhZFRvmaVY?si=7NcRYuRBb0F6sfKf
- https://youtu.be/FVqSiFUVX78?si=-ZMO0_yT-Hl-5UW0
- https://youtu.be/6OdCoMgpx7o?si=iq2oK3auNRI1Z7D0

Course Title: Capstone Project												
Semester: VII			Term: ODD				Course Code: 24CSDSPRJ701C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE1	IAE 2	ESE	CA	Or/Pr/ Tut.	Total
Th	Tu	Pr	Th	Tu	Pr							
-	-	4	-	-	2	2	-	-	-	50	50	100

Sustainable Development Goals: "SDG mapping will be carried out based on the project topic and its relevance to sustainable development goals."

Introduction:

The Capstone Project is a final academic exercise that integrates knowledge and skills acquired during the program. It enables students to solve real-world problems through design, analysis, and implementation. The project enhances critical thinking, research ability, teamwork, and communication skills, preparing students for professional practice and industry requirements.

Important Note: The Capstone Project is introduced in Semester VII as a foundational project-based learning experience. In Semester VIII, students may opt for either a Major Project or an Internship. Students choosing an internship must complete the Capstone Project in Semester VII. Those opting for a Major Project may either continue the same project or undertake a new project in Semester VIII.

Course Objectives:

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification, analyzing the problem and designing solutions.

Course Outcomes:

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

Students will be able to develop the understanding of the problem domain through extensive review of literature.

- Students will be able to identify and analyze the problem in detail to define its scope with problem specific data.
- Students will be able to identify various techniques to be implemented for the selected problem and related technical skills through feasibility analysis.
- Students will be able to design solutions for real-time problems that will positively impact society and environment.
- Students will be able to develop clarity of presentation based on communication, teamwork and leadership skills.
- Students will be able to inculcate professional and ethical behavior..

Guidelines:

Project Topic Selection and Allocation:

- Project topic selection Process to be defined and followed:
- Project orientation can be given at the end of sixth semester.
- Students should be informed about the domain and domain experts whose guidance can be taken before selecting projects.
- Student's should be recommended to refer papers from reputed conferences/ journals like
- IEEE, Elsevier, ACM etc. which are not more than 3 years old for review of literature.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements. Students can be informed to refer Digital India portal, SIH portal or any other hackathon portal for problem selection.
- Topics can be finalized with respect to following criterion:
- **Topic Selection**: The topics selected should be novel in nature (Product based, Application based or Research based) or should work towards removing the lacuna in currently existing systems.
- **Technology Used:** Use of latest technology or modern tools can be encouraged**.**
- Students should not repeat work done previously (work done in the last three years).
- Project work must be carried out by the group of at least 2 students and maximum 4.
- The project work can be undertaken in a research institute or organization/Industry/any business establishment. (out-house projects)
- The project proposal presentations can be scheduled according to the domains and should be judged by faculty who are expert in the domain.
- Head of department and senior staff along with project coordinators will take decision regarding final selection of projects.
- Guide allocation should be done and students have to submit weekly progress report to the internal guide.
- Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding continuous assessment marks.
- In case of industry/ out-house projects, visit by internal guide will be preferred and external members can be called during the presentation at various levels

Project Report Format:

At the end of semester, each group need to prepare a project report as per the guidelines issued by the institute.

A project report should preferably contain at least following details:

- Abstract
- Introduction
- Literature Survey
- Survey of Existing systems
- Limitations of Existing systems or research gaps
- Motivation (Challenges that are encouraging to choose the problem)
- Problem Statement and Proposed Solution
- Scope of the system
- Proposed System
- General Workflow/Block diagram
- Analysis and Modeling (only applicable diagrams)
- Design
- Architectural View
- Algorithms/ Methodology
- Experimental Set up
- Details of Database or details about input to systems or selected data
- Performance Evaluation Parameters (for Validation)
- Software and Hardware Set up
- Implementation Plan for Next Semester
- Timeline Chart for Term1 and Term-II (Project Management tools can be used.)
- Summary
- References

Desirable

1. Students can be asked to undergo some Certification course (for the technical skill set that will be useful and applicable for projects.)

G. Continuous Assessment:

Distribution of marks for continues assessment shall be done based on following:

- ❖ Weekly Log Report
- ❖ Project Work Contribution
- ❖ Project Report (Spiral Bound) (both side print)
- ❖ Term End Presentation (Internal)

The final certification and acceptance of CA ensures the satisfactory performance on the above aspects.

H. Oral & Practical:

Oral &Practical examination (Final Project Evaluation) of Project 1 should be conducted by Internal and External examiners approved by the institute at the end of the semester.

Suggested quality evaluation parameters are as follows:

- ➢ Quality of problem selected
- ➢ Clarity of problem definition and feasibility of problem solution
- ➢ Relevance to the specialization / industrial trends
- ➢ Originality
- ➢ Clarity of objective and scope
- ➢ Quality of analysis and design
- ➢ Quality of written and oral presentation
- ➢ Individual as well as team work

Bachelor of Technology

In

Computer Science & Engineering (Data Science)

Fourth Year
Semester – VIII

SJCEM: R–25

Effective from Academic Year

2026-27

Program Structure for Fourth Year Computer Science and Engineering (Data Science)

(With Effect from 2026-2027)

Semester VIII

Course Code	Vertical	Course Name	Contact Hrs			Credit Allotted			Total Credits
			Th	Tut	Pr	Th	Tut	Pr	
24CSDSPCC801C1	PCC	Data Warehousing and Mining	3	-	2	3	-	1	4
24CSDSPCC802C	PCC	Information Security	2	-	2	2	-	1	4
24CSDSPEC801XC	PEC	Program Elective – VII(MOOC)	3	-	-	3	-	-	3
24CSDSPEC802XC	PEC	Program Elective – VIII(MOOC)	3	-	-	3	-	-	3
24CSDSEV801C	VEC	Constitution of India	1	-	-	1	-	-	1
24CSDSPRJ801C	PRJ	Major Project	-	-	12	-	-	6	3
		Total	**12**	**0**	**16**	**12**	**0**	**8**	**20**

Course Code	Vertical	Course Name	Evaluation Scheme					
			IAE 1	IAE 2	ESE	CA	OR/ PR	Total
24CSDSPCC801C	PCC	Data Warehousing and Mining	20	20	60	25	25	150
24CSDSPCC802C	PCC	Information Security	20	20	60	25	25	150
24CSDSPEC801XC	PEC	Program Elective – VII(MOOC)	20	20	60	-	-	100
24CSDSPEC802XC	PEC	Program Elective – VIII(MOOC)	20	20	60	-	-	100
24CSDSEV801C	VEC	Constitution of India	10	10	30	-	-	50
24CSDSPRJ801C	PRJ	Major Project	-	-	-	100	50	150
		Total	**90**	**90**	**270**	**150**	**100**	**700**

Syllabus

for

Fourth Year

Computer Science & Engineering (Data Science)

Semester – VIII

SJCEM: R–25

(With Effect from 2026-27)

Course Title: Data Warehousing And Mining												
Semester: VIII			Term: EVEN				Course Code: 24CSDSPCC801C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	2	3	-	1	4	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

The course is aimed

1. Understand the fundamentals of data warehousing, dimensional modelling, and OLAP techniques.
2. Analyse data integration processes, ETL/ELT pipelines, and data quality issues.
3. Apply data pre-processing and core data mining algorithms for knowledge discovery
4. Evaluate advanced data mining techniques and their applications in real-world scenarios.

Course Outcomes:

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

1. Explain the fundamental concepts, characteristics, and importance of data warehousing
2. Apply OLAP operations for multidimensional data analysis.
3. Analyze ETL/ELT pipelines and data quality challenges in data integration.
4. Perform data preprocessing and exploratory analysis on datasets.
5. Apply classification, clustering, and association rule mining techniques.
6. Evaluate advanced data mining methods and emerging trends for decision-making

Module	Contents	Hours	Cos
I	**Data warehousing** Introduction to Data Warehousing, Traditional vs. Modern Data Warehouse (MDW); Characteristics of Datawarehouse. Architecture: Data Lake vs. Data Warehouse vs. Data Lakehouse (Delta Lake), Medallion Architecture. **Self-learning:** Why the Industry Moved to MDW, Case Study: How Netflix or Uber uses a Data Lakehouse for real-time recommendations.	6	CO1
II	**Dimensional Modeling and Analytical Design** Dimensional Modeling: Star, Snowflake, and Fact Constellation schemas, Factless Fact tables, Slowly Changing Dimensions (SCD Types 1, 2, 3). OLAP Operations: Data Cube, Roll-up, Drill-down, Slice, Dice, and Pivot. **Self-learning:** The Unified Semantic Layer in Modern BI, Case study on selecting Granularity for a high-volume E-commerce platform.	8	CO2
III	**Data Integration & Quality Engineering** ETL (Extraction, Transformation, and Loading) Vs ELT (Extract, Load, Transform). Change Data Capture (CDC): Real-time data ingestion techniques .Data quality issues: missing values, noise, duplicates, outliers,inconsistencies. **Self-learning:** Data Observability and Data Contracts	6	CO3
IV	**Data Mining and Pre-processing** Data Mining, Knowledge Discovery in Databases (KDD) process. Data Exploration: Types of Attributes, Statistical Description of Data, Data Visualization, Data Preprocessing: Data cleaning, Integration, Data transformation, Data Reduction, Discretization. **Self-learning:** Feature engineering, Automated Data Profiling & Outlier Detection	7	CO4

V	**Core Data Mining Algorithms** Classification: decision trees - Naïve Bayes ,Clustering overview: K-medoids, DBSCAN ,Association Rule Mining: Market Basket Analysis, Frequent Pattern ,Mining, Apriori Algorithm, FP Growth. Association Rule Generation, Improving the Efficiency of Apriori, Mining Frequent Itemsets without candidate, generation, Introduction to Mining Multilevel ,Association Rules and Mining, Multidimensional Association Rules **Self-learning:** The "Curse of Dimensionality" in Clustering, Real-world MBA: How Amazon uses Association Rules for "Frequently Bought Together".	11	CO5
VI	**Specialized Mining & Emerging Trends** Specialized Mining: Web & Text Mining, Spatial and Temporal Mining.Emerging Trends: Graph & Social Media Mining, AI-Augmented & Multimedia Mining, Privacy & Ethics in Mining. **Self-learning:** Privacy-Preserving Data Mining, Federated Learning, Advanced topic: Explainable AI (XAI) in Data Mining	7	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	To study and compare Data Warehouse, Data Lake, and Data Lakehouse architectures based on structure, features, and use cases.	CO1
2	Design of data warehouse schema for a given application. (Retail/ Library/ Banking)	CO1
3	Implementation of all dimension table and fact table.	CO2
4	Perform OLAP operations such as roll-up, drill-down, slice, dice, and pivot using SQL queries.	CO2
5	Implement an ETL process by extracting data from a source, transforming it, and loading it into a database.	CO3
6	Identify and handle data quality issues such as missing values, duplicates, and outliers in a dataset.	CO3
7	Perform statistical analysis and visualization to understand the characteristics of a dataset.	CO4

8	Apply data preprocessing techniques such as normalization, transformation, and discretization.	CO4
9	Implement classification algorithms such as Decision Tree or Naïve Bayes for predictive analysis.	CO5
10	Perform association rule mining using the Apriori algorithm for market basket analysis.	CO5
11	Perform sentiment analysis on text data to classify it into positive or negative 0.categories.	CO6
12	Analyze a real-world dataset using data mining techniques and derive meaningful insights.	CO6

Reference Books:

1. Reema Theraja, "Data warehousing", Oxford University Press 2009.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction to Data Mining", Pearson Publisher 2 nd edition.
3. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining", Morgan Kaufmann 3 rd edition.

Textbooks:

1. Paulraj Ponniah, " Data Warehousing: Fundamentals for IT Professionals", Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann 2 nd edition.
3. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Useful Links

1. https://onlinecourses.nptel.ac.in/noc20_cs12/preview
2. https://www.coursera.org/specializations/data-mining

Course Title: Information Security												
Semester: VIII			Term: EVEN				Course Code: 24CSDSPCC802C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
2	-	2	2	-	1	3	20	20	60	25	25	150

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives: The course aims

1. To understand the fundamental concepts of cryptography, network security, and secure communication systems.
2. To study encryption techniques, cryptographic algorithms, hashing, message authentication, and public key cryptography.
3. To analyze authentication protocols, Public Key Infrastructure (PKI), and security protocols such as Kerberos, IPsec, SSL/TLS, and secure email.
4. To apply cryptographic techniques and network security principles to design, implement, and evaluate secure communication systems and applications.

Course Outcomes:

At the end of the course students will be able:

1. Explain the fundamental concepts of information security, security goals, cryptographic services, attacks, and classical encryption techniques.
2. Apply symmetric key, asymmetric key, and public key cryptographic algorithms for secure encryption, decryption, authentication, and key exchange.
3. Analyze cryptographic hash functions, message authentication codes (MAC), digital signatures, authentication protocols, and Public Key Infrastructure (PKI) for secure communication.
4. Evaluate network security threats, TCP/IP vulnerabilities, and implement appropriate security mechanisms including firewalls, IDS/IPS, SSL/TLS, IPsec, and secure email systems.
5. Identify and mitigate web application security vulnerabilities based on the OWASP Top 10, including SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), and Server-Side Request Forgery (SSRF).
6. Examine emerging security technologies including Artificial Intelligence, Machine Learning, and Blockchain-based security mechanisms to analyze modern cyber threats and develop secure systems.

Module	Contents	Hours	Cos
I	**Introduction and Classical Cryptography** Security Goals, Security Services, Security Mechanisms, Types of Security Attacks, Classical Encryption Techniques, Symmetric Cipher Model, Mono-alphabetic and Poly-alphabetic Substitution Ciphers (Caesar, Vigenère, Playfair, Affine, Hill Cipher), Transposition Techniques (Keyed and Keyless), Steganography. **Self-learning Topics:** Caesar Cipher, Rail Fence Cipher, Modern Applications of Steganography.	7	CO1
II	**Block Ciphers and Public Key Cryptography** Block Cipher Principles, Modes of Operation (ECB, CBC, CFB, OFB, CTR), DES, Double DES, Triple DES, Advanced Encryption Standard (AES), Public Key Cryptography, RSA Algorithm, Diffie-Hellman Key Exchange, Man-in-the-Middle Attack, Elliptic Curve Cryptography (ECC). **Self-learning Topics:** Hybrid Cryptography, Post-Quantum Cryptography.	8	CO2
III	**Cryptographic Hashing and Digital Signatures** Authentication Requirements, Authentication Functions, Types of Authentication, Message Authentication Code (MAC), Cryptographic Hash Functions, MD5, SHA Family, Digital Signatures, Needham-Schroeder Authentication Protocol, RSA Digital Signature, Digital Certificates (X.509), Public Key Infrastructure (PKI). **Self-learning Topics:** SHA-3, Certificate Authorities, Blockchain Hashing.	7	CO3
IV	**Network Security and Security Applications** TCP/IP Vulnerabilities, Packet Sniffing, ARP Spoofing, Port Scanning, IP Spoofing, TCP SYN Flood, DNS Spoofing, Denial of Service (DoS) and Distributed DoS (DDoS), Firewalls, Intrusion Detection Systems (HIDS, NIDS), Honeypots, Kerberos, SSL, TLS, IPsec (AH & ESP), Secure Email (PGP, S/MIME), Key Management. **Self-learning Topics:** Zero Trust Security, VPN Technologies,	10	CO4

	Next-Generation Firewalls.		
V	**OWASP Top 10 Web Security Risks:** Introduction to OWASP, OWASP Top 10 (2013, 2017, 2021), SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF), Server-Side Request Forgery (SSRF), Secure Coding Practices and Vulnerability Mitigation Techniques. **Self-learning Topics:** OWASP ZAP Tool, Secure Software Development Lifecycle (SSDLC).	7	CO5
VI	**Emerging Technologies in Cybersecurity:** Artificial Intelligence and Machine Learning in Security, Intrusion Detection using AI/ML, Anomaly Detection, Fraud Detection, Adversarial Attacks on AI Systems, Blockchain-based Security Applications, Case Studies on AI-enabled Security Systems. **Self-learning Topics:** Explainable AI (XAI) for Security, Zero Trust Architecture, AI-powered Security Operations (SOC).	6	CO6
	Total	**45**	

List of Experiments:

Exp. No.	List of Experiments	Cos
1	To implement conventional cryptographic techniques Ceaser Cipher, and Vernam cipher.(Substitution cipher)	CO1
2	Study the use of network reconnaissance tools like WHOIS, dig, and traceroute ns lookup to gather information about networks and domain registrars	CO4
3	Implementation of Diffie Hellman Key exchange algorithm	CO2
4	Implementation and analysis of DES cryptosystem	CO2
5	Demonstrate and test the integrity of the message using MD-5, SHA- a) For varying message size and analyze the performance of the two protocols. Use crypt APIs.	CO3
6	Implementation and analysis of RSA cryptosystem and Digital signature scheme using RSA/El Gamal	CO2,CO3
7	Study of packet sniffer tools Wireshark :- a) Observer performance in promiscuous as well as non-promiscuous mode.	CO4

	b) Show the packets can be traced based on different filters	
8	Demonstrate the use of nmap with different options to scan open ports, perform OS fingerprinting, ping scan, tcp port scan, udp port scan, etc.	CO4
9	Study and Simulation of DOS attack using Hping and other tools	CO4
10	Study and use the NESSUS/ISO Kali Linux tool to scan the network for vulnerabilities	CO4,CO5
11	Set up IPSEC under LINUX and explore the GPG tool of Linux to implement email security	CO4
12	Study and perform CSRF and SSRF Attack using Burpsuite	CO5
13	Study and perform XSS Attack using Burp suite	CO5

Reference Books

1. Bernard Menezes, **Cryptography and Network Security**, 1st Edition, Cengage Learning, 2010.
2. Atul Kahate, **Cryptography and Network Security**, 2nd Edition, Tata McGraw-Hill, 2008.
3. Charles P. Pfleeger and Shari Lawrence Pfleeger, **Security in Computing**, 5th Edition, Pearson Education, 2015.
4. Nina Godbole, **Information System Security**, 2nd Edition, Wiley India, 2017.
5. William Stallings, **Network Security Essentials: Applications and Standards**, Pearson Education.

Text Books

1. Mark Stamp and Deven Shah, **Information Security: Principles and Practice**, 2nd Edition, Cengage Learning, 2011.
2. Behrouz A. Forouzan, **Cryptography and Network Security**, 2nd Edition, Tata McGraw-Hill, 2008.
3. William Stallings, **Cryptography and Network Security: Principles and Practice**, 6th Edition, Pearson Education, 2013.

Useful Links

1. Cryptography and Network Security: https://nptel.ac.in/courses/106105031/
2. OWASP TOP 10: https://www.owasp.org/index.php/Top_10_2013
3. Cryptography and System Security: https://www.udemy.com/course/cryptography-and-system-security/
4. Ethical Hacking for Beginners: BurpSuite, NMap and SNORT: https://www.udemy.com/course/ethicalhackingforbeg/
5. AI for Cybersecurity & Bug Bounty Hunting: https://www.udemy.com/course/ai-for-cybersecurity-bug-bounty-hunting/

Course Title: Program Elective – VII(MOOC) Mine Automation and Data Analytics

Semester: VIII			Term: EVEN				Course Code:24CSDSPEC8011C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. To understand the principles of mine automation, autonomous mining systems, and advanced communication and tracking technologies used in modern mining operations.
2. To develop knowledge of virtual reality applications and digital technologies for improving mining productivity, operational efficiency, and safety.
3. To introduce the fundamental concepts, lifecycle, techniques, and tools of data analytics for extracting meaningful insights from structured and unstructured data.
4. To develop the ability to apply statistical methods, exploratory data analysis, feature engineering, and predictive analytics techniques to solve real-world business and decision-making problems.

Course Outcomes:

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

1. Explain the concepts of mine automation, autonomous mining systems, and their role in improving mining productivity and operational efficiency.
2. Analyze the applications of communication, tracking, and monitoring technologies such as GNSS, RFID, SCADA, radar, and image processing in mining operations.
3. Apply virtual reality and simulation technologies for mining equipment design, safety training, and operational planning.
4. Understand the fundamental concepts of data analytics, including its importance, types of data, and foundational theories like the Law of Large Numbers.
5. Explain and apply the data analytics lifecycle and different types of data analytics to real-world problems.
6. Use appropriate tools and techniques such as feature engineering, data munging, and EDA to prepare and explore datasets.

Module	Contents	Hours	COs
I	**Fundamentals of Mine Automation** Essential Elements of an Automated System, Automation in Mine Production System, Principles and Strategies of Automation, Introduction to Automation Productivity. Autonomous mining systems- Autonomous haulage systems, Automated drilling systems, Fleet Management Systems: TDS, CMMS, ERP for Mining Industry, Mining Remote Operations & Control: Robotics & Armchair Mining. **Self-Learning Topics:** Industry 4.0 in Mining, Digital Twin Technology, Artificial Intelligence in Mining Automation	6	CO1
II	**Automated Communication and Tracking Technologies** Automated Communication and Tracking Technologies: Proximity Systems, GNSS/UPS, Radar Systems, RFID and Geo-fencing, CCD camera, Image Processing, SCADA, etc . **Self-Learning Topics:** Internet of Things (IoT) in Mining, Wireless Sensor Networks	7	CO2
III	**Immersive Technologies for Mining Operations** Virtual Reality Applications: Mining Equipment Concept development, Mine Safety Applications, Mining operation simulations . **Self-Learning Topics:** Augmented Reality (AR) in Mining, Mixed Reality (MR) Applications, VR-Based Operator Training	8	CO3
IV	**Data Analytics Introduction** What is Data Analytics, Data Analytics vs Data Science, Importance of Data Analytics in Today's World, Brief History of Data Analytics, Key Concepts in Data Analytics, Types of Data, Law of Large Numbers, Central Limit Theorem Data Collection and Management: Planning for Data Collection, Sources of Data, Types of Data, Data Preprocessing, Data Storage and Retrieval. **Self-Learning Topics:** Applications of Data Analytics in Mining, Open Data Sources for Mining, Big Data in Mining Industry	7	CO4
V	**Data Analytics Lifecycle** Types of Data Analytics**:** Descriptive Analytics, Inferential Analytics, Predictive Analytics, Prescriptive Analytics Data Analytics Lifecycle: Phase 1: Discovery, Phase 2: Data Preparation, Phase 3: Model Planning, Phase 4: Model Building, Phase 5: Communicate Results, Phase 6: Operationalize.	9	CO6

	Self-Learning Topics: Case Studies on Data Analytics Lifecycle, CRISP-DM Framework, Machine Learning Tools for Data Analytics		
VI	**Data Analytics Techniques** Tools and Techniques for Data Analytics: Feature Engineering Data Munging, Data Exploration and Cleaning, Sampling Techniques, Exploratory Data Analysis, Types of Distribution Basic Mathematical Techniques: Quadratic Equation, Permutation and Combination, Probability Distribution, Laws of Algebraic Operations, Plane Analytic Geometry, Venn Diagram **.** **Self Learning Topics:** Data Visualization Tools, Feature Engineering Techniques, Statistical Methods for Data Analytics, Applications of Data Analytics in Mining	8	
	Total	**45**	

Reference Books

1. G. Almgren, U. Kumar, N. Vagenas: Mine Mechanization & Automation 1st Edition
2. J. O'Shea M. Polis: Automation in Mining, Mineral and Metal Processing (1st Edition), Proceedings of the 3Rd Ifac Symposium, Montreal, Canada 18-20 August 1980
3. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, John Wiley & Sons, First Edition, 2012.
4. EMC Education Services, Data Science and Big Data Analytics, Wiley, 2015.

Text Books

1. Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: Springer, 2009.
2. Montgomery, Douglas C., and George C. Runger. Applied statistics and probability for engineers. John Wiley & Sons, 2010
3. Anand Rajaraman and Jeff Ullman, Mining of Massive Datasets, Cambridge University Press, First Edition, 2012.
4. Alex Holmes, Hadoop in Practice, Manning Publications (Dreamtech Press), Second Edition, 2015.

Useful Links

1. http://www.mmds.org/
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_mm23

Course Title: Program Elective – VIII (MOOC) Cloud Computing

Semester: VIII			Term: EVEN				Course Code: 24CSDSPEC8012C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. Understand and analyze the basics of cloud computing, service models, deployment models and architecture.
2. Define and understand the concept of virtualization and related technologies.
3. Understand the different cloud computing services and their relevance's.
4. Describe the various services provided by Amazon Web Services cloud platform.
5. Understand and analyze the functionality of Openstack cloud platform & Severless computing.
6. Describe the aspects of Security & Privacy in cloud computing. .

Course Outcomes:

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

1. Explain the basics concepts of cloud computing like service models, deployment models and its architecture.
2. Describe and apply virtualization in cloud computing.
3. Use and Analyze different cloud computing services.
4. Understand and apply various services provided by Amazon Web Services cloud platform
5. Discuss the functionality of Openstack cloud platform & Severless computing.
6. Recognize and examine the security and privacy concerns in cloud computing.

Module	Contents	Hours	Cos
I	**Introduction to Cloud Computing** Importance of Cloud Computing, Characteristics, Pros and Cons of Cloud Computing, Migrating into the Cloud, Seven-step model of migration into a Cloud, Trends in Computing. Cloud Service Models: SaaS, PaaS, IaaS, Storage. Cloud Architecture: Cloud Computing Logical Architecture, Developing Holistic Cloud Computing Reference Model, Cloud System Architecture, Cloud Deployment Models. **Self-Learning Topics:** Application of Cloud Computing .	7	CO1
II	**Data Storage and Cloud Computing** Data Storage: Introduction to Enterprise Data Storage, Direct Attached Storage, Storage Area Network, Network Attached Storage, Data Storage Management, File System, Cloud Data Stores, Using Grids for Data Storage. Cloud Storage: Data Management, Provisioning Cloud storage, Data Intensive Technologies for Cloud Computing. Cloud Storage from LANs to WANs: Cloud Characteristics, Distributed Data Storage. **Self-Learning Topics:** Application of Datastorage	7	CO2
III	**Virtualization in Cloud Computing** Introduction: Definition of Virtualization, Adopting Virtualization, Types of Virtualizations, Virtualization Architecture and Software, Virtual Clustering, Virtualization Application, Pitfalls of Virtualization. Grid, Cloud and Virtualization: Virtualization in Grid, Virtualization in Cloud, Virtualization and Cloud Security. Virtualization and Cloud Computing: Anatomy of Cloud Infrastructure, Virtual infrastructures, CPU Virtualization, Network and Storage Virtualization. **Self-Learning Topics:** Study of VMware	9	CO3
IV	**Cloud Platform and Cloud Application** Introduction to the AWS Cloud, AWS core services by categories. Compute Service: Introduction to EC2, EC2 Instances, EC2 Amazon Machine Images, Instance Types, Instance Lifecycle. Storage Service: Introducing S3, working with Buckets, setting bucket security, S3 event and notification, bucket properties, working with Elastic Block Store Volumes, Object Storage Vs Block Storage, Archives versus backups, Introduction to Glacier. Virtual Private Cloud: Introduction, Subnet, Elastic Network Interfaces, Internet Gateways, Route	9	CO4

	Tables, Security Groups. CloudWatch:Introduction, CloudWatch Metrics, CloudWatch Alarms. Database as a Service: Introduction to Amazon Relational Database Service (RDS), Database Engines, Database Instance Classes, Backup and Recovery, Non-relational (No-SQL) Databases, Types of Non relational Databases, Introduction to DynamoDB, Features, Partition and Hash Keys. **Self-learning Topics:** Overview of OpenStack architecture		
V	**Advance Techniques in Cloud Computing** Future Tends in cloud Computing, Mobile Cloud, Automatic Cloud Computing: Distributed Cloud Computing Vs Edge Computing, Containers, Docker, and Kubernetes, **Self-Learning Topics:** Introduction to DevOps. IOT and Cloud	7	CO5
VI	**Security in Cloud** Risk Management, Enterprise-Wide Risk Management, Types of Risks in Cloud Computing. Data Security in Cloud: Security Issues, Challenges, advantages, Disadvantages, Cloud Security Services: Confidentiality, Integrity and Availability, Security Authorization Challenges in the Cloud, Secure Cloud Software Requirements **Self-Learning Topics :** Cloud Software Testing.	6	CO6
	Total	**45**	

Reference Books

1. Distributed and Cloud Computing From Parallel Processing to the Internet of Things, Kai Hwang, Geoffrey C. Fox, Jack Dongarra, Morgan Kaufmann Publication
2. Cloud Computing for Dummies, Judith Hurwitz, Wiley Publication
3. Cloud Application Architectures: Building Applications and Infrastructure in the Cloud, George Reese, O'Reilly Publication.
4. Cloud computing security: foundation and challenges, John R Vecca, CRC Press

Text Books

1. Cloud computing Bible, Barrie Sosinsky, Wiley publication.
2. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah, Dreamtech Press
3. Mastering Cloud Computing, Rajkumar Buyya, MGH publication
4. AWS certified solution Architect, Joe Baron et.al, Cybex publication
5. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, and Shahed Latif, O'Reilly Publication.

6. Cloud security: A comprehensive guide to secure cloud computing by ronold L Krutz and Russell Dean Vines, Wiley publication.

Useful Links

1. https://www.aws.amazon.com/
2. https://arpitapatel.files.wordpress.com/2014/10/cloud-computing-bible1.pdf
3. https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-291r2.pdf
4. https://studytm.files.wordpress.com/2014/03/hand-book-of-cloud-computing.pdf

Course Title: Program Elective – VIII (MOOC) Business Intelligence & Analytics

Semester: VIII			Term: EVEN				Course Code: 24CSDSPEC8021C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1. To understand the fundamentals of Business Intelligence, data warehousing, and decision support systems.
2. To apply Business Intelligence tools and data visualization techniques for effective business decision-making.
3. To provide a comprehensive understanding of business analytics, its various analytical methods, and their role in solving business problems.
4. To develop the ability to analyze business data using appropriate analytical tools, data visualization techniques, and data-driven decision-making approaches.

Course Outcomes:

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

1. To understand the concepts of Business Intelligence
2. Apply and evaluate concepts of OLTP, OLAP, Data Cubes, and Data Warehouse Design.
3. Utilize Business Intelligence tools, reporting and visualization techniques, and understand ethical aspects of Business Intelligence.
4. Explain the fundamental concepts of Business Analytics, its applications, analytical methodologies, and identify business problems using appropriate analytical approaches.
5. Analyze the concepts of Augmented Business Intelligence and Augmented Analytics by applying AI-enabled tools and techniques to support business decision-making.
6. Evaluate ethical, legal, and emerging technological aspects of Business Analytics, including data privacy, fairness, regulatory compliance, and future trends in AI-driven business intelligence.

Module	Contents	Hours	COs
I	**Introduction To Business Intelligence** Operational and Decision Support System, Data-Information-Knowledge-Decision Making-Action cycle. Basic definitions- Business Intelligence; Data warehousing, Business Intelligence architecture, Use and benefits of Business Intelligence. Knowledge Discovery in Databases: KDD process model, Data Pre-processing: Cleaning: Missing Values; Noisy Values; Inconsistent values; redundant values.Outliers, Integration, transformation, reduction, Discretization: Equal Width Binning; Equal Depth Binning, Normalization, Smoothing. **Self-Learning Topics:** Business Intelligence Applications, Modern BI Tools (Power BI, Tableau), Cloud-based Business Intelligence Platforms.	8	CO1
II	**Designing Business Data Warehouse** OLTP and OLAP systems, Designing business information warehouse: Principles of dimensional modeling, Data cubes, Data cube operations, data cube schema. **Self-Learning Topics:** Comparison of Star and Snowflake Schemas, ETL and ELT Processes .	8	CO2
III	**Business Intelligence Tools and Technologies** Ethics in Business Intelligence, BI tools overview, Reporting and visualization tools, Principles of data visualization, Dashboard design best practices. **Self-Learning Topics:** Microsoft Power BI, Tableau, Qlik Sense, Google Looker Studio, Cloud-based Business Intelligence Platforms.	8	CO3
IV	**Introduction to Business Analytics** Meaning, Definition and Importance of Business Analytics. Analytics vs Analysis. Business Analytics vs Business Intelligence and Data Mining. Applications of Analytics. Types of Analytics: Descriptive, Diagnostic, Predictive, Prescriptive and Cognitive Analytics. Types of Analytical Tools. Identifying Business Problems and Opportunities through Data Analytics. Framing Business Problems as Analytical Problems. Structured Methodologies: CRISP-DM. **Self-Learning Topics:** Applications of Business Analytics.	7	CO4
V	**Augmented Business Intelligence** Introduction to Augmented Business Intelligence. Evolution from	8	CO5

	Traditional BI and Self-Service BI to Augmented Analytics. Augmented BI Roadmap: Data Reporting, Data Augmentation. Components of Augmented BI: Infrastructure (Cloud-native Solutions and SaaS), Analytics (Machine Learning, Cognitive BI, Conversational BI, Data Relationships, Insight Generators), Share (Data Stories and Decision Support Systems). Augmented Analytics: Definition, Five I's of Augmented Analytics, Benefits, Workflows, Automation and Artificial Intelligence, AI Archetypes, Bias in Analytics, Limitations and Challenges of Augmented Analytics. **Self-Learning Topics:** AI-based Business Intelligence Tools.		
VI	**Ethical Considerations and Future Trends** Data Privacy and Security. Bias and Fairness in Analytics. Regulatory Compliance (GDPR). Challenges in Business Analytics: Data Quality, Interpretation of Automated Insights and Human-Machine Collaboration. Future Trends in Business Analytics and Business Intelligence. Role of Artificial Intelligence and Machine Learning. Emerging Technologies and Innovations in Business Intelligence. Preparing the Future Workforce. **Self-Learning Topics:** Ethical AI and Emerging Trends in Business Analytics.	6	CO6
	Total	45	

Reference Books

1. Paul C. Zikopoulos, Chris Eaton, Dirk de Roos, Thomas Deutsch, and George Lapis, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, McGraw-Hill, 2012.
2. James Manyika, Michael Chui, Brad Brown, Jacques Bughin, Richard Dobbs, Charles Roxburgh, and Angela Hung Byers, Big Data: The Next Frontier for Innovation, Competition, and Productivity, McKinsey Global Institute, 2011.
3. S. Christian Albright, Wayne L. Winston, "Business Analytics: Data Analysis and Decision Making with MindTap", 7th Edition, Cengage Learning, 2022.
4. 2. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, "Cognitive Computing and Big Data Analytics", 1st Edition, John Wiley & Sons, 2012.

Text Books

1. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
2. Michael Minelli, Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses, Wiley, 2013.
3. J. Hurwitz et al., Big Data for Dummies, Wiley, 2013.
4. Jeffrey D. Camm, James J Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, "Business Analytics with MindTap", 4th Edition, Cengage Learning, 2024.
5. James R. Evans, "Business Analytics", 3rd Edition, Pearson, 2019.

Useful Links

1. **TutorialsPoint – Business Intelligence:** https://www.tutorialspoint.com/what-is-business-intelligence
2. **GeeksforGeeks – Machine Learning Clustering:** https://www.geeksforgeeks.org/clustering-in-machine-learning/
3. **Simplilearn – Machine Learning Classification:** https://www.simplilearn.com/tutorials/machine-learning-tutorial/classification-in-machine-learning

Course Title: Program Elective – VIII (MOOC) Blockchain and its Applications

Semester: VIII			Term: EVEN				Course Code:24CSDSPEC8022C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
3	-	-	3	-	-	3	20	20	60	-	-	100

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

1.Understand blockchain platforms and its terminologies

2. Understand the use of cryptography required for blockchain.

3. Understand smart contracts, wallets, and consensus protocols.

4. Design and develop blockchain applications .

Course Outcomes:

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

1. Explain blockchain concepts

2. Apply cryptographic hash required for blockchain.

3. Apply the concepts of smart contracts for an application.

4. Design a public blockchain using Ethereum.

5. Design a private blockchain using Hyperledger.

6. Use different types of tools for blockchain applications ..

Module	Contents	Hours	COs
I	**Introduction to Blockchain** What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees Components of blockchain, Block in blockchain, Types **Self-Learning Topics:** Limitations and Challenges of blockchain, Introduction to Block-chain and Why Blockchain Is Important	6	CO1
II	**Cryptocurrency** Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security),Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem,Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proofof-Elapsed Time (PoET). **Self-Learning Topics:** Life of a miner, Mining difficulty, Mining pool and its methods.	8	CO2
III	**Programming for Blockchain** Introduction to Smart Contracts, Types of Smart Contracts, Structure of a Smart Contract, Smart Contract approach Limitations of Smart Contracts. Introduction to Programming: Solidity Programming Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struck, Mapping, Inheritance, Error handling. **Self-Learning Topics:** Smart Contracts, Basics of Solidity Programming.	9	CO3
IV	**Public Blockchain** Introduction to Public Blockchain, Ethereum and its Compo-nents, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum **Self-Learning Topics:** Ethereum, Introductions of EVM	7	CO4
V	**Private Blockchain** Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Repli-cation, Consensus Algorithms for Private Blockchain - PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT Introduction to Hyper ledger, Tools and Frameworks Hyperledger	8	CO5

	Fabric, Comparison between Hyperledger Fabric & Other Technologies **Self-Learning Topics:** Introduction of Private Blockchain and Features		
VI	**Tools and Applications of Blockchain** Corda, Ripple, Quorum and other Emerging Blockchain Plat-forms, Blockchain in Defi: Case Study on any of the Blockchain Plat-forms. Remix IDE,Ethereum **Self-Learning Topics:** Introduction to Solc, Truffle, Ganache, Metamask, Remix, Geth	7	CO6

Reference Books

1. Ramchandra Mangrulkar and Pallavi Chavan, "Blockchain Essentials: Core Concepts and Implementations", 1 st Edition, Apress Springer, 2024.
2. Josh Thompson, "Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming", 1 st Edition, Create Space Independent Publishing Platform, 2017.
3. Andreas Antonopoulos, Gavin Wood, "Mastering Ethereum: Building Smart Contracts and DApps", 1 st Edition, O'Reilly Publications, 2018.

Textbooks

1. Tiana Laurence, "Blockchain for Dummies", 2nd Edition, Wiley Publications, 2017.
2. Daniel Drescher, "Block Chain Basics", 1 st Edition, Apress, 2017.
3. Daniel Drescher, "Blockchain Basics: A Non-Technical Introduction in 25 Steps", 1st Edition, Apress publisher, 2017.
4. Roberto Infante, "Building Ethereum Dapps", 1 st Edition, Manning Publication, 2019 .

Useful Links

1. https://www.frontiersin.org/journals/blockchain
2. https://hyperledger-fabric.readthedocs.io/en/release-2.5/
3. https://www.talentica.com/blogs/llms-empowering-the-blockchain-ecosystem/

Course Title: Constitution of India												
Semester: VIII			**Term: EVEN**				**Course Code: 24CSDSEV801C**					
Teaching Scheme							**Evaluation Scheme**					
Contact Hrs.			**Credit Allotted**			**Total Credit**	**IAE 1**	**IAE 2**	**ESE**	**CA**	**OR/PR**	**Total**
Th	**Tu**	**Pr**	**Th**	**Tu**	**Pr**							
1	-	-	1	-	-	1	10	10	30	-	-	50

IAE: Internal Assessment Examination
ESE:End Semester Examination
CA: Continuous Assessment.

Course Objectives:

1. To introduce students to the fundamental principles and key elements of the Indian Constitution.
2. To familiarize students with the historical evolution of India as a Republic.
3. To develop an understanding of the structure and functioning of major political institutions in India.
4. To enable students to analyze the role of the Constitution in shaping governance and democratic.

Course Outcomes:

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

1. Explain the making and key features of the Indian Constitution.
2. Describe Fundamental Rights, Duties, and Directive Principles.
3. Explain the structure and functions of the Union Government.
4. Describe the structure and functions of the State Government.
5. Explain the composition and role of the Judiciary and judicial review.
6. Describe the electoral process and role of the Election Commission.

Module	Contents	Hours	COs
I	**Making of Indian Constitution :** Constituent Assembly-Composition, Objectives, Preamble and Salient features of the Indian Constitution.	3	CO1
II	Fundamental Rights, Fundamental Duties, Directive Principles.	3	C02
III	**Union Government:** President, Prime Minister and Council of Ministers.	3	CO3
IV	**State Government:** Governor, Chief Minister and Council of Ministers.	2	CO4
V	**Judiciary:** Supreme Court and High Court: Composition, Powers and Functions and Judicial Review.	2	CO5
VI	**Electoral Process:** Election Commission-Composition, Powers and Functions, Electoral Reforms.	2	CO6
	Total	15	

Note: The Constitution of India is designated as a self-study course. Students are expected to undertake independent learning of the prescribed syllabus and appear for the examination accordingly.

Reference Books:

1. Durga Das Basu, Introduction to the Constitution of India, Gurgaon; Lexis Nexis, (23rdedn.)
2. 2018.
3. M. V. Pylee, India"s Constitution, New Delhi; S. Chand Pub., (16thedn.) 2017.
4. J. N. Pandey, The Constitutional Law of India, Allahabad; Central Law Agency, (55thedn.) 2018.
5. K. Sharma, Introduction to the Constitution of India, Prentice Hall of India, New Delhi,2002.
6. P. M Bakshi, Constitution of India, Universal Law Publishing House, NewDelhi,1999.
7. D. C. Gupta, Indian Government and Politics, Vikas publishing House, New Delhi, 1975.
8. S. N. Jha, Indian Political System: Historical Developments, Ganga Kaveri Publishing House, Varanasi,2005.

9. Arora & Mukherji, Federalism in India, Origin and Developments, Vikas Publishing House, New Delhi,1992.

Text books:

1. Durga Das Basu, "Introduction to the Constitution on India", (Students Edition) Prentice Hall EEE, 19th / 20th Edition, 2001.
2. Charles E. Haries, Michael S. Pritchard and Michael J. Robins, "Engineering Ethics", Thompson Asia, 2003.

Useful Links

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg151
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_lw05
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_lw09

Course Title: Major Project												
Semester: VIII			Term: EVEN				Course Code: 24CSDSPRJ801C					
Teaching Scheme							Evaluation Scheme					
Contact Hrs.			Credit Allotted			Total Credit	IAE 1	IAE 2	ESE	CA	OR/PR	Total
Th	Tu	Pr	Th	Tu	Pr							
-	-	12	-	-	6	6	-	-	-	100	50	150

IAE: Internal Assessment Examination
ESE: End Semester Examination
CA: Continuous Assessment

Course Objectives:

The Project work facilitates the students to develop and prove Technical, Professional and Ethical skills and knowledge gained during graduation program by applying them from problem identification to successful completion of the project by implementing the solution.

Course Outcomes:

1. Students will be able to implement solutions for the selected problem by applying technical and professional skills.
2. Students will be able to Analyse impact of solutions in societal and environmental context for sustainable development.
3. Students will be able to collaborate best practices along with effective use of modern tools.
4. Students will be able to develop proficiency in oral and written communication with effective leadership and teamwork.
5. Students will be able to nurture professional and ethical behavior.
6. Students will be able to gain expertise that helps in building lifelong learning experience.

1. Guidelines:

Internal guide has to keep track of the progress of the project and also has to maintain attendance report. This progress report can be used for awarding term work marks.

2. Project Report Format:

At the end of semester, each group needs to prepare a project report as per the guidelines issued by the University of Mumbai. Report should be submitted in hardcopy. Also, each group should submit softcopy of the report along with project documentation, implementation code, required utilities, software and user Manuals..

A project report should preferably contain at least following details:

- ➢ Abstract
- ➢ Introduction
- ➢ Literature Survey/ Existing system
- ➢ Limitation Existing system or research gap
- ➢ Problem Statement and Objective
- ➢ Proposed System
- ➢ Analysis/Framework/ Algorithm
- ➢ Design details
- ➢ Methodology (your approach to solve the problem) Proposed System

o Experimental Set up

- ➢ Details of Database or details about input to systems or selected data
- ➢ Performance Evaluation Parameters (for Validation)
- ➢ Software and Hardware Set up

o Results and Discussion

- ➢ Conclusion and Future Work
- ➢ References
- ➢ Appendix – List of Publications or certificates
- ➢

3. Desirable

● Students should be encouraged

- ➢ To participate in various project competitions.
- ➢ To write minimum one technical paper & publish in good journal.
- ➢ To participate in national / international conference.

4. Continuous Assessment:

Distribution of marks for term work shall be done based on following:

a. Weekly Log Report

b. Completeness of the project and Project Work Contribution

c. Project Report (Black Book) (both side print)

d. Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

5. Oral & Practical:

Oral & Practical examination (Final Project Evaluation) of Major Project-II should be conducted by Internal and External examiners at the end of the semester.

6. Suggested quality evaluation parameters are as following:

1. Relevance to the specialization / industrial trends
2. Modern tools used
3. Innovation
4. Quality of work and completeness of the project
5. Validation of results
6. Impact and business value
7. Quality of written and oral presentation
8. Individual as well as team work