BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

SCHEME & SYLLABUS

III - VIII SEMESTERS

2022 Batch Onwards

INSTITUTE VISION

Promoting Prosperity of mankind by augmenting Human Resource Capital through Quality Technical Education & Training**.**

INSTITUTE MISSION

Accomplish Excellence in the field of Technical Education through Education, Research and Service needs of society.

DEPARTMENT VISION

To be recognized as Centre for Quality Education in Computer Science and Engineering with emphasis on Data Science

DEPARTMENT MISSION

- Enable quality Computer Science education through continually evolving curriculum and pedagogical techniques.
- Conduct research collaboratively with established research labs and industries contributing to the futuristic field of Data Science.
- Nurture ethical and skilled professionals by promoting multi-disciplinary thinking in solving problems of the data-driven world.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Excel in professional career as a Data Science Professional thereby contributing to the public/private sector or as an entrepreneur.

PEO2: Graduates to pursue higher education and research to upgrade themselves to serve the global market.

PEO3: Contribute to humankind by solving societal problems and exhibiting professionalism, team work & ethics.

PROGRAMME OUTCOMES (POs)

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO 1: Apply computational principles, programming skills, and engineering tools to effectively formulate and solve computing problems.

PSO 2: Design and develop data driven solutions using statistical methods and data science principles to generate meaningful insights across various domains.

PSO 3: Demonstrate expertise in teamwork, professional ethics, communication, and documentation skills in the development of software systems.

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Scheme of Instructions

Semester – III

(With effect from the Academic Year 2023-24)

Course Type	Course Code	Course Title	Credits			Total Credits	Marks		
			L	T	P		CIE	SEE	Total
BS-1	23MA3BSSDM	Statistics and Discrete Mathematics	2	1	0	3	50	50	100
ES-1	23DC3ESCOA	Computer Organization & Architecture	3	0	0	3	50	50	100
PC-1	23DC3PCDSC	Data Structures	3	0	1	4	50	50	100
PC-2	23DC3PCDBM	Database Management Systems	3	0	1	4	50	50	100
PC-3	23DS3PCOOJ	Object Oriented Programming with Java	3	0	1	4	50	50	100
PC-4	23DS3PCFDS	Foundations of Data Science	3	0	0	3	50	50	100
AE-1	23DS3AEFWD	Full Stack Web Development	0	0	1	1	50	50	100
	23DS3AEDAE	Data Analytics with Excel	0	0	1	1	50	50	100
	23DS3AEGIT	Version Controller with GIT	0	0	1	1	50	50	100
NCMC	23NCMC3NS1	NSS	Non-credit mandatory Course						
	23NCMC3PE1	Physical Education							
	23NCMC3YG1	Yoga							
	24NCMC3FA1	Fine Arts							
	24NCMC3ID1	Indian Dance							
	24NCMC3IM1	Indian Music							
	24NCMC3MM1	Multimedia							
	24NCMC3TA1	Theatre Arts							
	24NCMC3WD1	Western Dance							
	24NCMC3WM1	Western Music							
TOTAL			17	1	4	22	350	350	700

Note: BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, AE: Ability Enhancement Course, NCMC: Non-credit mandatory course

Scheme of Instructions

Semester – IV

(With effect from the Academic Year 2023-24)

Course Type	Course Code	Course Title	Credits L	Credits T	Credits P	Total Credits	Marks CIE	Marks SEE	Marks Total
BS-2	23MA4BSLAO	Linear Algebra and Optimization	2	1	0	3	50	50	100
ES-2	23DC4ESTOC	Theory of Computation	3	0	0	3	50	50	100
PC-5	23DC4PCOPS	Operating Systems	3	0	0	3	50	50	100
PC-6	23DS4PCCON	Computer Networks	3	0	0	3	50	50	100
PC-7	23DS4PCMLG	Machine Learning	3	0	1	4	50	50	100
PC-8	23DC4PCDAA	Design and Analysis of Algorithms	3	0	1	4	50	50	100
AE-2	23DS4AEDVZ	Data Visualization using Tools	0	0	1	1	50	50	100
	23DS4AECPG	Competitive Programming	0	0	1	1	50	50	100
	23DS4AELCE	LaTeX and Canva Essentials	0	0	1	1	50	50	100
UHV	23MA4AEUHV	Universal Human Values	0	1	0	1	50	50	100
NCMC	23NCMC4NS2	NSS	Non-credit mandatory Course						
	23NCMC4PE2	Physical Education							
	23NCMC4YG2	Yoga							
	24NCMC4FA2	Fine Arts							
	24NCMC4ID2	Indian Dance							
	24NCMC4IM2	Indian Music							
	24NCMC4MM2	Multimedia							
	24NCMC4TA2	Theatre Arts							
	24NCMC4WD2	Western Dance							
	24NCMC4WM2	Western Music							
TOTAL			17	2	3	22	400	400	800

Note: BS: Basic Science Course, ES: Engineering Science Course, PC: Professional Core Course, AE: Ability Enhancement Course, NCMC: Non-credit mandatory course

Scheme of Instructions

Semester – V

(With effect from the Academic Year 2024-25)

Course Type	Course Code	Course Title	Credits			Total Credits	Marks		
			L	T	P		CIE	SEE	Total
PC-9	23DS5PCTSA	Time Series Analysis	2	1	0	3	50	50	100
PC-10	23DS5PCBDA	Big Data Analytics	3	0	1	4	50	50	100
PC-11	23DS5PCDLG	Deep Learning	4	0	1	5	50	50	100
PC-12	23DS5PCPWR	Programming with R	0	0	1	1	50	50	100
AE-3	23DC5AERMI	Research Methodologies & IPR	3	0	0	3	50	50	100
PE-1	23CS5PEPSI	Product, Services and IT Service Management	3	0	0	3	50	50	100
	23DS5PEIOT	Internet of Things	3	0	0	3	50	50	100
	23DS5PECNS	Cryptography & Network Security	3	0	0	3	50	50	100
	23DS5PEREA	Responsible and Explainable AI	3	0	0	3	50	50	100
PW-1	23DS5PWMAD	Mini Project – Mobile Application Development	0	0	2	2	50	50	100
HS-1	23DC5HSEVS	Environmental Studies	1	0	0	1	50	50	100
NCMC	23NCMC5NS3	NSS	Non-credit mandatory Course						
	23NCMC5PE3	Physical Education							
	23NCMC5YG3	Yoga							
	24NCMC5FA3	Fine Arts							
	24NCMC5ID3	Indian Dance							
	24NCMC5IM3	Indian Music							
	24NCMC5MM3	Multimedia							
	24NCMC5TA3	Theatre Arts							
	24NCMC5WD3	Western Dance							
	24NCMC5WM3	Western Music							
TOTAL			16	1	5	22	400	400	800

Note: PC: Professional Core Course, AE: Ability Enhancement Course, PE: Program Elective, PW: Project Work, HS: Humanities and Social Sciences, NCMC: Non-credit mandatory course

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Scheme of Instructions

Semester – VI

(With effect from the Academic Year 2024-25)

Course Type	Course Code	Course Title	Credits			Total Credits	Marks		
			L	T	P		CIE	SEE	Total
PC-13	23DS6PCCCT	Cloud Computing	2	1	0	3	50	50	100
PC-14	23DS6PCNGD	Next Gen Databases	3	0	1	4	50	50	100
PC-15	23DS6PCNLP	Natural Language Processing & Generative AI	3	0	1	4	50	50	100
PC-16	23DC6PCSEA	Software Engineering & Agile Methodologies	2	0	0	2	50	50	100
PE-2	23DS6PEOTD	Optimization Techniques for Data Science	3	0	0	3	50	50	100
	23DS6PECPV	Computer Vision	3	0	0	3	50	50	100
	23DS6PEDPT	Design Patterns	3	0	0	3	50	50	100
	23DS6PEADA	Advanced Data Structures & Algorithms	3	0	0	3	50	50	100
OE-1	23DS6OEDBM	Database Management Systems	3	0	0	3	50	50	100
PW-2	23DS6PWPP1	Project work – Phase I	0	0	2	2	50	50	100
AE-4	23DS6AESAI	Sustainable and Low-Resource AI	0	0	1	1	50	50	100
	23DS6AESWT	Software Testing	0	0	1	1	50	50	100
	23DS6AEDOP	DevOps	0	0	1	1	50	50	100
NCMC	23NCMC6NS4	NSS	Non-credit mandatory Course						
	23NCMC6PE4	Physical Education							
	23NCMC6YG4	Yoga							
	24NCMC6FA4	Fine Arts							
	24NCMC6ID4	Indian Dance							
	24NCMC6IM4	Indian Music							
	24NCMC6MM4	Multimedia							
	24NCMC6TA4	Theatre Arts							
	24NCMC6WD4	Western Dance							
	24NCMC6WM4	Western Music							
TOTAL			16	1	5	22	400	400	800

Note: PC: Professional Core Course, AE: Ability Enhancement Course, PE: Program Elective, PW: Project Work, OE: Open Elective, NCMC: Non-credit mandatory course

Scheme of Instructions

Semester – VII/VIII

(With effect from the Academic Year 2025-26)

Course Type	Course Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PC-17	23DC7PCEPM	Entrepreneurship & Project Management	2	0	0	2	2
PC-18	23DC7PCCYS	Cyber Security	3	0	0	2	3
BS-3	23DS7BSBIO	Bio-inspired Algorithms	0	0	1	1	2
PE-3	23DC7PENP1 /23DC8PENP1	Applied Accelerated Artificial Intelligence	3	0	0	3	0
	23DC7PENP2 /23DC8PENP2	Design & Implementation of HCI					
	23DC7PENP3 /23DC8PENP3	Ethical Hacking					
	23DC7PENP4 /23DC8PENP4	Introduction to Industry 4.0 and IoT					
	23DC7PENP5 /23DC8PENP5	Introduction to Large Language Models					
	23DC7PENP6 /23DC8PENP6	Reinforcement Learning					
	23DS7PENP7 /23DS8PENP7	Social Networks					
OE-2	23DS7OEDAV /23DS8OEDAV	Practical Data Analysis and Visualization	3	0	0	3	3
PW-3	23DS7PWPP2	Project work – Phase II	0	0	7	7	14
HS-2	25MA7HSIKL	Indian Knowledge Systems	1	0	0	1	1
		Details of 80 AICTE Activity Points Earned					
TOTAL						20	25

Note: PC: Professional Core Course, AE: Ability Enhancement Course, PE: Program Elective, PW: Project Work, OE: Open Elective, NCMC: Non-credit mandatory course

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Scheme of Instructions

Semester – VII/VIII

(With effect from the Academic Year 2025-26)

Course Type	Course Code	Course Title	Credits			Total Credits	Total Hours
			L	T	P		
PE-4	23DS8PEBCT /23DS7PEBCT	Blockchain Technology	3	0	0	3	3
	23DS8PEQML /23DS7PEQML	Quantum Machine Learning					
	23DS8PEMLO /23DS7PEMLO	Machine Learning Operations (MLOps)					
	23DS8PERPA /23DS7PERPA	Robotic Process Automation					
OE-3	23DS8OEDBI /23DS7OEDBI	Data-Driven Decision Making and Business Intelligence	3	0	0	3	3
INT-1	23DS8SRINT /23DS7SRINT	Internship *(16-20 weeks)*	0	0	6	6	12
		Details of 80 AICTE Activity Points Earned					
TOTAL						12	18

Note: PE-3, OE-3, INT-6

Internship shall be carried out at an Industry, NGO, MSME, Innovation center, Incubation center, Start-up, Centre of Excellence (COE) established in the institute and /or at reputed research organizations/institutes.

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III SEMESTER

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Computer Organization and Architecture

Semester	**III**		
Course Code	**23DC3ESCOA**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	Basic Structure of Computers and Instruction Set Architecture: Functional Units, Basic Operational Concepts, Number Representation and Arithmetic Operations, Memory Locations and Addresses, Memory Operations, Instructions, and Instruction Sequencing, Addressing Modes, Stored program concept.	8
2	Introduction to Assembly Language Concepts, Stacks, Subroutines, Additional Instructions, Basic Input/Output: Accessing I/O Devices, Interrupts, Bus Structure, Bus Operation, Arbitration	8
3	Memory System: Basic Concepts, Semiconductor RAM Memories, Read-only Memories, Direct Memory Access, Memory Hierarchy, Cache Memories: Mapping Functions, Virtual Memory	8
4	Arithmetic: Addition and Subtraction of Signed Numbers, Design of Fast Adders, Multiplication of Unsigned Numbers, Multiplication of Signed Numbers Fast Multiplication: Bit-Pair Recoding of Multipliers, Carry-Save Addition of Summands, Summand Addition Tree using 3-2 Reducers, Integer Division, Floating- Point Numbers and Operations: Arithmetic Operations on Floating-Point Numbers, Guard Bits and Truncation, Implementing Floating-Point Operations	8
5	Basic Processing Unit: Some Fundamental Concepts, Instruction Execution, Hardware Components, Instruction Fetch and Execution Steps, Hardwired Control Parallel Computer Architecture: Processor Architecture and Technology Trends, Flynn's Taxonomy of Parallel Architectures, Memory Organization of Parallel Computers: Computers with Distributed Memory Organization, Computers with Shared Memory Organization, Thread-Level Parallelism: Simultaneous Multithreading, Multicore Processors	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Computer Organization and Embedded Systems	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian	6th Edition	McGraw-Hill	2012
2.	Parallel Programming for Multicore and Cluster Systems	Thomas Rauber, Gudula Runger	2nd Edition	Springer	2013
Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Computer Organization and Design - The Hardware /Software Interface	David A. Patterson, John L. Hennessy	5th Edition	Elsevier	2014
2.	Computer Organization & Architecture	William Stallings	11th Edition	Pearson	2018

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Computer Architecture and Organization	NPTEL	2022	https://onlinecourses.nptel.ac.in/noc22_cs88/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Data Structures

Semester	**III**		
Course Code	**23DC3PCDSC**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	Introduction To Data Structure: Data Management concepts, Data types – primitive and non-primitive, Types of Data Structures- Linear & Non-Linear Data Structures. Structures and pointers Dynamic memory allocation: allocating a block of memory: Malloc, allocating multiple blocks of memory: Calloc, Releasing the used space: Free Altering the size of memory: Realloc.	8
2	Linear list: Singly linked list implementation, insertion, deletion and searching operations on linear list, circularly linked lists- insertion, deletion and searching operations for circularly linked lists, doubly linked list implementation, insertion, deletion and searching operations, maintaining directory of names, Manipulation of polynomials (addition), representing sparse matrices.	8
3	Stacks: Operations, array representations of stacks, stack applications - infix to postfix conversion, postfix expression evaluation, and function call tracing, recursion. Queues: Introduction, Basic concept, linear queue operations, circular queue, priority queues, double ended queues. Applications of Queues. Stack and queue implementation using linked lists	8
4	Trees: Definitions, tree representation, properties of trees, Binary tree, Binary tree representation, binary tree properties, binary tree traversals, binary tree implementation, Binary Search Tree operations and its implementation, applications of trees.	8
5	Balanced Trees: AVL Trees, Splay trees, Red- Black Trees – Definitions, Rotation and other basic operations.	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Data Structures in C	Horowitz, Sahni, Anderson Freed	Second	Universities Press	2008
2.	Data Structures using C	Reema Thareja	Second	Oxford University press	2014

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Structures using C	Aaron M. Tenenbaum, Yedidyah Langsam, Moshe J. Augenstein	Fifth	Pearson Education	2007
2	Data Structures - A Pseudocode Approach with C	Richard F. Gilberg Behrouz A. Forouzan	First	Cengage Learning	2005

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Structures using C	E. Bala guruswamy		McGraw Hill	2013	https://dokumen.pub/data-structures-using-c-9781259029547-1259029549.html
2.	Data structures and program design in C	Robert L. Kruse, Clovis L. Tondo, Bruce P. Leung	Second	Prentice Hal	1997	https://cdn.preterhuman.net/texts/math/Data_Structure_And_Algorithms/Data%20Structures%20and%20Program%20Design%20in%20C++%20-%20Robert%20L.%20Kruse.pdf

MOOC Courses

Sl. No.	Course name	Course Offered By	Year	URL
1	Data Structures	Coursera	2023	https://www.coursera.org /learn/data-structures
2	Data Structures and Algorithms	NPTEL	2023	https://nptel.ac.in/ courses/106102064/

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Database Management Systems

Semester	**III**		
Course Code	**23DC3PCDBM**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	Introduction to Database Systems: Introduction, An Example, Characteristics of Database approach, Advantages of using DBMS approach, when not to use a DBMS. Database System Concepts and Architecture: Data models, Schemas and instances, Three schema architecture. SQL: SQL Data Definition and Data Types specifying basic constraints in SQL, Basic retrieval queries in SQL, Insert, Delete and Update statements in SQL, Additional features of SQL, more complex SQL Queries, Specifying Constraints as Assertions and Triggers, Views (Virtual Tables) in SQL, Schema Change Statement in SQL.	8
2	Entity Relation Model: Using High-Level Conceptual Data Models for Database Design, a sample Database Application, Entity types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity types, Refining the ER Design, ER Diagrams, Relationship Types of Degree Higher than two, Relational Database Design using ER to Relational Mapping. Relational Databases: Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint Violations, Functional Dependencies	8
3	Relation Algebra: Unary Relational Operations: SELECT and PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations: JOIN and DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra. Normalization: Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form, Multi-valued Dependencies and a Fourth Normal Form, Join Dependencies, Fifth Normal Form.	8
4	Transaction Processing Concepts: Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Transaction Support in SQL, Two-Phase Locking Techniques for Concurrency Control.	8

5	Storage Systems: Overview of Physical Storage Media, Storage Interfaces, Magnetic Disks, Flash Memory, RAID, Disk-Block Access, Database Backup and Recovery from Catastrophic Failures Indexing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B+-Tree Extensions, Hash Indices, Multiple-Key Access, Creation of Indices, Write-Optimized Index Structures, Bitmap Indices, Indexing of Spatial and Temporal Data Query processing & operation	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Database Systems	Elmasri and Navathe	7th Edition	Pearson	2016
2.	Database System Concepts	Silberschatz, H Korth and S Sudarshan	7th Edition	McGrawHill	2019

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Database Management Systems	Ramakrishnan and Gehrke	3rd Edition	McGrawHill	2014
2.	Database Systems: Design, Implementation, and Management	Peter Rob and Carlos Coronel	8th Edition	CENGAGE Learning	2009

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	An Introduction to Relational Database Theory	Hugh Darwen	Third Edition	Ventus Publishing ApS	2012	https://www.e-booksdirectory.com/details.php?ebook=3093
2.	Database System the Complete Book	Hector GarciaMolina,JeffreyD. Ullman, Jennifer Widom	Second Edition	Pearson Education	2009	https://people.inf.elte.hu/miiqaai/elektroModulatorDva.pdf

MOOC Course				
Sl. No.	**Course name**	**Course offered by**	**Year**	**URL**
1.	Database Management Systems	SWAYAM	2023	https://onlinecourses.swayam2.ac.in/cec23_cs10/preview
2.	Database Management Essentials	Coursera	2023	https://www.coursera.org/learn/database-management

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Object Oriented Programming with Java

Semester	**III**		
Course Code	**23DS3PCOOJ**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	Introduction to Java: Java's Lineage, The Bytecode, The Java Buzzwords. An overview of Java: Object oriented programming, Structure of a Java Program, Datatypes and Arrays. Introducing classes: Class fundamentals, declaring objects, Assigning object reference variables, Introducing methods, Constructors, this keyword, Garbage Collection, A Stack class. Methods and classes: Overloading methods, Objects as parameters, argument passing, Returning objects.	8
2	Inheritance: Basics, using super, Multilevel hierarchy, when constructors are executed, Method overriding, Dynamic method dispatch, Abstract classes, Using final with inheritance. Packages and Interfaces: Packages, Access Protection, Importing packages, Interfaces, Default interface methods.	8
3	Exception Handling: Fundamentals, types, Uncaught exceptions, Try and catch blocks, multiple catch, nested try, throw, throws, finally, Creating own exceptions. Multithreaded programming: Java thread model, The main thread, Creating a thread and multiple threads, Using isAlive() and join(), Thread Priorities, Synchronization.	8
4	File I/O Basics, Reading console input, Writing console output, Print writer class, Reading and writing files, Closing a file. String Handling: The String Constructors, String Length, Special String Operations, Character Extraction, String Comparison, Searching Strings, modifying a String, Changing the Case of Characters Within a String, Joining Strings, StringBuffer.	8
5	Generics: Type Wrappers, Auto boxing, A simple generic example, Generic Class with two type parameters, The General Form of a Generic Class. Collections Framework: Overview, Collection classes - ArrayList Class, LinkedList Class, HashSet Class, TreeSet Class, ArrayDeque Class.	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Java: The Complete Reference	Herbert Schildt	11th Edition	McGraw-Hill Education	2018
2.	Programming with Java A Primer	E.BalaGuru Swamy	6th Edition	McGraw-Hill Education	2014

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Java Programming	Y. Daniel Liang	11th Edition	Pearson	2017
2.	Object Oriented Programming with Java: Essentials and Applications	Rajkumar Buyya, Thamarai Selvi, Xing	1st Edition	Tata McGraw Hill Education	2009

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	The Art and science of Java	Eric S. Roberts	-	Greg Tobin	2007	http://people.reed.edu/ ~jerry/121/materials/ artsciencejava.pdf
2.	Java Programming	Wikibooks Contributors	7th Edition	wikibooks .org	2016	https://upload.wikimedia.org/wikipedia/commons/e/e7/Java_Programming.pdf

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Object Oriented Programming in Java	Udacity	2022	https://www.udacity.com/course/java-programming-basics--ud282
2.	Java	Swayam NPTEL	2023	https://onlinecourses.swayam2.ac.in/aic20_sp13/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Foundations of Data Science

Semester	**III**		
Course Code	**23DS3PCFDS**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	Introduction to Data Science: Describing Data science, The data science Venn diagram, Python for Data Science, Data science case studies Types of Data: structured versus unstructured data, quantitative versus qualitative data, the four levels of data: nominal, ordinal, interval and ratio Total information awareness, Bonferroni's Principle, Rhine's paradox. The Data Science Process: Overview, defining research goals, retrieving data, Cleansing, integrating and transforming data, exploratory data analysis, Build the models, Presenting findings. Data Analytics Lifecycle.	8
2	Statistics & Probability: Statistics, Obtaining data, Sampling Data, Statistical measures, empirical rule. Points estimates, Sampling distributions, Confidence intervals, Hypothesis Tests: Conducting a hypothesis test, one sample t-tests, Type I and type II errors, Hypothesis testing for categorical variables,Information Gain & Entropy, Probability Theory, Probability Types, Probability Distribution Functions, Bayes' Theorem, Inferential Statistics	8
3	Correlation Analysis: Types of correlation, correlation coefficient. Regression Analysis: Linear Regression: Simple Linear Regression, Multilinear Regression, p-values, Logistic Regression, Multinomial logistic regression, Time-Series Model, Receiver Operating Characteristic	8
4	Dealing with missing data: single and multiple data imputation, Entropy based techniques, Monte Carlo and MCMC simulations; Correcting inconsistent data: Deduplication, Entity resolution, Pairwise Matching; Fellegi-Sunter Model Dimensionality Reduction: Eigenvalues and Eigenvectors of Symmetric Matrices: Definitions, Computing Eigenvalues and Eigenvectors, Finding Eigenpairs by Power Iteration, Eigenvector matrix Principal-Component Analysis: Example, Using Eigenvectors for Dimensionality Reduction, The matrix of distances Singular-Value Decomposition: Definition, interpretation, Dimensionality Reduction Using SVD, Why Zeroing Low Singular Values Works, Querying Using Concepts, Computing the SVD of a Matrix	8

5	Data Analytics on Text: Major Text Mining Areas – Information Retrieval – Data Mining – Natural Language Processing NLP) – Text analytics tasks: Cleaning and Parsing, Searching, Retrieval, Text Mining, Part-of-Speech Tagging, Stemming, Text Analytics Pipeline. NLP: Major components of NLP, stages of NLP, and NLP applications.	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Principles of Data Science	Sinan Qzdemir, Sunil Kakade & Macro Tibaldeschi	Second Edition	Packt	2018
2.	Fundamentals of Data Science	Sanjeev Wagh, Manisha Bhende, Anuradha Thakare,	First Edition	CRC Press	2022
3.	Introducing Data Science: Big Data, Machine Learning, and More	Davy Cielen, Arno D.B. Meysman, Mohamed Ali	-	Manning	2016

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Doing Data Science	Rachel Schutt, Cathy O'Neil	-	O'Reilly	2014
2.	Mining Massive Datasets	Jure Leskovec, Anand Rajaraman, Jeffrey D Ullman	2nd	Dreamtech Press	2016

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Science & Machine Learning	DirkP.Kroese, ZdravkoI Botev, ThomasTaimre, RadislavVaisman	-	University of Queensland	2023	https://people.smp.uq.edu.au/DirkKroese/DSML/DSML.pdf
2.	Becoming a Data Head	Alex J. Gutman Jordan Goldmeier	-	Wiley	2021	https://32net.id/bukaheula/share/QP2cf2JLdeOPn00y3Nyu8aXHp1Slq1bc6P4YcuI4.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	M Data Science	Coursera	2023	https://www.coursera.org/professional-certificates/ibm-data-science
2.	Foundations of Data Science	SWAYAM	2023	https://onlinecourses.swayam2.ac.in/imb23_mg64/preview

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Full Stack Web Development

Semester	**III**		
Course Code	**23DS3AEFWD**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Introduction:

1. This course focuses on developing comprehensive skills in Full Stack Web Application Development. Students will learn to develop both front-end and back-end components of web applications, integrate with databases and external services, and apply best practices in web development.
2. Under this project work, student should develop Advanced Web based Application using technologies such as PHP, Python, Node JS, React, Angular.
3. Students can form a group with minimum of two and maximum of four.
4. Teacher allotted for project work to students should teach full stack technologies like Node JS, React,
   etc., during Class/Lab hours as per the allotment. Teacher allotted for project work should guide the students in choosing the topic and towards carrying out project work and complete the evaluation of assigned students.

Rubrics for Project Evaluation:

Criteria	**Excellent**	**Good (3 Marks)**	**Satisfactory (2 Marks)**	**Needs Improvement (0-1 Marks)**
Problem Identification & Relevance (10)	(10 Marks) Clearly articulates a significant social/environmental issue with insightful, innovative solutions.	(7 Marks) Recognizes a pertinent issue and offers practical solutions.	(5 Marks) Identifies a basic issue with standard solutions.	(0-2 Marks) Fails to identify a relevant issue or solution.
Technical Implementation (10)	(10 Marks) Exemplary implementation of full-stack technologies, showcasing efficiency, scalability, and technical excellence.	(7 Marks) Reliable and proficient technical performance, meeting key objectives.	(5 Marks) Basic implementation incorporating essential features and functionalities.	(0-4 Marks) Inadequate or incomplete technical implementation.
User Experience & Interface (10)	(10 Marks) Exceptional UI/UX design, prioritizing intuitiveness and user-	(7 Marks) Competent UI design focused	(5 Marks) Basic UI design encompassing essential	(0-4 Marks) Poor or non-functional user

	friendliness, with a professional standard of execution.	on usability and functionality.	functions and user needs.	interface, lacking in user-centricity.
Group Participation (5)	(5 marks) Exhibits active engagement, exceptional collaboration, and effective teamwork throughout the project lifecycle.	(4 marks) Consistent participation and constructive collaboration within the group.	(2 marks) Minimal but noticeable participation and occasional contributions.	(0 marks) Lack of active participation and collaboration in the group.
Presentation (5)	(5 marks) Professional, engaging presentation with outstanding visuals and comprehensive content, demonstrating exceptional delivery skills.	(4 marks) Well-structured presentation with clear content and effective delivery.	(2 marks) Basic presentation with some structure and varying delivery quality.	(1 marks) Disorganized presentation lacking in coherence and adequate content.
Report & Documentation (10)	(10 marks) Comprehensive report covering all project aspects with meticulous documentation, including methodology, design, and future scope.	(7 marks) Well-structured report with detailed coverage of project implementation.	(5 marks) Basic report with limited content, covering essential project details.	(2-4 marks) Poorly structured and incomplete report, lacking essential details.

Laboratory Plan (if applicable)

Sl. No	Week	Activity	Content deliverables by the assigned teacher	Technologies/Skills to be Covered
1	1st	Formation of groups. Note: Student groups of size 2 or 3 or 4	Introduction to Full Stack Technologies & Issue Identification	• Overview of full stack development tools and frameworks. • Overview of web development (HTML, CSS, JavaScript), • Introduction to full stack frameworks (MEAN, MERN), Identifying social/environmental issues for web solutions.

2	2nd	Project topic selection by each Group. Presentation: Student and Project topic introduction by each group	Conceptualizing a Web Application	• Identifying problem and understanding social and environmental issues. • Brainstorming and planning a web application focused on a chosen social/environmental issue. • Tools for wireframing and prototyping (Figma, Sketch),
3	3rd	Design Layout of the Web Pages	Basic Front-end and Back-end Development	• Define layouts based on project scope and objectives. • Learning the basics of front-end (HTML, CSS, JavaScript) and back-end (Node.js, Python) development. • Front-end: HTML5, CSS3, JavaScript basics. • Back-end: Introduction to Node.js, Express.js, RESTful API development
4	4th ,5th , and 6th	Front end and back-end implementation	Data Management and Integration	• Techniques for managing and integrating data in web applications. • Database technologies (MongoDB, SQL), Integrating databases with back-end (Mongoose for MongoDB), Basic CRUD operations.
5	7th 8th and 9th	Design and Development of connecting among different web pages	Advanced Front-end & Back-end Technologies Project Development and Mid-term Review	• Delving into advanced front-end technologies (React, Angular) and back-end technologies (databases, server management). • Front-end: React.js/Angular for dynamic UI development. • Back-end: Advanced Node.js, Authentication (JWT, OAuth), Server-side rendering.
6	10th	Presentation by each group	Integrating Feedback & Refining Applications	Development of the project with guidance and a mid-term review to assess progress. • Applying feedback from the mid-term review and refining the application for better performance and impact. • Implementing feedback, Optimization for performance, Security best practices (HTTPS, data validation), User testing and UX improvements.

7	11th	Complete Project Work Demonstration by each group	Final Project Presentations and Submissions	Students present their completed projects and submit their final work for assessment.
8	12th	Project Report Preparation		

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Modern Full-Stack Development: Using Type Script, React, Node.js	Frank Zammetti	1st Edition	Apress	2020
2.	Beginning MERN Stack, Build and Deploy a Full Stack MongoDB, Express, React, Node.js App	Greg Lim			2021

Tutorial Link:

Sl. No.	Links
1	https://www.springboard.com/resources/learning-paths/web-development-python-django/
2	https://www.coursera.org/learn/introduction-to-web-development-with-html-css-javacript
3	https://www.boardinfinity.com/micro-learning/full-stack-development-course-with-certification
4	https://www.udemy.com/course/next-js-the-complete-developers-guide/
5	https://www.udemy.com/course/nextjs-build-full-stack-apps-with-nextjs-using-redux/
6	https://www.udemy.com/course/beginning-javascript/

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Data Analytics with Excel

Semester	**III**		
Course Code	**23DS3AEDAE**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Sl.No	Lab Programs
1	To create an excel worksheet for student result analysis – Perform the following operations i. Handle blank rows and duplicates. ii. text manipulation for cleaning data - TRIM () iii. UPPER () iv. LEFT (), RIGHT () v. FIND (), SUBSTITUTE (), vi. Clean a list of messy names (e.g., "JOhN SMITH" → "JOHN SMITH") vii. 'if', 'nested if', 'and' and 'or'.
2	Create worksheet on Inventory Management: Sheet should contain Product code, Product name, Product type, MRP, Cost after % of discount, Date of purchase. Use appropriate formulas to calculate the above scenario. Analyse the data using appropriate charts and report the data.
3	Create worksheet with following fields: Empno, Ename, Basic Pay (BP), Travelling Allowance (TA), Dearness Allowance (DA), House Rent Allowance (HRA), Income Tax (IT), Provident Fund (PF), Net Pay (NP). Use appropriate formulas to calculate the above scenario. Analyse the data using appropriate charts and report the data.
4	Create worksheet on Sales analysis of Merchandise Store: data consisting of Order ID, Customer ID, Gender, age, date of order, month, online platform, Category of product, size, quantity, amount, shipping city and other details. Use of formula to segregate different categories and perform a comparative study using pivot tables and different sort of charts.
5	A spreadsheet contains – Name, Joining Date, Department, Salary, Orders, Sales. i. Use Vlook to find the orders of a specific employee based on their name. ii. Use Xlookup to find the ORDER ID of a particular product based on their product name for vertical table iii. Use Xlookup to find the Unit Price of a product based on their order id in Horizontal Table. iv. Use Hlook to find out the Department of a Specific Employee based on their name.

6	Consider the Sales analysis of Merchandise Store worksheet and perform the following operations: i. Tabulation – Amount and category of the product ii. Bar diagram iii. Multiple Bar diagram iv. Pie diagram
STATISTICAL METHODS FOR EXECUTION USING EXCEL	
7	Measure of central tendency: Mean, median, mode, Measure of dispersion: variance, standard deviation, Coefficient of variation. Correlation, regression lines.
8	Demonstrate the statistical tests such as t-test, F-test, ANOVA one way classification, chi square test, independence of attributes.
9	A spread sheet contains the retail estate data with cost per square meter and the year. Perform linear regression using Data Analysis Toolpak. Interpret slope and intercept along with the visualization.
10	Demonstrate the goal seek and scenario manager for the given problem statement. A Company sells a product for $50 per unit. The fixed costs are $5,000. The variable cost per unit is $30. Using Goal Seek analysis: Company needs to sell 750 units for $10,000 profit. Scenario Manager: Profit ranges from $7,000 to $19,000 depending on selling price.

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Analysis Using Microsoft Excel	Michael R. Middleton	3	Cengage	2003
2.	Excel Data Analysis: Your visual blueprint for analyzing data, charts and PivotTables	Jinjer Simon	4	Wiley	2013

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Business Analytics: Data Analysis & Decision Making	S. Christian Albright, Wayne L. Winston	7th	Cengage Learning	2017

E-Book					
Sl. No.	**Book Title**	**Authors**	**Publisher**	**Year**	**URL**
1	Analyzing Data with Power BI and Power Pivot for Excel	Alberto Ferrari and Marco Russo	Microsoft Press	2017	https://download.microsoft.com/download/0/8/1/0816F8D1-D1A5-4F60-9AF5-BC91E18D6D64/Microsoft_Press_ebook_Introducing_Power_BI_PDF.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Data Analysis with Spreadsheet	IIT Bombay	2021	https://onlinecourses.nptel.ac.in/noc21_ge21/preview
2.	Microsoft Excel Data Analysis and Dashboard Reporting	Udemy	2021	https://www.udemy.com/course/microsoft-excel-data-analysis-and-dashboard- reporting/

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Version Control using Git

Semester	**III**		
Course Code:	**23DS3AEGIT**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Introduction:

1. This course introduces students to essential concepts of project management using Git for version control. Students will learn effective collaboration, version control best practices, project lifecycle management, and integration with modern development workflows.
2. Students will form groups of 2 to 4 members to carry out a small collaborative project utilizing Git.
3. Faculty will instruct students on Git concepts during lab sessions, guiding project selection, execution, and evaluation.

Laboratory Plan

Week	Activity	Detailed Content Deliverables	Technologies & Skills Covered	Expected Outcome
1	Introduction to Git & Group Formation	- Overview of version control systems (VCS) - Introduction to Git - Git installation & setup (CLI, GUI) - Creating GitHub/GitLab/Bitbucket accounts - Group formation (2-4 students per group)	- Git basics - Git installation & configuration - Repository setup (remote/local) - GitHub/GitLab account creation	- Groups formed - Git installed - Remote repositories created
2 & 3	Project Identification & Repository Initialization	- Selecting a suitable software project/topic for version control usage - Creating & cloning a repository - Writing and committing a clear project description (README.md)	- Repository initialization (git init) - Cloning (git clone) - Basic Git commands (add, commit, push, pull)	- Repository initialized & README.md created and committed
4	Branching & Commit Management	- Branch creation and management (feature/bug-fix branches) - Switching between branches - Commit best practices (atomic commits, commit messages)	- Git branches (branch, checkout) - Commit handling (git commit, git status, .gitignore)	- Multiple branches created - Commits made clearly with messages

5 & 6	Merging Branches & Resolving Conflicts	- Branch merging strategies - Simulating merge conflicts - Resolving merge conflicts clearly and correctly	- Merge and conflict resolution (git merge, resolving conflict markers) - Branch management techniques	- Successful branch merges - Conflicts resolved effectively
7	Collaborative Workflow & Pull Requests	- Collaborative workflow setup (fork, clone, push, pull) - Creating, managing, reviewing, and merging Pull Requests (PRs) - Conducting code reviews - Using GitHub/GitLab issues for communication	- Pull Requests management - Code reviews - Issues & collaboration tools on GitHub/GitLab	- Collaborative workflow in place - PRs reviewed and merged
8 & 9	Advanced Git Features & Mid-term Review	- Advanced Git commands and techniques (stash, revert, reset, tagging) - Mid-term project review (repository structure, branch management, commit quality) - Peer feedback sessions	- Git stash, revert, reset - Tagging versions (git tag)	- Mid-term evaluation completed - Advanced Git features demonstrated
10	Project Refinement & Repository Optimization	- Incorporate mid-term feedback - Clean repository structure (remove unnecessary files, organize branches) - Implement Git best practices (clean commit history, proper branching strategy)	- Repository cleanup - Commit history optimization - Advanced branching strategies	- Optimized, clean repository structure ready for final presentation
11 & 12	Project Presentation, Demonstration & Submission	- Final project demonstration showcasing effective use of Git - Submission of complete Git repository (remote link) - Submission of documentation/report clearly detailing Git workflow and repository management	- Final presentation - Project demonstration - Comprehensive project documentation	- Final presentations delivered - Projects and documentation submitted

Rubrics for Project Evaluation:

Criteria	**Excellent**	**Good**	**Satisfactory**	**Needs Improvement**
Problem Identification & Relevance (5)	Clearly identifies a suitable software project, fully relevant for version control application. (5 Marks)	Identifies a suitable project but with minor relevance issues. (4 Marks)	Basic project identified, minimal relevance. (2 Marks)	Poor or irrelevant selection. (0-1 Marks)
Technical Implementation with Git (15)	Exemplary usage of branching, merging, resolving conflicts, and commits clearly demonstrating version control best practices. (15 Marks)	Good demonstration of Git fundamentals, minor improvement possible. (10 Marks)	Basic Git usage with functional but suboptimal repository management. (6 Marks)	Poor or incorrect usage of Git tools. (0-5 Marks)
Collaborative Workflow & Communication (10)	Exemplary implementation of collaboration strategies; continuous integration and clear communication through commit messages/issues/PRs. (10 Marks)	Reliable collaboration with minor communication gaps. (7 Marks)	Basic collaboration, minimal communication and integration. (5 Marks)	Poor teamwork, limited collaboration, unclear communication . (0-4 Marks)
Group Participation (5)	Active, consistent contributions from all members, strong teamwork. (5 Marks)	Consistent contributions, occasional uneven participation. (4 Marks)	Basic contributions from some members. (2 Marks)	Limited or no contributions, poor teamwork. (0-1 Marks)
Presentation (5)	Professional, detailed demonstration of Git usage, excellent clarity. (5 Marks)	Structured presentation with clear but less detailed demonstration. (4 Marks)	Basic demonstration with limited clarity. (2 Marks)	Poor presentation, unclear Git demonstration. (0-1 Marks)
Report & Documentation (10)	Comprehensive, clear documentation covering Git repository structure, branching strategies, commits, and collaboration clearly. (10 Marks)	Good documentation covering most Git practices, minor details missing. (7 Marks)	Basic documentation with essential details. (5 Marks)	Poor or incomplete documentation. (0-4 Marks)

Prescribed Textbooks					
SI No	**Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Pro Git (2nd Edition)	Scott Chacon, Ben Straub	2nd	Apress	2014
2	Version Control with Git	Jon Loeliger, Matthew McCullough	2nd	O'Reilly	2012

Reference Books					
SI No	**Title**	**Authors**	**Edition**	**Publisher / Source**	**Year**
1	Git Pocket Guide: A Working Introduction	Richard E. Silverman	1st	O'Reilly Media	2013
2	Git for Teams: A User-Centered Approach to Creating Efficient Workflows in Git	Emma Jane Hogbin Westby	1st	O'Reilly Media	2015
3	Mastering Git: Attain Expert-level proficiency with Git	Jakub Narębski	1st	Packt	2016

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

IV SEMESTER

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Theory of Computation

Semester	**IV**		
Course Code	**23DC4ESTOC**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	Introduction to Finite Automata: Central Concepts of Automata Theory, Deterministic Finite Automata (DFA), Nondeterministic Finite Automata (NFA), Finite Automata with Epsilon Transition, An Application Text Search. NP Problems solvable in Polynomial Time, Satisfiability Problem	8
2	Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Proving Languages Not to Be Regular, Closure Properties of Regular Languages, Equivalence and Minimization of Automata	8
3	Context Free Grammars and Languages Parse Trees: Context Free Grammars, Parse trees, Applications of Context Free Grammars, Ambiguity in Grammars and Languages, Eliminating Useless Symbols, Computing the Generating and Reachable Symbols, Eliminating Epsilon Productions, Eliminating Unit Productions, Chomsky Normal Form, Greibach Normal form	8
4	Pushdown Automata: Definition of the Pushdown Automaton, The Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata, The Pumping Lemma for Context Free Languages, Closure Properties of Context Free Languages	8
5	Introduction to Turing Machine: Problems That Computers Cannot Solve, The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers, Definition of Post Correspondence Problem, A Language That Is Not Recursively Enumerable, An Undecidable Problem That is RE, Other Undecidable Problems	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Introduction to Automata Theory, Languages and Computation	John E. Hop croft, Rajeev Motwani, Jeffrey D. Ullman: education	3rd Edition	Pearson	2007

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Introduction to Languages and Automata Theory	John C Martin	3rd Edition	Tata McGraw- Hill	2007
2.	An Introduction to formal Languages and Automata	Peter Linz	5th Edition	Narosa Publishing House	2012

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Introduction to Theory of Computation	Anil Maheshwari, Michiel Smid	-	Carleton University	2019	https://cglab.ca/~michiel/TheoryOfComputation/TheoryOfComputation.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Automata Theory	edX	2022	https://www.edx.org/course/automata-theory
2.	Introduction to Automata, Languages and Computation	IITB	2022	https://onlinecourses.nptel.ac.in/noc21_cs19/preview
3.	Automata Theory	Stanford University	2022	https://online.stanford.edu/courses/soe-ycsautomata-automata-theory

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Operating Systems

Semester	**IV**		
Course Code	**23DC4PCOPS**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	Introduction to Operating Systems: What operating systems do, Operating System operations, Process management, Memory management, Storage management, Protection and security System Structures: Operating System Services, System calls, Operating System design and implementation, Operating System structure, System Boot.	8
2	Processes: Process Concept, Process Scheduling, Operations on Processes, Inter-process Communication. Threads: Overview, Multi-core Programming, Multithreading Models, Implicit Threading, Threading Issues. Process Synchronization-Background, The Critical section problem, Synchronization hardware, Mutex Locks, Semaphores, Classical problems of synchronization.	8
3	CPU Scheduling- Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple-Processor scheduling. Deadlocks: System Model, Deadlock characterization, Methods for handling deadlocks, Deadlock prevention, Deadlock avoidance, Deadlock detection and recovery from deadlock.	8
4	Memory Management Strategies: Background, Swapping, Contiguous memory allocation, Paging, Structure of page table, Segmentation. Virtual Memory Management- Background, Demand paging, Page replacement, Thrashing.	8
5	Virtual Machines: Overview, Benefits and features, Building Blocks, Types of Virtual Machines and their implementations, Virtualization and Operating System Components, Protection Rings Case Study: VMWare	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Operating System Concepts	Abraham Silberschatz, Peter Baer Galvin , Greg Gagne	9th Edition	John Wiley & Sons	2018
2.	Modern operating systems	Andrew Tanenbaum	4th Edition	Pearson Education	2009
Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Operating System: Internals and Design Principles	William Stallings	8th Edition	Prentice Hall	2014
2.	Schaum's Outline of Operating Systems	J. Archer Harris	Kindle Edition	McGraw-Hill	2001

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Operating Systems Course Notes	Dr. John T.Bell	-	University of Illinois Chicago	2013	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/index.html
2.	Operating System Concepts	Abraham Silberschatz, Peter Baer Galvin , Greg Gagne	Ninth Edition	John Wiley & Sons	2018	https://drive.uqu.edu.sa/_/mskhayat/files/MySubjects/2017SS%20Operating%20Systems/Abraham%20SilberschatzOperating%20System%20Concepts%20(9th,2012_12).pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Operating Systems	SWAYAM	2023	https://onlinecourses.nptel.ac.in/noc20_cs04/preview
2.	Introduction to Operating Systems	Coursera	2023	https://www.coursera.org/specializations/codio-introduction-operating-systems

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Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Computer Networks

Semester	**IV**		
Course Code	**23DS4PCCON**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	Introduction: Data Communications, Networks, Network Types, Network Models, Protocol Layering, Reference Models: The OSI Reference Model, The TCP/IP Reference Model, Physical Layer: Data and signals Digital Transmission, (D-D Conversion) Bandwidth Utilization, Multiplexing, Switching, Circuit Switched Networks, Packet Switching.	8
2	Data Link Layer: Link Layer Addressing, Error Detection and Correction, Block Coding, Cyclic Codes, Checksum. Data Link Control: DLC Services, Data-Link Layer Protocols, Media Access Control, Wired LANs, Ethernet protocol.	8
3	Network Layer: Network Layer Services, Packet Switching, Network Layer Performance, IPV4 Addresses. Network Layer Protocols: Internet Protocol, ICMPV4, Unicast Routing, Routing algorithms, Unicast routing protocols, Internet Structure, Routing Information Protocol (RIP), Next Generation IP: IPV6 Addressing, IPV6 Protocol, ICMPv6 Protocol, Transition from IPV4 to IPV6, Congestion Control Algorithms, QoS	8
4	Transport Layer: Transport Layer Protocols, User Datagram Protocol, Transmission Control Protocol.	8
5	Application Layer: Introduction, Standard Client Server Protocols, DNS—The Internet's Directory Service, SMTP, SNMP, FTP	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Communications and Networking	Behrouz A Forouzan	5th Edition	McGraw Hill	2013
2.	Computer Networks	Andrew S. Tanenbaum, David J. Wetherall	5th Edition	Pearson	2011

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Data and Computer Communication	William Stallings	8th Edition	Pearson Education	2008
2.	Computer Networks – A Systems Approach	Larry L. Peterson and Bruce S. Davie	4th Edition	Elsevier	2007

E-books:						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	An Introduction to Computer Networks	Peter L Dordal	1st Edition	-	2020	https://intronetworks.cs.luc.edu/current/ComputerNetworks.pdf
2.	A Top-Down Approach: Computer Networking	James F Kurose & Keith W Ross	8th Edition	Pearson	2021	https://gaia.cs.umass.edu/kurose_ross/online_lectures.htm

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Computer Networking	Coursera	2023	https://www.coursera.org/learn/illinis-tech-computer-networking
2.	NOC: Computer Networks and Internet Protocol	NPTEL		https://nptel.ac.in/courses/106105183

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Machine Learning

Semester	**IV**		
Course Code	**23DS4PCMLG**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit no.	Topics	Hours
1	Machine Learning Landscape: Introduction, Types of Machine Learning, Challenges of Machine Learning, Testing and Validating. Supervised Learning Decision Tree Learning: Decision tree representation, Appropriate problems for decision tree learning, Basic decision tree learning algorithm, Issues in Decision tree learning, CART Training algorithm	8
2	Support Vector Machines: Linear SVM, Non Linear SVM, SVM Regression, Under the Hood. Instance Based Learning: Introduction, k-Nearest Neighbor learning	8
3	Probabilistic Learning Bayesian Learning: Bayes Theorem and Concept Learning, Maximum Likelihood, Minimum Description Length Principle, Bayes Optimal Classifier, Gibbs Algorithm, Naïve Bayes Classifier, Bayesian Belief Network, EM Algorithm.	8
4	Ensemble Learning and Random Forests: Voting Classifiers, Bagging and Pasting, Random Patches and Random Subspaces, Random Forests, Boosting, Stacking	8
5	Unsupervised Learning Techniques Clustering – Kmeans, DBSCAN, Other Clustering Algorithms, Gaussian Mixtures – Anomaly Detection, Selecting Clustering, Bayesian Gaussian Mixture Models, Other algorithms for anomaly and novelty detection.Reinforcement Learning: Markov Decision Process, Introduction, Learning Task, Q Learning	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Machine Learning	Tom M. Mitchell	First	McGraw Hill Education	2013
2	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	Aurelien Geron	Second	O'Reilly	2020

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Introduction to Machine Learning with Python	Andreas C Muller & Sarah Guido	First	Shroff Publishers	2019
2.	Thoughtful Machine learning	Mathew Kirk	First	Shroff Publishers	2019

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	The Elements of Statistical Learning	Trevor Hastie, Robert Tibshirani, Jerome H. Friedman	Second	-	2009	https://web.stanford.edu/~hastie/Papers/ESLII.pdf
2.	Machine Learning in Action	Peter Harrington	First	Manning	2017	http://www2.ift.ulaval.ca/~chaib/IFT-4102-7025/public_html/Fichiers/Machine_Learning_in_Action.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Machine Learning	Coursera	--	https://www.coursera.org/learn/machine-learning
2.	Introduction to Machine learning	NPTEL	2016	https://swayam.gov.in/nd_noc20_cs29/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Design and Analysis of Algorithms

Semester	**IV**		
Course Code	**23DC4PCDAA**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	Introduction to Algorithm, Fundamentals of Algorithmic Problem Solving. Analysis of Algorithm Efficiency: The Analysis Framework, Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non Recursive Algorithm, Mathematical Analysis of Recursive Algorithms.	8
2	Brute-Force: String Matching, Exhaustive Search: TSP, Knapsack Problem, Assignment Problem, Depth-First Search and Breadth-FirstSearch. Decrease-and-Conquer: Topological Sorting, Algorithms for Generating Combinatorial Objects: Generating Permutations, Decrease by-a-Constant-Factor Algorithms: Binary Search, Russian Peasant Multiplication, Variable Size-Decrease Algorithms: Computing Median and the Selection Problem	8
3	Divide-and-Conquer: Merge sort, Quicksort, Multiplication of Large Integers and Strassen's Matrix Multiplication. Transform-and-Conquer: Presorting, Heaps and Heap sort, Horner's Rule. Space and Time Tradeoffs: Horspool Algorithm, Boyer-Moore Algorithm.	8
4	Dynamic Programming: Coin Problem, The Knapsack Problem, Warshall's and Floyd's Algorithms. Greedy Technique: Prim's Algorithm, Kruskal's Algorithm-Without disjoint subsets and Union Find algorithms, Dijkstra's Algorithm, Huffman Trees.	8
5	Backtracking: n-Queens Problem, Subset-Sum Problem. Branch-and-Bound: Knapsack Problem, Traveling Salesman Problem. NP-Completeness: Polynomial time, Polynomial-time verification, NP-completeness and reducibility. NP-Complete Problems: The Clique problem, The Vertex Cover problem, Approximation Algorithms: The Vertex-Cover problem.	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Introduction to the Design and Analysis of Algorithms	Anany Levitin	Third Edition	Pearson	2014
2.	Introduction to Algorithms	Charles E Leiserson, Ronald L Rivest, Clifford Stein	Third Edition	The MIT Press	2009

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Fundamentals of Computer Algorithms	Ellis Horowitz,Satraj Sahni and Rajasekhara m	2ndEdition	University Press Pvt. Ltd,	2009
2.	Analysis and design of Algorithms	Padma Reddy		Sri Nandi Publications	2009

E-Books						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Introduction to Design & Analysis of Algorithms	K. Raghava Rao	-	Smash words	2013	https://www.smashwords.com/books/view/365630
2.	Data structures and Algorithm Analysis in C++	Allen Weiss	Fourth edition	Pearson education	2014	http://www.uoitc.edu.iq/images/documents/informatics-institute/Competitive_exam/Data Structures.pdf

MOOC Courses				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1	Algorithms	Coursera	2023	https://www.coursera.org/course/algs4partI
2	Design and Analysis of Algorithms	NPTEL	2023	https://onlinecourses.nptel.ac.in/noc19_cs47/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Data Visualization using Tools

Semester	**IV**		
Course Code	**23DS4AEDVZ**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

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Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Python Data Science Handbook	Jake Vander Plas	2nd Edition	O'Reilly	2017
2.	Pro Tableau: A Step by Step Guide	Seema Acharya , Subhashini Chellappan	2nd Edition	Apress	2016

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Analysis and Visualization Using Python: Analyze Data to Create Visualizations for BI Systems	Sossama Embarak	-	Apress	2018
2.	Python Data Visualization Cookbook	Igor Milovanović , Dimitry Foures , Giuseppe Vettigl	Second Edition	O'Reilly	2015

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Visualization with Python and JavaScript	Kyran Dale	-	O'Reilly	2016	https://github.com/jllovet/dataviz-with-py-and-js
2.	Jumpstart Tableau: A Step-by-Step Guide to Better Data Visualization	Arshad Khan	-	Apress	2016	https://link.springer.com/book/10.1007/978-1-4842-1934-8

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Laboratory plan

Cycle 1

Sl. No.	Experiment
1	Using the sales_data.csv, create the visualization report for the following using Matplotlib: a. Get total profit of all months and show line plot with the following Style properties. Generated line plot must include following Style properties: 1. Line Style dotted and Line-colour should be green 2. Show annotation 3. Add a square marker. 4. Add ticks for both X and Y axis b. Read Bathing soap facewash of all months and display it using the Subplot
2	Using the sales_data.csv, create the visualization report for the following using Matplotlib: a. Get total profit of all months and show line plot with the following Style properties Generated line plot must include following Style properties: – 1. Line Style dashed and Line-colour should be green 2. Show legend at the lower right location. 3. Add ticks for both X and Y axis 4. Line width should be 2 b. Read toothpaste sales data of each month and show it using a bar plot
3	Using the sales_data.csv, create the visualization report for the following using Matplotlib: a. Calculate total sale data for last year for each product and show it using a Pie chart 1. Print the total sale inside each part 2. Explode the highest sale 3. Set the start angle=60 b. Read face cream and facewash product sales data and show it using the horizontal bar chart
4	Write a Python programming for the following: a. to display a horizontal bar chart of the sale of book. Use different color for each bar. Sample data: Programming languages: Fict, Tech, Moti, Business, Nutri, Dev Sale: 5.2,19.6, 8.7, 8, 7.7, 3.7 1. Add ticks for both axes 2. Show legend at the upper right corner b. Write a Python program to create a stacked bar plot. Note: Use bottom to stack the women bars on top of the men bars. Sample Data: Means (men) = (22, 30, 35, 35, 26) Means (women) = (25, 32, 30, 35, 29) 1. Add labels and ticks 2. Use annotation

5	Write a Python programming for the following: a. To create a pie chart with a title of the pass percentage of subjects. Sample data: Subjects: DSC, OOP, OPS, COA, MAT, Java Pass percentage (%): 40, 25.6, 8.8, 30, 7.7, 60.7 1. Print percentage inside the chart 2. Use explode property b. Using the sales_data.csv, read the total profit of each month and show it using the histogram to see the most common profit ranges
6	Using the dataset planets.csv, create the visualization report for the following using Seaborn: a. Get the distance covered year-wise and show scatter plot with the following properties 1. Add “mass” as additional features 2. Use different markers 3. Control the range of marker areas with sizes b. Read the orbital_period of each year and show it using the histogram.
7	Using the dataset planets.csv, create the visualization report for the following using Seaborn: a. Get the distance covered year-wise and show scatter plot with the following properties 1. Add “mass” and “method” as additional features 2. Change the default colour palette 3. Display the complete legend b. Read the distance for each method and show it using the bar chart.
8	Using the dataset titanic.csv, create the visualization report for the following using Seaborn: a. Demonstrate the use of “displot” b. Plot the distribution using Kernel density estimation. c. Use lineplot for any two suitable features d. Generate scatter plot with different color palette
9	Using the dataset titanic.csv, create the visualization report for the following using Seaborn: a. Demonstrate the subplots (2x1) on scatter plots b. Demonstrate the use of violin plot c. Get different line plots for survival of passengers’ class wise. d. Create visualization for strip plot without jitter
10	Using the dataset titanic.csv, create the visualization report for the following using Seaborn: a. Create a visualization using categorical plot and re-order the axis contents b. Demonstrate the use of violin plot c. Demonstrate the subplots (1x3) on line plots d. Generate scatter plot with different color palette

Lab-cycle-2

Sl. No.	Experiment
1	Create the visualization using Tableau for the "Corriander_seed_2021.csv" dataset. a. Demonstrate the use of filters (General, wildcard, condition and limits) b. Demonstrate the group creation, removing and renaming a group. c. Demonstrate the creation of constant set d. Create the visualization by using quick table calculation e. Customize the data using any three number functions
2	Create the visualization using Tableau for the "Corriander_seed_2021.csv" dataset. a. Demonstrate the use of cascading filter, calculation filter and data source filter. b. Demonstrate creating Hierarchies c. Demonstrate the creation of computed sets d. Create a visualization using a calculated field e. Customize the data using any three string functions
3	Create the visualization using Tableau for the "Corriander_seed_2021.csv" dataset. a. Demonstrate the use of cascading filter, calculation filter and data source filter. b. Demonstrate the group creation, removing and renaming a group. c. Create a visualization using a calculated field d. Customize the data using any three number functions e. Demonstrate the creation of constant set
4	Create the visualization using Tableau for the "supermarket_sales.csv" dataset. a. Demonstrate the use of filters (General, wildcard, condition and limits) b. Demonstrate the group creation, removing and renaming a group. c. Demonstrate the creation of constant set d. Create a visualization using a calculated field e. Customize the data using any three string functions
5	Create the visualization using Tableau for the "supermarket_sales.csv" dataset. a. Demonstrate the use of cascading filter, calculation filter and data source filter. b. Demonstrate creating Hierarchies c. Demonstrate the creation of computed sets d. Create the visualization by using quick table calculation e. Customize the data using any three number functions
6	Create the visualization using Tableau for the "supermarket_sales.csv" dataset. a. Demonstrate the use of filters (General, wildcard, condition and limits) b. Demonstrate creating Hierarchies c. Create the visualization by using quick table calculation d. Demonstrate the creation of constant set e. Customize the data using any three string functions

7	Create the visualization using Tableau for the "supermarket_sales.csv" dataset. a. Demonstrate the use of cascading filter, calculation filter and data source filter. b. Demonstrate the group creation, removing and renaming a group. c. Demonstrate the creation of constant set d. Create a visualization using a calculated field e. Customize the data using any three number functions

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	IBM Data Science	Coursera	2023	https://www.coursera.org/professional-certificates/ibm-data-science
2.	Data Visualization with Tableau	Coursera	2023	https://www.coursera.org/specializations/data-visualization

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Competitive Programming

Semester	**IV**		
Course Code:	**23DS4AECPG**	**Total Contact Hours: 24**	
L-T-P:	**0-0-1**	**Total Credits:**	**1**

Sl.no	Programming Challenges on the topics listed below	Hours
1	Getting Started: Programming Fundamentals	**2**
2	Arithmetic & Algebra	**2**
3	Sorting and Searching Algorithms	**2**
4	Tree Queries	**2**
5	Range Queries	**2**
6	Divide and Conquer	**2**
7	Greedy Algorithms - I	**2**
8	Greedy Algorithms - II	**2**
9	Dynamic Programming - I	**2**
10	Dynamic Programming - II	**2**
11	Graph Algorithms	**2**
12	String Algorithms	**2**

Prescribed Text Book				
Sl. No.	**Book Title**	**Authors**	**Publisher**	**Year**
1.	Competitive Programming in Python: 128 Algorithms to Develop Your Coding Skills	Christoph Dürr and Jill-Jênn Vie	Cambridge University Press	2021
2.	Guide to Competitive Programming	Antti Laaksonen	Springer	2017

Reference Text Book				
Sl. No.	**Book Title**	**Authors**	**Publisher**	**Year**
1.	**Introduction to Algorithms**	**Thomas H. Cormen, Charles E. Leiserson**	MIT Press	2022
2.	**Programming Challenges**	Steven S. Skiena Miguel A. Revilla	Springer	2003

E-Book					
Sl. No.	**Book Title**	**Authors**	**Publisher**	**Year**	**URL**
1.	Competitive Programming 3	Steven Halim, Felix Halim	Lulu	2013	https://files.gitter.im/SamZhangQingChuan/sam/DA1g/Steven-Halim_-Felix-Halim-Competitive-Programming-3_-The-New-Lower-Bound-of-Programming-Contests-Lulu.com-_2013_.pdf
2.	Algorithms	Jeff Erikson	-	2019	https://jeffe.cs.illinois.edu/teaching/algorithms/

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Getting started with Competitive Programming	NPTEL	2024	https://onlinecourses.nptel.ac.in/noc24_cs103/preview
2	Competitive Programming Essentials, master Algorithms	Udemy	2024	https://www.udemy.com/course/competitive-programming-algorithms-coding-minutes/

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

LaTeX and Canva Essentials

Semester	**IV**		
Course Code	**23DS4AELCE**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Sl.no	Lab Programme	Hours
1	Introduction & Installation • Overview of LaTeX for Data Science reports. • Install TeX Live/MiKTeX & Overleaf. Hands-on: Compile "Hello, Data Science" document. Exercise: Typeset the formula $E = mc^2$ inline and display.	2
2	Document Classes & Structure • article/report for Data Science papers; preamble, packages, TOC. Hands-on: Skeleton report with abstract & TOC. Exercise: Insert the linear regression equation $\hat{y} = \beta_0 + \beta_1 x$.	2
3	Text Formatting & Typography • Custom macros for vectors/matrices; font sizing for tables. Hands-on: Style a multi-section methods section. Exercise: Typeset the gradient vector $\nabla f(x) = [\partial f/\partial x_i]$.	2
4	Lists, Floats & Environments • itemize/enumerate, floating code snippets & tables. Hands-on: Nested lists for DS workflow; include a CSV table. Exercise: Table of activation function $\sigma(z) = 1/(1 + e^{-z})$.	2
5	Tables & Math • longtable for DataFrames; amsmath for aligned equations. Hands-on: Confusion matrix and metrics alignment. Exercise: Typeset $MSE = (1/n)\sum(y_i - \hat{y}_i)^2$.	2
6	Graphics & TikZ • Include matplotlib plots as PDF; basic TikZ for pipelines. Hands-on: Embed a normal-distribution plot. Exercise: Draw an ETL pipeline diagram in TikZ.	2
7	Cross-referencing & Hyperlinks • label/ref, hyperref for code and figures. Hands-on: Link to GitHub and reference Figure 1. Exercise: Reference the ROC curve formula $TPR = TP/(TP + FN)$.	2

8	Bibliographies & Citations • BibLaTeX for DS papers, IEEE/ACM styles. Hands-on: Compile a .bib file of key DS refs. Exercise: Cite "Scikit-learn: Machine Learning in Python."	2
9	Custom Layouts & Styles • Custom class for DS reports; headers/footers. Hands-on: Template with institute logo. Exercise: Box the K-means update rule $\mu_k = (1/\|S_k\|)\sum_{xi} \in S_k\, x_i$.	2
10	Beamer Presentations, Version Control & Collaboration & Journal & Thesis Formatting (Case Study) • DS-themed Beamer; overlays for stepwise reveal. • IEEE DS templates & Springer journals. • GitHub workflows for LaTeX + Jupyter. Hands-on: 5-slide DS project overview. Exercise: Reveal the $SVD\ A = U\Sigma V^T$ step by step.	2
11	Scientific Posters & Visual Storytelling • Principles of effective scientific poster design. • Layouts: Grid systems, whitespace, balance. • Fonts, contrast, color palettes for readability. • Structuring a poster: Introduction, Methods, Results, Conclusion. • Using Canva for A0/A1 formats with academic-style templates. Hands-on Activity: • Design a **poster** for a **Data Science project** using Canva. • Use charts, icons, timelines to summarize a pipeline (e.g., "EDA → Model → Accuracy"). Exercise: • Students must convert a 500-word abstract into a **one-page visual poster**.	2

12	Scientific Social Media Graphics & Infographics • Communicating research to the public. • Twitter/Instagram science visuals: Size, tone, and simplicity. • Science memes, data infographics, visual abstracts. • Branding with logos, colors, and consistency. Hands-on Activity: • Create an **Instagram-style science graphic** explaining a concept like **Gradient Descent** or **Overfitting vs. Underfitting**. Exercise: • Make a 3-slide mini carousel to visually explain a core ML concept using Canva (e.g., bias-variance tradeoff)	2

Prescribed Textbooks

SI No	Title	Authors	Edition	Publisher	Year
1	TheLaTeX Companion	Frank Mittelbach, Michel Goossens, et al.	3rd	Addison–Wesley Professional	2021
2	LaTeX: A Document Preparation System	Leslie Lamport	2nd	Addison–Wesley	1994
3	The Canva Workbook: Teach Yourself How to Use Canva to Create Amazing Designs	Diana Adriana	1st	Independent	2022

Reference Books

SI No	Title	Authors	Edition	Publisher / Source	Year
1	The Chicago Manual of Style	University of Chicago Press Staff	17th	University of Chicago	2017
2	Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded	Joshua Schimel	1st	Oxford University Press	2012
3	The Elements of Style	William Strunk Jr., E.B. White	4th	Pearson	2019

E-book

SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Learn LaTeX in 30 Mins	Overleaf	1st Edition	Overleaf	2022	https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes
2	LATEX for Beginners	Workbook	1st Edition	LaTeX	2024	https://shorturl.at/ZUzZJ

MOOC Course

SI No	Course Name	Offered By	Year	URL
1	Write Smarter with Overleaf and LaTeX	Coursera	2025	https://www.coursera.org/learn/overleafandlatex
2	LaTeX & XFig - typesetting software	NPTEL	2025	https://onlinecourses.swayam2.ac.in/aic20_sp17/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Universal Human Values

Course Code	**22MA4HSUHV**		
Credits	**01**	**L-T-P**	**0-1-0**
Total Number of hours		**30**	

Course Objectives:

Unit no	Topics	Hours
1	**Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education** 1. Purpose and motivation for the course, recapitulation from Universal Human Values-I 2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations 4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority 5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario 6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking	6
2	**Understanding Harmony in the Human Being - Harmony in Myself!** 7. Understanding human being as a co-existence of the sentient 'I' and the material 'Body' 8. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility 9. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) 10. Understanding the characteristics and activities of 'I' and harmony in 'I' 11. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail 12. Programs to ensure Sanyam and Health. Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with diseaseharmony at various levels.	6

3	**Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship** 1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship 2. Understanding the meaning of Trust; Difference between intention and competence 3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship 4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives	6
4	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** 1. Understanding the harmony in the Nature 2. Holistic perception of harmony at all levels of existence.	6
5	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** 1. Natural acceptance of human values 2. Definitiveness of Ethical Human Conduct	6

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi,2010

REFERENCE MATERIAL:

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)

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V SEMESTER

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Time Series Analysis

Semester	**V**		
Course Code	**23DS5PCTSA**	**Total Contact Hours**	**40**
L-T-P	**2-1-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Time Series Data:** Purpose, Time series: Plots, Trends, and seasonal variation, Decomposition of series, Characteristics of Time Series: Introduction, Examples, Objectives and its nature, Introduction to time series databases and applications, Measures of dependence, Stationary Time Series, Estimation of Correlation, Vector Valued and Multi-Dimensional Series **Components of Time Series:** Trends, Seasonality, Cycles, Noise, Mathematical Models: Additive and Multiplicative models. Resolving components of a Time Series - Measuring Trend: Graphic, Semi-Averages, Moving Average and Least Squares Methods.	**8**
2	**Correlation:** Expectation and the ensemble, correlogram, covariance of sum of random variables, Measuring Seasonal Variation: Method of Simple Averages, Ratio-to- Trend Method, Ratio-to-Moving Average Method and Link Relative Method, Cyclical and Random Fluctuations, Variate Difference Method.	**8**
3	**Index Numbers and their Definitions:** Construction and Uses of Fixed and Chain based Index Numbers, Simple and Weighted Index Numbers, Laspeyres, Paasche's, Fisher's, and Marshall - Edgeworth Index Numbers, Optimum Tests for Index Numbers, Cost of Living Index Numbers. Forecasting Strategies: Leading variables and associated variables, Bass Model, Exponential Smoothing and Holt-Winters method	**8**
4	**Basic Stochastic Models:** White Noise, Random Walks, Fitted models & diagnostic plots, Autoregressive models: stationary and non-stationary Autoregressive process **Time series Regression and Exploratory Data Analysis:** Classical Regression, Exploratory Data Analysis, generalized least square method, linear models with seasonal variables, Harmonic seasonal models, logarithmic transforms.	**8**
5	**Linear Models:** Moving Average models, Fitted MA Models, ARIMA Models: Autoregressive Moving Average Models, Differential Equations, Autocorrelation and Partial Correlation, Forecasting & Estimation, Non-stationary Models: Building non-seasonal ARIMA Models, ARCH Models, GARCH Models.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introductory Time series with R	Paul S.P. Cowpertwait, Andrew V. Metcalfe	1st Edition	Springer	2010
2.	Time Series Analysis and its Applications with R Examples	Robert H Shumway, David S Stoffer	4th Edition	O'Reilly	2020

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Time Series and Forecasting	Peter J Brokewell, Richard A Davis	Third	Springer	2016
2.	The Analysis of Time Series – An Introduction	Chris Chatfield	First	Chapman & Hall / CRC	1996

E-book

SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Time Series Analysis: Univariate and Multivariate methods	William W. S Wei	2nd Edition	Pearson	2007	https://civil.colorado.edu/~balajir/CVEN6833/lectures/wwts-book.pdf
2	Time Series Analysis: Forecasting and Control	Georgee.P.Box Gwilymm.Jenkins Gregoryc.Reinsel Gretam.Ljung	5th Edition	Wiley	2017	http://repo.darmajaya.ac.id/4781/1/Time%20Series%20Analysis_%20Forecasting%20and%20Control%20%28%20PDFDrive%20%29.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Intro to Time Series Analysis in R	Coursera	2024	https://www.coursera.org/projects/intro-time-series-analysis-in-r
2.	Applied Time-Series Analysis	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc21_ch28/preview
3	Time Series Analysis in R	DataCamp	2024	https://www.datacamp.com/courses/time-series-analysis-in-r

Big Data Analytics

Semester	**V**		
Course Code	**23DS5PCBDA**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	**Introduction to Big Data Analytics:** Introduction - Need of Big Data, Types of Digital Data, Definition of Big Data Analytics, Data intensive scientific discovery and the role of Big Data, Phases in Analytics, Characteristics of Big Data. **Designing Data Architecture:** Managing Data for Analysis, Architecture reference model, Big Data Stack, Case Study on Business Analytics for Emerging Trends and Future Impacts, Big Data Analytics standards - Process management framework for big data analytics- ISO/IEC 24668:2022	8
2	**NoSQL:** Data Store and Characteristic features, CAP theorem, NoSQL Data Architecture Patterns, Shared- Nothing Architecture for Big Data Tasks, MongoDB Databases - Features, Querying commands **Apache Cassandra:** Features and Components of Cassandra, Data types, Cassandra Data Model, CQL commands, Keyspaces, CRUD Operations, Time to Live (TTL), Alter Commands, Import and Export	8
3	**Introduction to Hadoop:** Introduction, Hadoop and its Ecosystem – Zookeeper, Ozie, Sqoop and Flume **MapReduce Framework and Programming Model:** Anatomy of MapReduce Job Run, Shuffle and Sort Map Tasks, MapReduce Execution Apache Yarn - How Yarn runs an application, Scheduling in Yarn, Scheduler options.	8
4	**The Hadoop Distributed File System: The** design of HDFS, HDFS Concepts, Hadoop File Systems and Interface, Dataflow - Anatomy of a File read and write Essential Hadoop Tools, Using Sqoop, Flume, Oozie, HBase.	8
5	**Spark and Big Data Analytics:** Spark basic architecture, Overview of structured spark types, Structured API Execution Components, Data Frame Transformation **Spark works with different types of data:** Boolean, numbers, JSON, Dates and Timestamp. Spark SQL - Tables, Views, Databases	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Science & Analytics – A Hands-on Approach	Arshdeep Bahga, Vijay Madisetti	First	VPT	2019
2	Hadoop - The definitive Guide	Tom White	Fourth	O'Reilly	2015
3	Spark: The Definitive Guide - Big Data Processing made Simple	Bill Chambers and Matei Zaharia	First	O'Reilly	2018

Lab Programs

Sl. no	Programs
1	Install Apache Hadoop and write a program to run basic HDFS commands.
2	Write a MapReduce program to count word frequency in a given file.
3	Install MongoDB and write a program to connect and perform basic operations.
4	Write a program to insert, read, update, delete data in a MongoDB collection, and use aggregate and comparison functions.
5	Install Apache Cassandra and write a program to create keyspace and table using CQL.
6	Write a program to insert, update, delete, and query data in a Cassandra table.
7	Install PySpark and write a program to count word frequency in a text file.
8	Write a PySpark program to create a DataFrame and perform select and filter operations.

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Big Data Analytics	Rajkamal, Preeti Saxena	First	McGraw Hill Education	2019
2.	Business Intelligence, A managerial Perspective on Analytics	Sharda, R, Delen D, Turban E	Tenth	Pearson	2015

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Hadoop Starter Kit	Udemy	--	Free Hadoop Tutorial - Hadoop Starter Kit | Udemy, 2023
2.	NPTEL IIT Patna 2023 https://nptel.ac.in/courses/10610418	NPTEL	2023	https://nptel.ac.in/courses/10610418 9, 2023

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Deep Learning

Semester	**V**		
Course Code	**23DS5PCDLG**	**Total Contact Hours**	**50**
L-T-P	**4-0-1**	**Total Credits**	**5**

Unit No.	Topics	Hours
1	**Introduction to Artificial Neural Networks:** From Biological to Artificial Neurons: Biological Neurons, Logical Computations with Neurons, The Perceptron, The Multilayer Perceptron and Backpropagation, Regression and Classification MLPs, Implementing MLPs with Keras, Fine-tuning Neural Network Parameters **Introduction to Deep Learning:** Challenges motivating Deep Learning, Historical Trends in Deep Learning, Deep Feedforward Networks, Gradient-based Learning, and Efficient Computation.	**10**
2	**Convolution Neural Networks(CNN):** The Architecture of the Visual Cortex, Convolutional Layer, Pooling Layer, CNN Architectures- LeNet-5, AlexNet, GoogLeNet, VGGNet, ResNet, Xception, Pre-trained Models for Transfer Learning, Classification and Localization, Object Detection-Fully Convolutional Networks (FCNs), You Only Look Once (YOLO), Semantic Segmentation, Convolution Networks and the History of Deep Learning.	**10**
3	**Training Deep Neural Networks:** Vanishing/Exploding Gradients, Reusing Pretrained Layers, Faster Optimizers, Avoiding Overfitting Through Regularization. **Recurrent Neural Networks(RNN):** Recurrent Neurons and Layers, Training RNNs, Forecasting a Time Series, Handling Long Sequences-LSTM, GRU, Bidirectional RNNs, Recursive Neural Networks, Attention Mechanisms.	**10**
4	**Representation Learning using Autoencoders:** Stacked Autoencoders, Convolutional Autoencoders, Recurrent Autoencoders, Denoising Autoencoders, Sparse Autoencoders, Applications of Autoencoders, Transfer Learning, and Domain Adaptation. **Generative Adversarial Networks(GANs):** Difficulties of training GANs, Deep Convolutional GANs, Progressive Growing of GANs, StyleGANs	**10**
5	**Deep Generative Models:** Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief Networks, Deep Boltzmann Machines, Boltzmann Machines for Real-Valued Data **Applications:** Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications.	**10**

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Deep Learning	Ian Goodfellow,Yoshua Bengio, Aaron Courville	First	MIT Press	2016
2.	Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow	Aurelien Geron	Second	O'Reilly	2020

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Deep Learning with Tensor Flow and Keras	Amita Kapoor, Antonio Gulli, Sujit Pal	Third	Packt	2022
2.	Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers using TensorFlow	Magnus Ekman	First	Addison-Wesley Professional	2021

E-Books

Sl. No	Authors	Authors	Edition	Publisher	Year	URL
1	Dive into Deep Learning	Aston Zhang, Zachary C.Lipton, Mu Li, Alexander J. Smola	First	Cambridge University Press	2023	https://d2l.ai/d2l-en.pdf
2	The Little Book of Deep Learning	François Fleuret	-	University of Geneva, Switzerland	2024	https://fleuret.org/public/lbdl.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Deep learning – IIT Ropar	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc24_cs114/preview
2.	Neural Networks and Deep Learning	Coursera	2024	https://www.coursera.org/learn/neural-networks-deep-learning?specialization=deep-learning

Laboratory Plan

Sl. No.	**Lab Program**
1	Write a program to implement XOR gates using Perceptron.
2	Design a deep NN, optimize the network with Gradient Descent, and optimize the same with Stochastic gradient descent (SGD).
3	Classification of MNIST Dataset using CNN.
4	Implement Region-Based CNN for object detection.
5	Implement RNN for handwriting digit recognition.
6	Implement Bidirectional RNNs for music generation.
7	Implement Bidirectional LSTM for sentiment analysis.
8	Implement Variational Autoencoders for image-denoising.
9	Implementation of a Restricted Boltzmann Machine (RBM) that demonstrates stacking.
10	Implement Generative Adversarial Networks to generate realistic photographs.

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Programming With R

Semester	**V**		
Course Code	**23DS5PCPWR**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Module 1

SI no	Lab Program	Hours
1	**Introduction to R and RStudio:** Install R and RStudio. Write and execute your first R script that includes basic arithmetic operations, variable assignments, and printing results. Document the steps to install R and RStudio and describe the purpose of each line of your script.	**1**
2	**Basic Data Types and Operations:** Design an R program to create and manipulate vectors, matrices, lists, and data frames. Include operations such as indexing, subsetting, and applying functions like sum(), mean(), and length(). Create a data frame from scratch, perform basic operations, and describe the structure and type of each element in the data frame.	**1**
3	**Basic Statistical Operations**: Design an R program to calculate mean, median, mode, standard deviation, and variance of a dataset. Use a sample dataset, calculate each statistical measure, and provide a detailed explanation of what each measure represents and how it can be interpreted in the context of the data.	**1**
4	**Data Import and Export:** Design an R program to import data from a CSV file, perform some basic cleaning (such as removing NA values), and export the cleaned data to a new CSV file. Include steps to check the structure of the imported data, summarize its contents, and verify the successful export of the cleaned data.	**1**
5	**Basic Data Visualization:** Design an R program to create simple plots including a histogram, bar plot, line plot, and scatter plot. Use a given dataset, generate each plot, customize the plots with titles, axis labels, and colors, and save the plots as image files. Provide a brief interpretation of each plot in the context of the data.	**1**

Module 2

SI no	Lab Program	No. of Hours
1	**Data Cleaning and Preparation:** Design an R program to handle missing data, filter rows based on certain conditions, and select specific columns from a dataset. Use a sample dataset with missing values, filter the data to include only relevant rows, and create a new dataset with selected columns. Document the cleaning process and the rationale behind each step.	**1**
2	**Advanced Data Manipulation using dplyr:** Design an R program to use dplyr functions to manipulate data frames. Include tasks such as selecting columns, filtering rows, creating new columns with mutate, summarizing data with summarize, and arranging rows. Apply these operations to a complex dataset and provide a detailed explanation of each operation and its outcome.	**1**
3	**Data Visualization using ggplot2:** Design an R program to create advanced plots using ggplot2. Include examples of faceting, customizing plot aesthetics, and adding annotations. Use a dataset with multiple variables, generate plots that show different aspects of the data, and explain the insights gained from each plot.	**1**
4	**Descriptive Statistics and Data Summary:** Design an R program to generate descriptive statistics and create a data summary report. Use a comprehensive dataset, calculate measures such as mean, median, range, quartiles, and create summary tables. Write a report that includes the calculated statistics and an interpretation of the data distribution.	**1**
5	**Basic Data Analysis:** Design an R program to perform simple linear regression analysis. Use a dataset with a clear dependent and independent variable, fit a linear model, plot the regression line, and interpret the results. Include diagnostic plots to check the assumptions of the linear model and provide a detailed analysis of the findings.	**2**

Module 3

Sl no	Lab Program	Hours
1	**Advanced Data Analysis:** Design an R program to perform multiple linear regression analysis. Use a dataset with multiple predictor variables, fit a multiple regression model, interpret the coefficients, and evaluate the model's performance. Include steps to check for multicollinearity, perform model selection, and validate the model using cross-validation techniques.	**2**
2	**Introduction to Machine Learning with R:** Design an R program to implement a basic k-means clustering algorithm. Use a dataset with multiple features, normalize the data, perform k-means clustering, visualize the clusters, and interpret the results. Provide an analysis of the optimal number of clusters and discuss the practical applications of clustering in data analysis.	**3**
3	**Time Series Analysis:** Design an R program to analyze and forecast time series data using ARIMA models. Use a time series dataset, perform exploratory data analysis, fit an ARIMA model, and make future forecasts. Include steps to check for stationarity, select model parameters, and evaluate the model's forecasting accuracy. Provide a detailed interpretation of the time series components and the forecast results.	**4**
4	**Creating Interactive Visualizations:** Design an R program to create interactive plots using the plotly package. Use a complex dataset, generate interactive visualizations such as scatter plots, line charts, and bar charts, and customize the interactivity features. Include examples of how to incorporate tooltips, hover effects, and interactive legends. Discuss the advantages of using interactive visualizations for data exploration.	**2**
5	**Data Reporting with RMarkdown:** Design an R program to generate a comprehensive report using RMarkdown. Include sections that combine code, text, and visualizations to create a dynamic and reproducible report. Use a case study to demonstrate the end-to-end data analysis process, from data cleaning and manipulation to analysis and visualization. Provide the final RMarkdown document and the rendered report, highlighting the key findings and insights.	**2**

Prescribed Textbook					
SI No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	R for Data Science	Hadley Wickham & Garrett Grolemund	First	O'Reilly Media, Inc	2017
2.	An Introduction to R	W. N. Venables, D. M. Smith and the R Core Team	First	R Core Team	2023

Reference Textbook					
SI No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	R in Action	Robert Kabacoff	2nd Edition	Manning	2015
2	The Art of R Programming	Norman Matloff	1st Edition	No Starch Press	2011

E-book						
SI No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1	Hands-On Programming with R	Garrett Grolemund	1st Edition	O'Reilly	2014	https://rstudio-education.github.io/hopr/index.html
2	R Graphics Cookbook	Winston Chang	2nd Edition	O'Reilly	2018	https://r-graphics.org/

MOOC Course				
SI No	**Course Name**	**Offered By**	**Year**	**URL**
1	Data Science: Foundations using R	Coursera (Johns Hopkins University)	2023	https://www.coursera.org/specializations/jhu-data-science
2	R Programming	Coursera (Johns Hopkins University)	2023	https://www.coursera.org/learn/r-programming
3	Foundations of R	IIT Kanpur	2024	https://onlinecourses.nptel.ac.in/noc22_ma69/preview

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Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Research Methodologies and IPR

Semester	**V**		
Course Code	**23DC5AERMI**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Research Methodology: An Introduction** - Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research methods vs Methodology, Research and scientific method, Research Process, Criteria of Good Research. **Define the Research Problem** - What is research problem, Selecting the problem, Necessity of Defining the problem, Technique involved in Defining a Problem **Research Design** - Meaning of Research Design, Need for Research Design, Features of Good Design, Important concepts Relating to Research Design, Different Research Design.	**8**
2	**Design of Sample Surveys** - Introduction, Sample Design, Sampling and Non-Sampling Errors, Sample Survey vs Census Survey, Types of Sampling Designs **Chi-Square Tests** - Test of Difference of more than Two proportions, Test of Independence of Attributes, Test of Goodness of Fit **Analysis of Variance** - The ANOVA technique, The Basic principle of ANOVA, One way ANOVA, Two way ANOVA, Latin-square Design.	**8**
3	**Nature of Intellectual property,** IPRs- Invention and Creativity - Importance and Protection of Intellectual Property Rights (IPRs) – procedure for grant of patents and patenting under PCT-types of patents-technological research and innovation-international cooperation on IP.	**8**
4	**A brief summary of Patents-Copyrights-Trademarks**, patent rights-licensing and transfer of technology-patent databases-case studies on IPR-Geographical indications-new developments in IPR-protection of IPR rights.	**8**
5	**Interpretation and Report Writing** - Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Different steps in Writing Report, Layout of the Research Report, Types of Reports, Oral presentation, Mechanics of writing a research Report, Precautions of Writing Research Report	**8**

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Research Methodology: Methods and Techniques	C R Kothari, Gaurav Garg	Multicolor (Fourth)	New Age International Publishers	2019
2	An introduction to Research Methodology	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K	Fourth	RBSA Publishers	2002
3	Handbook of Intellectual property law and practise	Subbaram NR	First	S Viswanathan Printers and Publishing Private Limited	1998

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	**Understanding Research Methods**	Coursera	2024	https://www.coursera.org/learn/research-methods
2.	Fundamentals of Research Methodology	Udemy	2024	https://www.udemy.com/course/fundamentals-of-research-methodology/

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Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Product, Services and IT Service Management

Semester	**5**		
Course Code	**23CS5PEPSI**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Overview of Products and IT Services**: Introduction to industrial revolutions from 1.0 to 5.0, overview of products, services, and their underlying components, IT Infrastructure, Data Center and Cloud computing, Application management (Development to maintenance)	8
2	**IT Service Management and delivery of IT Services:** Introduction to IT Service Management, the standards and frameworks in the industry and its evolution, concepts Value management, 4 Ps of IT service management, Principles and guidelines, IT Service management process and procedures overview	8
3	**IT Service Management best practices:** Application of IT service management best practices in IT Service delivery, **Portfolio, Program and Project Management while delivering IT Product and Services:** Introduction to Portfolio, Program and Project Management structure and its importance while delivering IT products and services. Methodologies and industry practices, Agile overview, Concepts of Scrum, Kanban and Lean, use of Agile mindset, principles and methods in IT products and service delivery	8
4	**Everything as a Service:** Different types of Cloud based computing models (IaaS, PaaS, SaaS), Role of service management in service-based cloud model, importance of service integration and management in multi supplier environment **DevOps and IT Service management:** Introduction to DevOps, management of deployment and releases, improve resilience and reliability of products and IT services, understanding service mindset	8
5	**Use of technology to manage services:** How technology enables management of services, tools for IT service management, IT operations management (event monitoring and integration), Toil reduction using automation, Artificial Intelligence infused IT service operations	8

Prescribed textbook:

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	ITIL Foundation: ITIL 4 Edition (ITIL 4 Foundation)	Axelos	2nd	Axelos UK	2024
2	Mastering IT Infrastructure Management: Concepts, Techniques, and Applications	Nikhilesh Mishra	NA	Independently Published (by Amazon)	2023
3	Agile Essentials: From Concepts to Customer Delight	Rahul Shah	NA	Notion Press Media Pvt Ltd	2025

Online Courses and Video Lectures

- **https://www.udemy.com/course/agile-fundamentals-scrum-kanban-scrumban/?couponCode=CP130525**
- **https://www.udemy.com/course/certmike-comptia-it-fundamentals-itf/?couponCode=CP130525**

AAT Plan

Sl. No	Week	Activity
1	3rd	Formation of groups. Note: Groups size - min 4 and max 6 students
2	5th	AAT (case study) topic selection by each group
3	6th	Presentation: Team and topic introduction by each group
4	8th	Presentation: Share the understanding of problem
7	10th	Presentation: Present the analysis of the problem and possible causes
8	12th	Presentation: Present the solution steps and possible outcome that can be achieved
9	15th	Final AAT presentation submission

Case Study Evaluation Criteria					
#	**Criteria**	**Needs Improvement**	**Good**	**Excellent**	**Max Points**
	Score	**0 - 1**	**2 - 4**	**5**	**40**
1	Introduction: Brief overview of the case Background and context Objectives of the case study	The students have a brief overview and some background, but the objectives are unclear or incomplete.	The students have a clear overview, adequate background information, and defined objectives, but has not gone into much detail.	The students have a comprehensive overview, detailed background information, and clearly defined objectives, with good organization and clarity.	5
2	Problem State ment: Clearly define the core issue(s) Identify any underlying problems and challenges	The problem statement is defined but not clear or detailed, and only some underlying problems are identified	The problem statement is clear and most challenges are identified, but there are some minor gaps or unclear points	The problem statement is clear and detailed, and all main challenges are well explained and understood.	5
3	Problem Analysis and identification of possible causes:	The students can analyse some part of the problem, but missing holistic approach and identification of possible causes	The students can analyse the problem and identify the possible causes, but missing holistic approach	The students can analyse the problem and identify the possible causes by applying holistic approach	5
4	Solutions: Best solution with justification Action plan or steps for implementation Considerations (time, cost, quality)	The solutions are based on a poor understanding of the problem and could lead to the wrong outcome.	The solutions are based on possible causes, but may need more detail and a better overall approach.	The solutions are creative, practical, and well-matched to the situation, with clear links to time, cost, and quality, and realistic assumptions.	5

5	Conclusion: Summary of findings Lessons learned	The students are able summarize the case study with solution; however, critical findings are missing in the reflection	The students are able summarize the case study with solution, however, missing structured approach	The students are able summarize the case study showing good understanding of the problem and a structured approach to the solution.	5
6	Clarity and Organization of Presentation Well-structured PPT Logical flow of information and organization of information	The presentation is somewhat organized but not very clear	The presentation has clear communication of findings with good visuals	The presentation is engaging, well-structured, and uses strong visuals and clear storytelling.	5

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Internet of Things

Semester	**V**		
Course Code	**23DS5PEIOT**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hrs
1	**Introduction to Internet of Things:** Introduction: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, Logical Design of IoT: IoT Functional Blocks, IoT Communication Models, IoT Communication APIs. **IOT Enabling Technologies:** Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Embedded Systems, IoT Levels and Deployment Templates.	**8**
2	**Introduction to Embedded Systems for IoT:** Embedded Computing Basics - Microcontrollers, System-on-Chips, Choosing Your IoT Development Platform, Working with Arduino: Introduction to Arduino, Setting Up and Developing on the Arduino, Working with Raspberry Pi, Introduction to Raspberry Pi. Sensors and Actuators in IoT: Working Principles and Types of Sensors, Working Principles and Types of Actuators. Smart Objects - Overview and Trends.	**8**
3	**IoT and M2M Communications:** Introduction, M2M, Differences between M2M and IoT, SDN and NFV for IoT. **Connecting smart Things:** Communication Criteria, IoT access Technologies (IEEE 802.15.4, IEEE 802.15.4g and IEEE 802.15.4e, IEEE 1901.2a, IEEE 802.11ah, LoRaWAN, NB-IoT)	**8**
4	**IP as the IoT Network Layer:** The business case for IP, The need for Optimization, Optimizing IP for IoT -From 6LoWPAN to 6Lo, 6TiSCH, RPL. **Application Protocols for IoT:** Transport Layer, IoT Application Layer Protocols: CoAP, MQTT.	**8**

5	**IoT Applications:** Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, and Healthcare. Case Studies – Home Intrusion Detection, Smart Parking, Weather Monitoring System, Air Pollution Monitoring, Forest Fire Detection, and Smart Irrigation.	**8**

Prescribed Text Books					
SL.No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Internet Of Things - A Hands-On Approach	Arsheep Bahga, Vijay Madisetti	First Edition	Universities Press	2023
2	Designing the Internet of Things	Adrian McEwen and Hakim Cassimally	First Edition	John, Wiley & Sons	2014
3	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro	First Edition	CISCO Press	2022
	Reference Text Books				
SL.No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Internet of Things	Surya S. Durba	First Edition	Oxford University Press	2021
2	Internet of Things: Principles and Paradigms	Rajkumar buyya	First Edition	Todd Green	2016

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things	David Hanes, Gonzalo Salgueiro	First	CISCO Press	2022	https://nibmehub.com/opac-service/pdf/read/IoT%20Fundamentals.pdf
2.	Using the Web to build IOT	Dominique Guinard and Vlad Trifa ,	First	Manning	2016	https://www.manning.com/books/using-the-web-to-build-the-iot

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	**Introduction To Internet of Things**	NPTEL	2024	https://onlinecourses.nptel.ac.in/noc24_cs35/preview
2.	**An Introduction to Programming the Internet of Things (IOT)**	Coursera	2024	https://www.coursera.org/specializations/iot

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Cryptography And Network Security

Semester	**V**		
Course Code:	**23DS5PECNS**	**Total Contact Hours**	**40**
L-T-P:	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction:** Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security. **Classical Encryption Techniques:** Symmetric Cipher Model, Substitution Techniques – Caesar Cipher, Monoalphabetic Ciphers, Play fair Cipher, Hill Cipher, Polyalphabetic Ciphers, One-Time Pad, Transposition Techniques.	**8**
2	**Block Ciphers:** Traditional Block Cipher Structure – Stream Ciphers and Block Ciphers, Motivation for the Feistel Cipher Structure, The Feistel Cipher, Block Cipher Design Principles, The Simplified Data Encryption Standard (S-DES) – S-DES Encryption, S-DES Decryption, SDES Key Generation. **Stream Ciphers:** StreamCiphers, RC4 – Initialization of S, StreamGeneration, Strength ofRC4	**8**
3	**Public-Key Cryptosystems:** Principles of Public-Key Cryptosystems – Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptosystems, Public-Key Cryptanalysis, The RSA Algorithm – Description of the Algorithm, Computational Aspects, The Security of RSA, Diffie-Hellman Key Exchange – The Algorithm, Key Exchange Protocols, Man-in-the-Middle Attack. **Cryptographic Hash Functions:** Secure Hash Algorithm (SHA) – SHA-512 Logic, SHA-512 Round Function, Examples.	**8**
4	**Key Management and Distribution:** Symmetric Key Distribution using Symmetric Encryption, Symmetric Key Distribution using Asymmetric Encryption, Distribution of Public Keys. **Transport-Level Security:** Transport Layer Security – Architecture, Record Protocol, Change Cipher Spec Protocol, Alert Protocol, Handshake Protocol, Cryptographic	**8**

	Computations, Heartbeat Protocol, SSL/TLS Attacks, HTTPS – Connection Initiation, Connection Closure	
5	**Digital Signatures:** Digital Signatures – Properties, Attacks and Forgeries, Digital Signature Requirements, Direct Digital Signature, SCHNORR Digital Signature Scheme, NIST Digital Signature Algorithm. **IP Security:** IP Security Overview – Applications, Benefits, Routing Applications, IPsec Documents, IPsec Services, IP Security Policy – Security Associations and its Database, Security Policy Database, IP Traffic Processing, Encapsulating Security Payload – ESP Format, Encryption and Authentication Algorithms.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Cryptography and Network Security – Principles and Practice	William Stallings	7th Edition	Pearson	2017
Reference Text Book					
1	Network Security Essentials Applications and Standards	William Stallings	4th Edition	Pearson	2012
2	Network Security Private Communication in a Public world	Charlie Kaufman, Radia Perlman and Mike Speciner	Second	PHI	2013

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Cryptography I	Coursera	2024	https://www.coursera.org/learn/crypto
2.	Cryptography and System Security	Udemy	2024	https://www.coursera.org/specializations/agile-development

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VT

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Responsible and Explainable AI

Sem	**V**		
Course Code:	**23DS5PEREA**	**Total Contact Hours: 40**	
L-T-P:	**3-0-0**	**Total Credits:**	**3**

Unit No.	Topics	Hours
1	**Introduction to AI**: Introduction, Background of AI, Autonomy, Adaptability, Interaction, ISO/IEC 42001: A New Standard for Ethical and Responsible AI Management, Objective and Scope of the IT Act. **Taking Responsibility**: Introduction, Responsible research and innovation, The ART of AI, Design for values. **An Ethical Framework for a Good AI Society**: Opportunities, Risks, Principles and Recommendations, Establishing the rules for building trustworthy AI.	**8**
2	**Translating Principles into Practices of Digital Ethics**: five risks of being Unethical, The Ethics of Algorithms: Key problems and Solution, How to Design AI for Social Good: Seven Essential Factors. **How to design AI for Social good**: From What to How - An Initial Review of publicly available AI Ethics tools, Methods and Research to Translate principles into Practices. **Innovating with Confidence**: Embedding AI Governance and fairness in financial Services Risk management framework, What the near future of AI could be.	**8**
3	**Introduction:** Introduction to Explainable AI, Needs of Explainability Challenges in Explainability, Evaluating Explainability. Explainability Usage. **An Overview of Explainablity:** Interpretability and Explainability, Explainability Consumers, Types of Explanations, Themes Throughout Explainability. **Explainability for Tabular Data:** Permutation Feature Importance, Shapley Values, SHAP (SHapley Additive exPlanations), Explaining Tree-Based Models, Partial Dependence Plots and Related Plots.	**8**

4	**Explainability for Image Data:** Integrated Gradients (IG), XRAI, Grad-CAM, LIME, Guided Backpropagation and Guided Grad-CAM- Guided Backprop and DeConvNets, Guided Grad-CAM. **Explainability for Text Data:** Overview of Building Models with Text, LIME, Gradient x Input, Layer Integrated Gradients, Layer-Wise Relevance Propagation (LRP), Language Interpretability Tool.	**8**
5	**Advanced and Emerging Topics:** Alternative Explainability Techniques, Other Modalities, Evaluation of Explainability Techniques. **Interacting with Explainable AI:** Who Uses Explainability, How to effectively present explanations, common pitfalls in using explainability, Building with explainability in mind, AI regulations and explainability, what to look forward in explainable AI.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way	Virginia Dignum	First	Springer Nature	2019
2.	Ethics, governance and Policies in Artificial Intelligence	Luciano Floridi	First	Springer	2021
3.	Explainable AI for Practitioners	Michael Munn, David Pitman	First	O'Reilly	2022

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Responsible AI in the Enterprise	Adnan Masood, Heather Dawe	First	Packt	2023
2.	Interpretable Machine Learning	Christoph Molnar	First	Lulu	2019

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Responsible AI - Interdisciplinary perspectives	Silja Voeneky, Philipp Kellmeyer, Oliver Mueller, Wolfram Burgard,	First	Cambridge University Press	2022	https://doi.org/10.1017/9781009207898
2.	xxAI - Beyond Explainable AI	Andreas Holzinger · Randy Goebel	1st Edition	Springer	2020	https://link.springer.com/book/10.1007/978-3-031-04083-2

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Responsible AI in Generative AI era	Coursera	2024	https://www.coursera.org/learn/responsible-ai-in-generative-ai?action=enroll
2.	Responsible & Safe AI systems	NPTEL	2025	https://onlinecourses.nptel.ac.in/noc24_cs132/preview
3.	Explainable Artificial Intelligence (XAI) Concepts	Datacamp	2023	https://datacamp.com/courses/explainable-artificial-intelligence-xai- concepts

Mini Project – Mobile Application Development

Semester	**V**		
Course Code	**23DS5PWMAD**	**Total Contact Hours**	**48**
L-T-P	**0-0-2**	**Total Credits**	**2**

I. Cycle -1

Programs based on Android Components and Layouts:

- Overview of Android Architecture, Android Activity Life Cycle, Android Manifest File.
- Layout Manager: Linear Layouts, Relative Layouts and Constraint Layouts.
- Android Widgets: UI development in Android, Working with Button, TextView, EditText, AutoCompleteTextView, DatePicker, TimePicker, Toast, CustomToast, ToggleButton, Switch, Checkbox,Custom Checkbox, RadioButton, AlertDialog, ProgressBar.
- Spinner, drawing custom shapes on Canvas.
- Intents: Explicit and Implicit Intents.

II. Cycle - 2

Programs based on:

- RecyclerView.
- Android Animation.
- Android Menu: Options Menu, Context Menu, Popup Menu.
- Android Fragments.
- Android Services.

III. Cycle-3

- Programs based on Android Shared Preferences primitives.
- Programs based on SQLite/Room to store and fetch the data from the database application.
- Introduction to Networking with Android using HTTP/Retrofit/Volley.

IV. Projects on APP Development.

Text Book

SI No	Book Title	Authors	Edition	Publisher	Year
1	Android Programming with Kotlin for Beginners	John Horton	First	Packt	2019
2	Programming Android with Kotlin	Pierre-Olivier Laurence, Amanda Hinchman-Dominguez, Mike Dunn, G. Blake Meike	First	O'Reilly	2021

Reference Text Book

SI No	Book Title	Authors	Edition	Publisher	Year
1	Pro Android 5	Dave MacLean, Satya Komatineni ,Grant Allen	Fifth	Apress	2015
2	Jetpack Compose 1.2 Essentials	Neil Smyth	First	Payload Media	2022

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Android Development with Kotlin	Marcin Moskala, Igor Wojda	First	Packt	2017	https://www.shabakeh-mag.com/sites/default/files/files/attachment/1397/04/1530550032.pdf
2.	Learn Kotlin for Android Development	Peter Spath	First	Apress	2019	https://dl.ebooksworld.ir/motoman/Apress.Learn.Kotlin.for.Android.Development..www.EBooksWorld.ir.pdf

MOOC Course

Sl. No.	Course name	Offered By	Year	URL
1.	Android Basics with Compose	Developer. Android	2022	https://developer.android.com/courses/android-basics-compose/course
2.	Android app using Kotlin – IIT, Bombay	SWAYAM	2024	https://onlinecourses.swayam2.ac.in/aic20_sp02/preview

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Environmental Studies

Semester	**V**		
Course Code	**23DC5HSEVS**	**Total Contact Hours**	**15**
L-T-P	**1-0-0**	**Total Credits**	**1**

Unit No.	Topics	Hrs.
1	**Introduction to Environment:** Definition, About Earth i.e, Atmosphere, Hydrosphere, Lithosphere and Biosphere, Structure of Atmosphere, Internal structure of Earth, Ecology & Ecosystem, balanced ecosystem, types of ecosystems.	3
2	**Effect of Human activities on Environment:** i) Agriculture ii) Housing iii) Industries iv) Mining and v) Transportation activities. **Sustainability Standards:** ISO 14001, LEED, REACH, ISO 50001, UN's Sustainable Development Goals (SDGs).	3
3	**Natural Resources:** Definition, Water resources – its availability, quality, water borne & water induced diseases. Mineral resources, Forest resources, Energy resources – conventional & non - conventional energy resources, Hydroelectric, wind power, solar, Biogas. Fossil fuel-based energy resources- Coal, Oil & Gas, Nuclear power. Hydrogen as an alternate future source of energy.	3
4	**Environmental pollution:** Introduction and its types, Water pollution – definition, effects, control methods. Land pollution - definition, effects, Solid waste management. Noise pollution - definition, effects, control methods. **Current environmental issues & importance:** Population growth, effects & control, climatic changes, Global warming, Acid rain, ozone layer depletion & effects, Environmental protection, Role of government, legal aspects.	3
5	**Green Computing- Sustainable IT Practices and Metrics:** Introduction to Sustainable Information Systems, Environmental Impacts of IT- E-waste, Carbon footprint, Energy footprint, Water footprint. Green IT- Green Data Centers, Green Data Storage, Applying IT for Enhancing Environmental Sustainability, Green IT Standards and Eco-Labelling of IT.	3

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Environmental studies	Dr. Geetha Balakrishnan	Seventh	SUNSTAR	2016
2	Harnessing Green IT Principles and Practices	San Murugesan, G.R. Gangadharan	First	John Wiley & Sons	2016

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Environmental studies	Benny Joseph	Second	Tata McGraw-Hill	2019

E-Books				
Sl. No.	**Book Title**	**Publisher**	**Year**	**URL**
1.	Environmental studies	University Grants Commission (UGC)	2019	https://www.ugc.gov.in/oldpdf/modelcurriculum/env.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Environmental studies	Swayam	2019	https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
2	Sustainable Software Development	Microsoft	2022	https://learn.microsoft.com/en-us/training/modules/sustainable-software-engineering-overv

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VI SEMESTER

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Cloud Computing

Semester	**VI**		
Course Code	**23DS6PCCCT**	**Total Contact Hours**	**40**
L-T-P	**2-1-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction, Cloud Infrastructure:** Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing at Amazon, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems.	**8**
2	**Cloud Computing:** Application Paradigms: Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study: The Gre The Web application, Cloud for science and engineering, High performance computing on a cloud, Cloud computing forBiology research, Social computing, digital content and cloud computing.	**8**
3	**Cloud Resource Virtualization:** Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and paravirtualization, Hardware support for virtualization, Case Study: Xen a VMM based paravirtualization, Optimization of network virtualization, vBlades,Performance comparison of virtual machines, The dark side of virtualization, Exercisesand problems	**8**
4	**Cloud Resource Management and Scheduling:** Policies and mechanisms for resource management, Stability of a two level resource allocation architecture, Feedback controlbased on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility-based model for cloud-based Web services, **Resourcing bundling**: Combinatorial auctions for cloud resources, Schedulingalgorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling, Exercises and problems	**8**

5	**Cloud Security:** Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor, **Cloud Application Development:** Amazon web services: EC2 instances, Connectingclients to cloud instances through firewalls, Security rules for application and transport layer protocols in EC2, How to launch an EC2 Linux instance and connect to it, How to use S3 in java, Cloud-based simulation of a distributed trust algorithm, A trust management service, A cloud service for adaptive data streaming, Cloud basedoptimal FPGA synthesis. Exercises and problems.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Publisher	Year
1.	Cloud Computing: Theoryand Practice	Dan C Marinescu Elsevier	Morgan Kaufmann	2013
2.	Computing Principles andParadigms	RajkumarBuyya , James Broberg, Andrzej Goscinsk,	John Wiley & Sons	2014

Reference Text Book

Sl. No.	Book Title	Authors	Publisher	Year
1.	Cloud Computing Implementation, Management and Security	John W Rittinghouse, JamesF Ransome	CRC Press	2013

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Cloud Computing :Theory and Practice	Dan C Marinescu Elsevier	-	Morgan Kaufmann	2013	https://eclass.uoa.gr/modules/document/file.php/D416/CloudComputingTheoryAndPractice.pdf
2.	Computing Principles and Paradigms	RajkumarBuyya , James Broberg, Andrzej Goscinsk,	-	John Wiley& Sons	2014	https://dhoto.lecturer.pens.ac.id/lecture_notes/internet_of_things/CLOUD%20COMPUTING%20Principles%20and%20Paradigms.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Introduction to Cloud Computing	Coursera	2024	https://www.coursera.org/learn/introduction-to-cloud
2.	Cloud Computing Foundations	Coursera	2024	https://www.coursera.org/learn/cloud- computing-foundations-duke

Next Gen Databases

Semester	**VI**		
Course Code	**23DS6PCNGD**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	**Early Database Management Systems** - Database revolutions: First, second and Third generation - Big Data Revolution - Google: Pioneer of Big Data, Hadoop: Open-Source Google Stack. Introduction to Sharding - CAP Theorem	8
2	**Object Oriented Database:** Introduction, properties and applications. **PostgreSQL**, Relations, CRUD and Joins, starting with SQL, Working with tables, Join Reads, The outer limits, Fast Lookups with Indexing, Advanced queries, Code and Rules, Aggregate functions, Grouping, Window Functions, Transactions, Stored procedures, Pull the triggers, View, Full Text and Multidimensions, Fuzzy searching, PostgreSQL's Strengths and Weaknesses	8
3	**Document Database** : Introduction and its types. **Couch DB**, CRUD, Futon and cURL Redux, Getting Comfortable with Futon, Performing RESTful CRUD Operations with cURL, Creating a Document with POST, Updating a Document with PUT, Removing a Document with DELETE, Creating and Querying Views, Accessing Documents Through Views, Importing Data Into CouchDB Using Ruby, Creating Advanced Views with Reducers, CouchDB's Strengths and Weaknesses	8
4	**Graph Database :** Introduction and its architecture **Neo4J:** Graphs, Groovy, and CRUD, Neo4j's Web Interface, Neo4j via Gremlin, The Power of Pipes, Pipeline vs. Vertex, Schemaless Social, Domain-Specific Steps, Update, Delete, Done, REST, Indexes, Creating Nodes and Relationships Using REST, Indexing, Distributed High Availability, Transactions, Neo4J's Strengths and Weaknesses, NEo4J on CAP	8
5	**Key Value Database** : Introduction, features and advantages **Redis**: Data Structure Server Store, CRUD and Datatypes, Transactions, Complex Data Types, Expiry, Database Namespaces, Advanced Usage, Distribution, publish-subscribe , Redis Configuration, Master-Slave Replication, Data Dump, Redis Cluster, Bloom Filters , Redis's Strengths and Weaknesses **SSD & In-Memory Databases**—SAP HANA, Berkeley Analytics Data Stack and Spark.	8

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Next Generation Databases	Guy Harrison	First	Apress	2015
2	Seven Databases in Seven Weeks - A Guide to Modern Databases and the NoSQL Movement	Erick Redmond, Jim R Wilson	Second	Pragmatic Bookshelf	2018

Reference Text Book

No.	Book Title	Authors	Edition	Publisher	Year
1.	NoSQL for Dummies	Adam Fowler	First Edition	John Wiley & Sons	2015
2	Fundamentals of Database Systems	Ramez Elmasri and Shamkant Navathe	Sixth Edition	Pearson	2011

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Seven Databases in Seven Weeks	Eric Redmond , Jim R. Wilson	First	O′Reilly	2012	https://lib.fbtuit.uz/assets/files/8.-EricRedmondJimRWilson-SevenDatabasesinSevenWeeks-EN.pdf
2.	NoSQL for Mere Mortals	Dan Sullivan	Second	Addison-Wesley Professional	2015	https://datubaze.wordpress.com/ wp-content/uploads/2021/03/nosql- for-mere-mortals.pdf

MOOC Courses

Sl. No.	Course name	By	Year	UR L
1	Introduction to NoSQL Databases	Course era	2024	https://www.coursera.org/learn/introduction-to-nosql-databases
2	Introduction to Graph Databases using Neo4J	Udemy	2024	https://www.udemy.com/course/introduction-to-graph- databases-using-neo4j

Laboratory Plan

Sl.no	Program Details
1	PostgreSQL Query Questions - Hospital Management System Create a database for a hospital management system with tables: Patients (PatientID, Name, Age, Gender, AdmissionDate) and Doctors (DoctorID, Name, Specialization, Experience). a. Fetch Patient Details: b. List Patients Admitted on a Specific Date ('2024-06-15'): c. List Patients by Age Group: d. Update Patient Details (Change Name for PatientID = 1): e. List Doctors by Specialization ('Cardiology'): f. Count Patients per Doctor: g. Calculate Average Experience of Doctors:
2	CRUD operations in CouchDB Student Database Create a student database with the fields: (SRN, Sname, Degree, Sem, CGPA) a. Display all the documents b. Display all the students in BCA c. Display all the students in ascending order d. Display first 5 students e. Display students 5,6,7 f. List the degree of student "Rahul" g. Display students details of 5,6,7 in descending order of percentage h. Display all the BCA students with CGPA greater than 6, but less than 7.5
3	CRUD operations in CouchDB Library Database Create a library database with the fields: (ISBN, Title, Author, Genre, PublicationYear, CopiesAvailable, Rating). a. Display all the documents in the library database. b. Display all the books in the genre "Fiction". c. Display all books sorted by their Title in alphabetical order. d. Display the first 3 books. e. Display books 4, 5, and 6. f. List the Author of the book titled "The Great Gatsby".
4	CRUD Operations in Neo4j - Social Network Database Create a social network database with nodes: User (UserID, Username) and relationships: (FOLLOWS). a. Write a query to display all users. b. Write a query to display users followed by a specific user with Username "Jane". c. Write a query to display all users in ascending order by Username. d. Write a query to find users who follow both "Alice" and "Bob". e. Write a query to find users with the most number of followers. f. Display first 5 users:

5	CRUD Operations in Neo4j - Movie Recommendation Database: where we have nodes: Movie (MovieID, Title) and User (UserID, Username), and relationships: (LIKES) indicating a user likes a specific movie. a. Write a query to display all movies liked by a specific user with Username "John". b. Write a query to find all users who like the movie titled "Inception". c. Write a query to display all movies in ascending order by Title. d. Write a query to find users who like both "The Matrix" and "Inception". e. Write a query to find the most liked movie. f. Write a query to display the top 5 users who like the most movies.
6	Redis Query Questions - Product Catalog Scenario Create a product catalog database with products having attributes: (ProductID, Name, Category, Price) a. Insert products into Redis with keys like product:{ProductID} and values as JSON objects containing Name, Category, and Price. b. Retrieve details of a specific product by ProductID. c. Fetch all products belonging to a specific category.(Electronics) d. List Products in a Price Range (500 - 1000): e. Update Product Price: Delete a Product:
7	Consider an employee management system where each employee has attributes: (EmployeeID, Name, Department, Position, Salary). a. Insert Employee Details into Redis: Insert employee records into Redis with keys like employee:{EmployeeID} and values as JSON objects containing Name, Department, Position, and Salary. b. Retrieve All Employees in a Specific Department (e.g., "HR"): Write a Redis query to fetch all employees belonging to a specific department, such as "HR." c. List Employees with a Salary Above a Certain Amount (e.g., $50,000): Write a Redis query to list all employees whose salaries are above a certain threshold (e.g., $50,000). d. Update an Employee's Position: Write a Redis query to update the position of a specific employee identified by their EmployeeID.

Natural Language Processing and Generative AI

Semester	**VI**		
Course Code	**23DS6PCNLP**	**Total Contact Hours**	**40**
L-T-P	**3-0-1**	**Total Credits**	**4**

Unit No.	Topics	Hours
1	**Introduction:** What is Natural Language Processing (NLP), Origins of NLP, Phases of NLP, Ambiguities in NLP. Why is NLP hard? **Text Processing:** Regular Expressions, Word normalisation - Lemmatization, Stemming, Tokenizations - Word Tokenization, Character Tokenization, Byte Pair Encoding, Word piece	**8**
2	**Sequence Labeling for Parts of Speech and Named Entities**: EnglishWord Classes, Part-of-Speech Tagging, Named Entities and NamedEntity Tagging, HMM Part-of-Speech Tagging **Vector Semantics and Embeddings:** Lexical Semantics, Vector Semantics, Words and Vectors, Cosine for measuring similarity, TF- IDF: Weighing terms in the vector, Pointwise Mutual Information (PMI),Word embeddings. **Parsing:** Constituency Parsing, Dependency Parsing: Transition-Based Dependency Parsing	**8**
3	**Language Modeling:** Types of language models, Statistical Language Models. **The Transformer:** A Self-Attention Network, Multihead Attention, Transformer Blocks, The Residual Stream view of the TransformerBlock, The input: embeddings for token and position, The Language Modeling Head, Large Language Models with Transformers, Large Language Models: Generation by Sampling, Large Language Models: Training Transformers, Introduction to Pre-trained Language Models, Masked Language Model - BERT. Fine-tuning LLMs for specific tasks	**8**
4	**Generative Modeling:** What is Generative Modeling? ProbabilisticGenerative Models **Variational Autoencoders:** Building a VAE, Using VAE to generatefaces. Transformer based Generative Models (GPT and T5), Potential Harmsfrom Language Models.	**8**
5	**Teaching Machines to Paint, Write and Compose:** Creating CycleGAN to paint, LSTM Network to generate text, Music generating RNN	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Speech and LanguageProcessing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition	James H Martin	Third	Pearson EducationIndia	2024
2.	Generative DeepLearning	David Foster	Second	O'Reilly	2023

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Natural Language Processing and Information Retrieval	Tanveer Siddiqui, U.S. Tiwary	First	Oxford University Press	2008
2.	Natural Language Understanding	James Allen	Second	Benjamin /Cummings publishing company	1995
3.	Generative AI withPython and Tensorflow2	Raghav Bali	First	Packt	2021

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Natural Language Processing Recipes	Akshay Kulkarni Adarsha Shivananda	First	APRESS	2019	https://www.aitskadapa.ac.in/e-books/CSE/DEEP%20LEARNING/Natural%20Language%20Processing%20Recipes_%20Unlocking%20Text%20Data%20with%20Machine%20Learning%20and%20Deep%20Learning%20using%20Python%20(%20PDFDrive%20).pdf
2.	HANDBOOK OF NATURAL LANGUAGE PROCESSING	NITIN INDURKHY A FRED J. DAMERAU	Second	CRC Press	2010	https://karczmarczuk.users.greyc.fr/TEACH/TAL/Doc/Handbook%20Of%20Natural%20Language%20Processing,%20Second%20Edition%20Chapman%20&%20Hall%20Crc%20Machine%20Learnin

						g%20&%20Pattern%20Recognition%202010.pdf
3	Natural Language Processing with Python	Steven Bird, Ewan Klein, and Edward Loper	First	O'Reilly	2011	https://www.nltk.org/book/

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Natural Language Processing	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc19_cs56/preview
2.	Natural Language Processing	Coursera	2024	https://www.coursera.org/specializations/natural-language-processing
3	Generative AI Fundamentals Specialization	Coursera	2024	https://www.coursera.org/specializations/generative-ai-for-everyone

Laboratory Plan

Sl. No.	Lab Program
1	Write a Python program using nltk to perform tokenization, eliminate stopwords, perform stemming and lemmatization
2	Implement traditional machine learning algorithms to perform Parts of Speech tagging and Named entity recognition.
3	Write a python program to find Term Frequency and Inverse Document Frequency (TF-IDF).

4	Write a python program to find all unigrams, bigrams and trigrams present in the given corpus.
5	Build traditional machine learning models for sentiment analysis. Compare the performance with a transformer model fine-tuned on a dataset like IMDb or Twitter
6	Implement a VAE on the MNIST dataset and generate new images by sampling from the latent space.
7	Fine-tune a pre-trained language model (e.g., GPT, BERT) using transfer learning techniques on a domain-specific dataset and evaluate its performance for text generation tasks.
8	Implement a Long Short-Term Memory (LSTM) model on a dataset of text sequences and generate new text samples.

Software Engineering & Agile Methodologies

Semester	**VI**		
Course Code	**23DC6PCSEA**	**Total Contact Hours**	**25**
L-T-P	**2-0-0**	**Total Credits**	**2**

Unit No.	Topics	Hours
1	**Introduction** - Software metrics, Overview of Software Development Projects, Emergence of Software Engineering **Software Life Cycle Models** - Basic Concepts, Waterfall Model and its Extensions, Rapid Application Development, Agile Development Models: Essential Ideas Behind Agile Models, Agile vs. Other Models, Spiral Model, Comparison of Different Life Cycle Models	5
2	**Requirements Analysis and Specification** - Requirements Gatheringand Analysis, Software Requirements Specification (SRS) **Case Study - IEEE SRS** **Software Design** - Overview of the Design Process, Characteristics of Good Software Design: Cohesion and Coupling, Approaches to Software Design **Function-Oriented Software Design** - Overview of SA/SD Methodology, Structured Analysis: Developing the DFD Model of a System, Structured Design and Detailed Design	5
3	**Software Project Management** - Project Planning, Metrics for ProjectSize Estimation, Project Estimation Techniques: Empirical Estimation Techniques, COCOMO (A Heuristic Estimation Technique), Scheduling and Team Structures	5
4	**Understanding Agile** - What is Agile?, The Agile Manifesto and Principles, Why Agile Works Better than Traditional Models **Kanban and Lean** - Introduction to Kanban Method, Lean Principlesin Agile **Jira Fundamentals** - Overview of Jira: Project Boards, Enrich Issues, Kanban Boards, Scrum Projects, Quick Search and Basic Search, JQL(Jira Query Language), Filters, Epics, Dashboards	5
5	**Understanding XP** - The XP Life cycle, The XP Team, XP Concepts, **Software Configuration Management** - Configuration Management Process, Version Control Systems, Change Management and Control	5

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Fundamentals of SoftwareEngineering	Rajib Mall	Fifth	PHI Learning	2018
2	Agile Foundations: Principles, Practices, andFrameworks	Peter Measey	Fourth	BCS Learning & DevelopmentLimited	2015
3	Atlassian Jira Service DeskA Complete Guide	Gerardus Blokdyk	First	S Viswanathan Printers and Publishing Private Limited	2020

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Essential Scrum: A PracticalGuide to the Most Popular Agile Process	Kenneth Rubin	First	Pearson	2017
2.	The Art of Agile Development	James Shore &Shane Warden	Second	O'Reily	2007

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Agile Scrum Tutorial: A Step-by-Step Guide for Beginners	Simplilearn	2024	https://www.simplilearn.com/tutorials/agile-scrum-tutorial
2.	Agile Development Specialization	Coursera	2024	https://www.coursera.org/specializations/agile-development

Optimization Techniques for Data Science

Semester	**VI**		
Course Code	**23DS6PEOTD**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to Optimization:** Definition, Need for optimization algorithms, Optimization Process, Basic Optimization Problem, Constraints, Handling huge matrices in Python, Mathematical Formulation, Example: A Transportation Problem **One-Dimensional Search Methods:** Golden Section Search, Fibonacci Search	8
2	**Approaches of optimization:** Continuous versus Discrete Optimization, Constrained and Unconstrained Optimization, Global and Local Optimization, Stochastic and Deterministic Optimization Convexity **Convex optimization:** Convex Functions, Convex Optimization Problems	8
3	**Gradient Descent:** Variants of Gradient Descent: Projected, Stochastic, Proximal, Accelerated, Coordinate Descent, Cauchy's steepest descent method, Newton's Method – Optimization in practice, conjugate gradient method **Function optimization:** interpolation, extrapolation	8
4	**Optimizing Model Performance Using Optimization Algorithms:** Batch Normalization, Grid Search, RMSProp optimizer Random Search, derivative-free optimization algorithms **Hyperparameter Tuning:** Evolution algorithms, Bayesian optimization	8
5	**Particle Swarm Optimization:** Particle Swarm Optimization (PSO) Algorithm, PSO System Parameters, Particle Swarm Optimization versus Evolutionary Computing. **Ant colony Optimization:** The Invisible Manager, The Pheromone, Ant Colonies and Optimization, Ant Colonies and Clustering, Applications	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Algorithms for Optimization	Mykel J. KochenderferTim A. Wheeler	-	MIT Press Cambridge	2019
2	Numerical Optimization	Jorge Nocedal Stephen J.Wright	Second	Springer	2006
Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Computational Intelligence An Introduction	Andries P. Engelbrecht	-	John Wiley & Sons, Ltd	2002
2.	An Introduction to Optimization	Edwin K. P. Chong, Stanislaw H. Zak	Second	John Wiley & Sons, Ltd	2004

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Optimization Algorithms for Machine Learning Models	Lovekush Chaurasia, Amol Borse	-	Global Logic	2020	https://www.globallogic.com/wp-content/uploads/2020/02/Optimization-Algorithms-for-Machine-Learning-1.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Optimization for Machine Learning	NPTEL	2024	https://nptel.ac.in/courses/106106245

Computer Vision

Semester	**VI**		
Course Code	**23DS6PECPV**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to Computer Vision:** Overview of Computer Vision, Brief History, Applications of Computer Vision **Image Formation:** Introduction to Basic 2D, 3D Primitives (points, lines,and planes),2D and 3D computer vision transformations, Overview of 3Drotation representations, 3D to 2D projections, Photometric image formation, A Simple Model of Digital Camera Image Processing or Image Formation Pipeline in Digital Cameras.	**8**
2	**Image Processing:** Pixel Transform, Color Transform, Separable filteringand Examples of Linear Filtering. Fourier Transforms- Two dimensional Fourier Transforms, Application: Sharpening, blur, and noise removal. Multi-Resolution Image Processing: Pyramids, Decimation, decomposition of an image using wavelet and Application: Image blending. Geometric Transformations: Forward Warping and Basic 2D Geometric Transformations, Inverse Warping and Resampling in Geometric Transformations, Image Morphing.	**8**
3	**Model fitting and Optimization:** Scattered data interpolation, Radial basis functions, Overfitting and underfitting, and Robust data fitting.Variational methods and regularization, Discrete energy minimization, Total variation, and Bilateral solver. Markov random fields, Conditional random fields, and Application: Interactive segmentation **Recognition:** Instance recognition, Image classification (feature-based methods and deep networks), and Object detection (face detection and pedestrian detection).	**8**
4	**Feature detection and matching:** Points and patches-Feature detectors, descriptors and matching; Edges and contours detection, Contour tracking Lines- Snakes and scissors, level sets and vanishing points Segmentation **Image alignment and stitchin**g: Pairwise alignment using least squares, Image stitching- parametric motion models, rotational panoramas, Global alignment- Bundle adjustment, Parallax removal.	**8**

5	**Segmentation using the clustering method:** Human vision: Grouping and Gestalt, Applications: Shot Boundary Detection, Background Subtraction and Skin Finding-Background Subtraction, Shot Boundary Detection, Finding Skin Using Image Color; Image Segmentation by Clustering Pixels- Simple Clustering Methods, Segmentation Using Simple Clustering Methods, Clustering and Segmentation by K-means; Segmentation by Graph-Theoretic Clustering- Basic Graphs, The OverallApproach, Affinity Measures, Eigenvectors and Segmentation, Normalized Cuts. **Motion estimation:** Translational alignment, Parametric motion, Opticalflow, Layered motion	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Computer Vision: Algorithms and Applications	Richard Szeliski	Second	Springer	2021
2.	Computer Vision: A Modern Approach	David Forsyth and Jean Ponce	Second	Pearson	2015

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Multiple View Geometry in Computer Vision	Richard Hartley and Andrew Zisserman	Second	Cambridge UniversityPress	2003
2.	Modern Computer Vision with PyTorch	V Kishore Ayyadevara, Yeshwanth Reddy	Second	Packt	2024

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Algorithms for Image Processingand Computer Vision	J R Parker	Second	Wiley	2011	http://kiwi.bridgeport.edu/cpeg585/Algorithms_for_Image_Processing_and_Computer_Vision.pdf
2.	Programming Computer Visionwith Python	Jan Erik Solem	-	Creative commons	2012	http://programmingcomputervision.com/downloads/ProgrammingComputerVision_CCdraft.pdf

MOOC Course				
Sl. No.	**Course name**	**Course OfferedBy**	**Year**	**URL**
1.	Computer Vision and Image Processing - Fundamentals and Applications	SWAYAM	2024	https://onlinecourses.nptel.ac.in/noc23_ee39/preview
2.	Introduction to Computer Vision and Image Processing	COURSERA	2024	https://www.coursera.org/learn/introduction-computer-vision-watson-opencv

Design Patterns

Sem	**VI**		
Course Code:	**23DS6PEDPT**	**Total Contact Hours: 40 hours**	
L-T-P:	**3-0-0**	**Total Credits:**	**3**

Unit No.	Topics	Hours
1	**Introduction to UML:** The Essential Principles of Software Development, Importance of Modeling, Principles of Modeling, Object-Oriented Modeling, Overview of UML, A Conceptual Model of the UML, UML Architecture Overview, Software Development Life Cycle Overview. **Key UML Diagrams**: Structural Modeling- Class Diagrams, Object Diagrams Behavioral Modeling- Use Case Diagrams, Interaction Diagrams, State Machines Diagram. Architectural Modeling- Component Diagrams, Deployment Diagrams. Overview of UML tools and their applications.	**8**
2	**Introduction to Design Patterns:** What is a Design Pattern, Design Patterns in Smalltalk MVC, Describing design patterns, the catalog of design pattern, Organizing the catalog, How design patterns solve design problems, How to select a design pattern, How to use a design pattern.	**8**
3	**A Case Study:** Designing a Document Editor- Design Problems, Document Structure, Formatting, Embellishing the User Interface, and Supporting Multiple Look – and - Feel Standards, Supporting Multiple Window Systems, User Operations Spelling Checking and Hyphenation. **Creational Patterns:** Overview, Types of Creational Patterns with its Applicability, Benefits, and Constraints. **Case Studies:** Implementing the Singleton Pattern for Ensuring Unique Object Instances, Applying the Builder Pattern for Flexible RTF Document Conversion, Using the Factory Method Pattern for Document Creation in Frameworks (with sample code implementation).	**8**

4	**Structural Patterns:** Overview, Types of Structural Patterns with its Applicability, Benefits, and Constraints. **Case Studies:** Integrating Incompatible Interfaces Using the Adapter Pattern, Decoupling Abstraction and Implementation with the Bridge Pattern, Simplifying Complex Diagram Creation with the Composite Pattern, Implementing the Decorator Pattern for Dynamic Object Enhancement, Using the Facade Pattern to Simplify Subsystem Interfaces (with sample code implementation).	**8**
5	**Behavioral Patterns:** Overview, Types of Behavioral Patterns with its Applicability, Benefits, and Constraints. **Case Studies:** Enhancing Request Management and Decoupling with the Command Pattern, Managing Consistency and Notification with the Observer Pattern, Applying the Strategy Pattern for Flexible Linebreaking Algorithms, Using the Template Method Pattern to Standardize Document Processing (with sample code implementation).	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	The unified modeling language user guide	Grady Booch, James Rumbaugh and Ivar Jacobson	Second	Pearson Education	2017
2.	Design Patterns: Elements of Reusable Object-Oriented Software	Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides	First	Pearson Education	2016

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Object-Oriented Analysis, Design and Implementation	Brahma Dathan, Sarnath Ramnath	Second	Springer	2015
2.	Head First Design Patterns	Eric Freeman, Bert Bates, Kathy Sierra, and Elisabeth Robson	Second	O'Reilly	2020

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Object-Oriented Analysis, Design and Implementation	Brahma Dathan, Sarnath Ramnath	Second	Springer	2015	https://warin.ca/ressources/books/2015_Book_Object-OrientedAnalysisDesignA.pdf
2.	Head First Design Patterns	Eric Freeman, Bert Bates, Kathy Sierra, and Elisabeth Robson	Second	O'Reilly	2020	https://learning.oreilly.com/library/view/head-first-design/9781492077992/

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Object Oriented System Development using UML, Java and Patterns	SWAYAM	2020	https://onlinecourses.nptel.ac.in/noc20_cs84/preview
2.	Design Patterns	Coursera	2018	https://www.coursera.org/learn/design-patterns

Advanced Data Structures and Algorithms

Semester	**VI**		
Course Code	**23DS6PEADA**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Balanced Search Trees:** B-Trees **Tree structures for Set of Intervals:** Interval trees and Segment trees. **Data Structures for String:** Tries, Suffix trees.	**8**
2	**Advanced Lists:** Memory efficient doubly linked list, XOR Linked List, Skip Lists, Self-Organizing List , Unrolled Linked List. **Heaps:** Leftist Heap, Binomial heaps.	**8**
3	**Hashing:** Rehashing, Dynamic Hashing, Direct-address tables, Hash tables, Hash functions, Open addressing and separate chaining. **Dynamic Programming:** Rod cutting, Matrix-chain multiplication, Longest common subsequence, Multistage graph, Edit Distance, Egg Dropping Puzzle.	**8**
4	**Graph Algorithms:** Flow networks, The Ford-Fulkerson method, Bellman - Ford Algorithm, Maximum bipartite matching. **Multithreaded Algorithms:** The basics of dynamic multithreading, Multithreaded matrix multiplication, Multithreaded merge sort.	**8**
5	**String matching:** The Rabin-Karp algorithm, String matching with finite automata, Knuth-Morris-Pratt algorithm. **Number -Theoretic Algorithms:** GCD, The Chinese remainder theorem.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Advanced Data Structures	Peter Brass	First	Cambridge universityPress	2019
2.	Introduction toAlgorithms	Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein	Fourth	The MIT Press	2022

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Data Structures and Algorithms Analysis in C++	Mark Allen Weiss	Fourth Edition	Pearson	2014
2.	Algorithms	Jeff Erickson	First Edition	Cambridge University Press	2019

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Data Structures and Algorithms	John Bullinaria	-	-	2019	https://www.cs.bham.ac.uk/~jxb/DSA/dsa.pdf
2.	Introduction to Algorithms	T. H Cormen, C. E. Leiserson and R. L. Rivest	Fourth Edition	The MIT Press	2022	https://dl.ebooksworld.ir/books/Introduction.to.Algorithms.4th.Leiserson.Stein.Rivest.Cormen.MIT.Press.9780262046305.EBooksWorld.ir.pdf

MOOC Course

Sl. No.	Course name	Course Offered By	Year	URL
1.	Advanced Data Structures in Java	Coursera	2019	https://www.coursera.org/learn/advanced-datastructures
2.	Data Structures and Algorithms in Java	NPTEL	2023	https://onlinecourses.nptel.ac.in/noc23_cs85/preview

Database Management Systems

Semester	**VI**		
Course Code	**23DS6OEDBM**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to Database Systems:** Introduction, An Example, Characteristics of Database approach, Advantages of using DBMS approach, when not to use a DBMS. **Database System Concepts and Architecture:** Data models, Schemas and instances, Three schema architecture. **Basic SQL**- SQL Data Definition and Data Types, Specifying Constraints in SQL, Basic Retrieval Queries in SQL, INSERT, DELETE and UPDATE Statements in SQL, Additional Features of SQL, More Complex SQL Retrieval Queries, Views, Schema Change Statements in SQL.	8
2	**Entity-Relationship Model-** Entity Types, Entity Sets, Attributes and Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, ER Diagrams, A Sample Database Application, Relationship Types of Degree Higher than Two. Relational Database Design Using ER-to Relational Mapping. **Relational Databases-** Relational Model Concepts, Relational Model Constraints and Relational Database Schemas, Update Operations, Transactions and Dealing with Constraint.	8
3	**The Relational Algebra-** Unary Relational Operations**:** SELECT, PROJECT, Relational Algebra Operations from Set Theory, Binary Relational Operations-JOIN, DIVISION, Additional Relational Operations, Examples of Queries in Relational Algebra. **Normalization for Relational Databases-** Informal Design Guidelines for Relation Schemas, Functional Dependencies, Normal Forms Based on Primary Keys, General Definitions of Second and Third Normal Forms, Boyce-Codd Normal Form.	8

4	**Transaction Processing Concepts:** Introduction to Transaction Processing, Transaction and System Concepts, Desirable Properties of Transactions, Characterizing Schedules Based on Recoverability, Characterizing Schedules Based on Serializability, Transaction Support in SQL, Two-Phase Locking Techniques for Concurrency Control.	8
5	**NoSQL:** An overview of NoSQL, Characteristics of NoSQL, NoSQL storage types, Writing queries - Queries for a Single Entity (Simple Result & Aggregate). **Storage Systems:** Overview of Physical Storage Media, Magnetic Disks, RAID, Optimization of Disk-Block Access, Database Backup and Recovery from Catastrophic Failures	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Fundamentals of Database Systems	Elmasri and Navathe	7th Edition	Pearson	2016
2.	Getting Started with NoSQL	Gaurav Vaish	1st	Packt	2013
3.	Database System Concepts	Silberschatz, H Korth and S Sudarshan	7th Edition	McGrawHill	2019

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Database Management Systems	Ramakrishnan and Gehrke	3rd Edition	McGrawHill	2014
2.	Database Systems: Design, Implementation, and Management	Peter Rob and Carlos Coronel	8th Edition	CENGAGE Learning	2009

E-Book

Sl.No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	An Introduction to Relational Database	Hugh Darwen	3rd	Ventus Publishing Aps	2012	https://www.e-booksdirectory.com/details.php?ebook=3093
2	Database System The complete book	Hector GarciaMolina, JeffreyD. Ullman, Jennifer widom	2nd	Pearson Education	2009	https://people.inf.elte.hu/kiss/DB/ullman_the_complete_book.pdf

MOOC Course

Sl. No.	Course name	Course offered by	Year	URL
1.	Database Management Systems	SWAYAM	2023	https://onlinecourses.swayam2.ac.in/cec23_cs10/preview
2.	Database Management Essentials	Coursera	2023	https://www.coursera.org/learn/database-management

Project work – Phase I

Semester	**VI**		
Course Code	**23DS6PWPP1**	**Total Contact Hours**	**4 hours/Week**
L-T-P	**0-0-2**	**Total Credits**	**2**

The Project work is a comprehensive, two-semester course designed to enable students to apply their technical knowledge to solve real-world problems. The project carries a total of 9 credits, with 2 credits for Phase 1 and 7 credits for Phase 2. It should be undertaken in teams of up to three students under the supervision of a faculty guide.

During Project Phase-1, the emphasis is on identifying a data-driven problem of societal, industrial, or academic relevance, followed by initial exploration and modeling. Students are expected to conduct a thorough literature survey, review recent research and tools, and finalize a feasible project scope. They must acquire or generate relevant datasets, perform data cleaning and exploratory data analysis (EDA), and engineer meaningful features. Baseline models should be implemented with initial performance analysis. The deliverables for this phase include a concise technical report formatted in LaTeX and a project presentation.

Scheme of Evaluation

The continuous Evaluation of Project Phase-1 involves three review stages each assessed using well defined rubrics.

CIE and SEE Marks Distribution			
	Review-1	**Review-2**	**Review-3**
Evaluation By	Project Guide	Internal Committee	Project Guide and Industry Expert
Max Marks	30	30	50
Reduced CIE	10	10	30
Total CIE	**50 Marks**		
SEE	**50 Marks**		

Sustainable and Low-Resource AI

Semester	**VI**		
Course Code	**23DS6AESAI**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Unit no.	Lab Excercises	Hours
1	**Topic and objective:** Introduction to Open LLMs & LM Studio / Ollama Prompt Engineering 101 **Activities:** Install LM Studio / Ollama, download a model (e.g., Mistral or LLaMA 3), run basic prompts. Experiment with prompt formats (zero-shot, few-shot, instruction prompts) **Deliverables:** Students run their first local LLM and understand how prompt structure affects output	**2**
2	**Topic:** Sustainable AI **Activities:** Compare local vs cloud-based LLM setups (e.g., LM Studio vs ChatGPT API). Discuss trade-offs in compute, privacy, energy, and accessibility. Explore quantifiable factors like model size, RAM/VRAM usage, CPU/GPU temperature. Read case studies (e.g., TinyML, edge AI) and relate them to local LLM use. **Deliverables:** Understand how local, open-source LLMs promote sustainability, optimize resource use, balance performance trade-offs, and support ethical, decentralized AI adoption.	**2**
3	**Topic:** Text Analytics with LLMs **Activities:** Feed unstructured data (CSV/Text), summarize, extract keywords or topics. **Deliverables:** Use LLMs for quick NLP tasks.	**2**
4	**Topic:** Data Exploration via Prompting **Activities:** Use small tabular datasets (CSV/Excel), ask LLMs to interpret simple datasets (mean, median, outliers, trends). **Deliverables:** Generate insights from raw data.	**2**
5	**Topic:** Conversational Data Exploration via Prompting and Local coding models for housekeeping. **Activities:** Prompt LLMs to describe data (columns, types, missing values).	**2**

	Install and use local code LLMs (e.g., Code LLaMA, StarCoder). Prompt to write/rewrite Python scripts for file cleanup, directory operations, and data loading. **Deliverables:** Learn to frame exploratory questions. Use LLMs as a data interpreter.Use LLMs to automate repetitive task. Experience practical utilities beyond text generation.	
6	**Topic:** LLM-Assisted Code Generation **Activities:** Prompt for code to clean, transform, and visualize data **Deliverables:** Use LLM to scaffold Pandas/Matplotlib code	**2**
7	**Topic:** Debugging and Code Explanation with LLMs **Activities:** Provide buggy code to LLM and prompt for fixes. Ask LLM to explain logic line-by-line. Compare its fix to manual debugging. **Deliverables:** Develop debugging support skills. Evaluate the trustworthiness of LLM-generated code explanations.	**2**
8	**Topic:** Build a Local EDA Assistant **Activities:** Develop a repeatable prompt or chain of prompts for dataset analysis **Deliverables:** Automate data profiling using LLM	**2**
9	**Topic:** API Integration (Optional Advanced) **Activities:** Use LM Studio's API with Python (if available on their system) **Deliverables:** Build an offline chatbot/notebook integration	**2**
10	**Topic:** Model Evaluation & Limitations **Activities:** Test how model handles ambiguity or bias **Deliverables:** Develop critical thinking about LLM use	**2**
11	**Topic:** Mini Project Planning **Activities:** Discuss project ideas in small groups and share problem statements, expected LLM usage, datasets/tools. **Deliverables:** Develop feasible project ideas aligned with tools and timelines, and refine them through feedback.	**2**
12	**Topic:** Mini Project Implementation & Showcase **Activities:** Students implement and demo their project (solo or in pairs)	**2**

	Deliverables: Build and showcase functional, explainable AI solutions using local LLMs.	

Prescribed Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1.	Natural Language Processing with Transformers	Lewis Tunstall, Leandro von Werra, Thomas Wolf	1st	O'Reilly Media	2022
2.	Hands-On Large Language Models: Language Understanding and Generation	Jay Alammar, Maarten Grootendorst	1st	O'Reilly Media	2024

Reference Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1.	Build a Large Language Model from Scratch	Sebastian Raschka	1st	Manning Pubns Co	2024
2.	AI for Humanity: Building a Sustainable AI for the Future	Andeed Ma, Ph.D. Ong, James, Siok Siok Tan	1st	John Wiley & Sons Inc	2024
3.	Sustainable Ai: Tools for Moving Towards Green Ai	Raghavendra Selvan	1st	Oreilly & Associates Inc	2025

E-book

SI No	Title	Authors	Edition	Publisher	Year	URL
1	Build a Large Language Model from Scratch	Sebastian Raschka	1st	Manning Pubns Co	2024	https://github.com/ZengWeiTHU/eBook/blob/main/LLM/Build-a-Large-Language-Model-From-Scratch.pdf

MOOC Course/ Online resources				
SI No	**Course Name**	**Offered By**	**Year**	**URL**
1	Generative AI with Large Language Models	Coursera	2025	https://www.coursera.org/learn/generative-ai-with-llms
2	Tiny Machine Learning (TinyML)	edX	2025	https://www.edx.org/certificates/professional-certificate/harvardx-tiny-machine-learning
3	LLM course	Huggingface	2022	https://huggingface.co/learn/llm-course/chapter1/1

Software Testing

Semester	**VI**		
Course Code	**23DS6AESWT**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Sl. No	Lab Exercise	Hours
1	**Topic:** Introduction to Software Testing **Activities:** Manually test a simple program (e.g., login or calculator). Document valid/invalid inputs and outputs. Write 3 test cases and 1 bug report. **Deliverables:** Test case table and bug report	**2**
2	**Topic:** Unit Testing with JUnit or PyTest **Activities:** Choose a programming language: Java (JUnit) or Python (PyTest). Write test functions for at least 3 functions. Execute tests and interpret results. **Deliverables:** Source code, test file and screenshot of successful test run	**2**
3	**Topic:** Test Case Design Techniques **Activities:** Write test cases for a grading system. Identify equivalence classes. Perform boundary value analysis. **Deliverables:** 6 designed test cases and classification table	**2**
4	**Topic:** Code Coverage and Test Sufficiency **Activities:** Use coverage.py (Python) or JaCoCo (Java). Write test cases for a program with branching logic. Generate and analyze coverage report. **Deliverables:** Code, tests, and coverage report	**2**
5	**Topic:** Integration Testing with Mocks and Stubs **Activities:** Create 2 interdependent modules. Replace one with a mock/stub. Test the interaction. **Deliverables:** Test code using mock/stub and summary of results	**2**
6	**Topic:** Test-Driven Development (TDD) **Activities:** Define 3 test cases before writing the code. Write minimal code to pass tests. Refactor and optimize code. **Deliverables:** Test-first implementation and Git commit log or journal	**2**
7	**Topic:** System Testing **Activities:**	**2**

	Use a sample project (To-Do App, Login App). Write and execute end-to-end test cases. **Deliverables:** Test plan and log and test case results	
8	**Topic:** Regression Testing **Activities:** Simulate a bug, fix it. Re-run the test suite. Document test results pre- and post-fix. **Deliverables:** Pre- and post-fix test outputs and reflection write-up	**2**
9	**Topic:** Automated UI Testing (Selenium) **Activities:** Write a script to test a web form. Run test in Chrome/Firefox using Selenium. **Deliverables:** Script file and screenshot of automation output	**2**
10	**Topic:** Performance Testing using JMeter or Locust **Activities:** Install and configure JMeter or Locust. Simulate multiple user interactions. Generate and interpret performance reports. **Deliverables:** Load test scripts, report snapshots	**2**
11	**Topic:** Static Code Analysis and Security Testing **Activities:** Use static analysis tools like SonarQube or pylint. Run scans and review code smells or issues. Introduce simple OWASP top 10 security issues. **Deliverables:** Analysis reports, summary of findings	**2**
12	**Topic:** Existing Project Demo + Debugging Reflection **Activities:** Select a project with testable features. Create test plan, test cases, execute, and evaluate. Present in lab. **Deliverables:** Mini project test suite, bug report summary, and reflection report	**2**

Prescribed Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Software Testing,	Paul Ammann, Jeff Offutt	1st	Cambridge University Press	2008
2.	Foundations of Software Testing ISTQB Certification	Rex Black, Erik van Veenendaal, Dorothy Graham	3rd	Cengage Publications	2015

Reference Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1	Software Testing: Principles and Practices	Srinivas Desikan, Gopalaswamy Ramesh	1st	Pearson	2005
2	Test Driven Development: By Example	Kent Beck	1st	Addison-Wesley Educational Publishers Inc	2002

E-book

SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Performance Testing Guidance for Web Applications	J.D. Meier Carlos Farre Prashant Bansode Scott Barber Dennis Rea	1st	Microsoft Press	2007	http://download.51testing.com/ddimg/uploadsoft/20101206/PerfTestGuide.pdf
2	The Art Of Software Testing	Glenford J. Myers Tom Badgett Corey Sandler	3rd	Wiley	2012	https://malenezi.github.io/malenezi/SE401/Books/114-the-art-of-software-testing-3-edition.pdf

MOOC Course

SI No	Course Name	Offered By	Year	URL
1	Foundations of Software Testing and Validation	Coursera	2025	https://www.coursera.org/learn/foundations-of-software-testing-and-validation
2	Introduction to Software Testing	Coursera	2025	https://www.coursera.org/learn/introduction-software-testing

DevOps

Semester	**VI**		
CourseCode	**23DS6AEDOP**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

A Introduction:

1. This course develops skills in DevOps practices, including CI/CD, infrastructure as code, configuration management, and containerization.
2. Students will develop a DevOps pipeline using technologies such as Jenkins, Docker, Kubernetes, Ansible, Terraform, and cloud platforms like AWS, GCP, or Azure.
3. Groups should consist of 2 to 4 students.
4. The teacher allotted for project work should teach DevOps technologies like Jenkins, Docker, Kubernetes, etc., during Class/Lab hours as per the allotment. The teacher allotted for project work should guide the students in choosing the project topic and in carrying out the project work, as well as completing the evaluation of assigned students.

B Laboratory Plan:

Project Topics:

E-commerce Platform with CI/CD Pipeline, Social Media Analytics Dashboard, Online Learning Management System, Real-time Chat Application, Personal Finance Management App, Content Management System (CMS), Smart Home IoT Dashboard, Healthcare Appointment Booking System, Weather Forecasting Application, Online Voting System

Note: Apart from the above-mentioned project topics if student groups come up with any innovative project ideas which are useful for the Department / College academic purpose will be considered based on the approval and acceptance from class teacher.

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Sl.no	Activity	Content Delivered by Assigned Teacher	Technologies/Skills to be Covered
1	Lecture and discussion, Formation of groups, Basicsetup of a lab environment	Introduction to DevOps, History andevolution of DevOps, Key concepts and principles, DevOps lifecycle, Importance and benefits of DevOps,Group Formation, Lab Setup	DevOps Fundamentals, GroupCollaboration, Lab Setup
2	Hands-on exercises with Git, Creating and managinga repository	Introduction to version control, BasicGit commands (clone, commit, push,pull), Branching and merging, UsingGitHub for collaboration, Git Repository Management	Git, Version Control, GitHub
3	Installing Docker, Creatingand running Docker containers	Introduction to containers, Docker architecture and components, BasicDocker commands (build, run, images), Dockerfile and containerization of applications, Docker Container Management	Containerization, Docker
4	Setting up a Kubernetes cluster, Deploying a sample application	Introduction to container orchestration,Kubernetes architecture, Basic Kubernetes objects (pods, services, deployments), Deploying applications on Kubernetes, Kubernetes Application Deployment	Container Orchestration, Kubernetes
5	Jenkins installation and setup, Configuring a simpleCI pipeline	Introduction to CI/CD, Setting up Jenkins, Creating and running basic Jenkins jobs, Integrating Jenkins with GitHub, CI Pipeline Configuration	Continuous Integration, Jenkins,CI/CD Pipeline
6	Installing and configuringAnsible, Writing simple playbooks	Introduction to configuration management, Basics of Ansible, Writing and running Ansible playbooks, Managing infrastructurewith Ansible, Ansible Playbook Creation	Configuration Management, Ansible

7	Installing Prometheus and Grafana, Configuring basic monitoring and alerts	Importance of monitoring and logging in DevOps, Introduction to Prometheusand Grafana, setting up monitoring with Prometheus, Visualizing metrics with Grafana, Prometheus and GrafanaConfiguration	Monitoring, Prometheus, Grafana
8	Installing Terraform, Creating and applying Terraform scripts	Introduction to IaC, Basics of Terraform, Writing and applying Terraform configurations, managing infrastructure with Terraform, Terraform Scripting	Infrastructure as Code, Terraform
9	Setting up security scanningtools, Running security scans on applications	Introduction to DevSecOps, Security best practices in DevOps, Tools for security scanning (e.g., OWASP ZAP, Snyk), Integrating security into CI/CDpipelines, Security Scanning Procedures	DevSecOps, Security Scanning
10	Setting up an account on a chosen cloud provider, Deploying a simple application on the cloud	Overview of cloud computing, Introduction to AWS/GCP/Azure (choose one), Using cloud services in DevOps workflows, Cloud ApplicationDeployment	Cloud Computing, AWS/GCP/Azure,Cloud Deployment
11	Groups work on theirDevOps projects	Project Work	Project Management, DevOps Practices
12	Project presentations and demonstrations by each group, Submission of project reports	Presentation of Projects, Project ReportSubmission	Presentation Skills, Documentation,Project Showcase

Text Book

Sl No	Book Title	Authors	Edition	Publisher	Year
1	The DevOps Handbook: How to Create World-ClassAgility, Reliability, & Security in Technology Organizations	Gene Kim, Patrick Debois, JohnWillis, and Jez Humble	1st Edition	IT Revolution Press	2016
2	DevOps for Dummies	Emily Freeman	1st Edition	John Wiley &Sons	2019

Reference Text Book

Sl No	Book Title	Authors	Edition	Publisher	Year
1	DevOps: A Software Architect's Perspective	Len Bass, Ingo Weber,and Liming Zhu	1st Edition	Addison-Wesley Professiona l	2015

E-Book

SL No	Authors	Author	Edition	URL
1	The DevOps	Gene Kim, Patrick, Debois, John Willis, and Jez Humble	1st Edition	https://dl.faghatketab.ir/Books/Computer/Programming/WebProgramming/The.DevOps.Handbook_faghatketab.ir.pdf

MOOC Course

SL No	CourseName	Course Offered By	Year	URL
1	DevOps for Software Development	IIT Madras	2021	https://nptel.ac.in/courses/128106012
2	Introduction to DevOps	Coursera	2022	https://www.coursera.org/learn/intro-to-devops

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VII / VIII SEMESTER

Entrepreneurship & Project Management

Semester	**VII**		
Course Code	**23DC7PCEPM**	**Total Contact Hours**	**25**
L-T-P	**2-0-0**	**Total Credits**	**2**

Unit No	Topics	Hours
1	**The Entrepreneurial mind-set:** The nature of entrepreneurship, How Entrepreneurs Think, Entrepreneur background and characteristics. Reasons for interest in corporate entrepreneurship, Sustainable Entrepreneurship, Generation of new entry opportunity, Entry strategy for new entry exploitation, Risk reduction for new entry exploitation.	5
2	**Creativity and the business idea**: Sources of New Ideas, Methods of Generating Ideas, Creative Problem Solving. **Innovation:** Innovation, Opportunity recognition, Product planning and development process, Ethics: Factors that Shape Trust in Business and Innovation Ecommerce and business start-up, international v/s domestic entrepreneurship, Entrepreneurial entry strategies, Legal issues in setting up the organization.	5
3	**Project Management:** concept of project management attributes of a project, project management systems, project life cycle, Difference among Projects, Routine Activities and Programs, responsibilities and qualities of a project manager, project management team-composition, functions and responsibilities, co-ordination procedures.	5
4	**Project Planning:** Work Breakdown Structure, Types of Work Breakdown Structure, Planning Framework and Its Importance. **Project Formulations and Planning:** Private commercial criteria for project choice, feasibility, marketing feasibility, Financing for Projects and financial feasibility, Preparation of techno-economic feasibility report.	5
5	**Project Identification:** Principles of project identification, Project Implementation. Brief outline of social cost benefit analysis: rationale, UNIDO and Little Mirrlees approaches, UNIDO IDCAS manual. **Project appraisal:** time value of money, project appraisal techniques: Non discounting criteria, discounting criteria, appraisal and selection in practice, payback period, accounting rate of return, net present value, internal rate of return, benefit cost ratio, social cost benefit analysis, effective rate of protection, risk analysis: measures of risk, sensitivity analysis, simulation analysis, decision tree analysis.	5

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Entrepreneurship: The Practice and Mindset	Heidi M. Neck, Christopher P. Neck, Emma L. Murray	3rd	SAGE Publications	2023	https://www.barnesandnoble.com/
2.	The Handbook of Project Management	Martina Huemann & Rodney Turner	6th	Routledge		https://rpitst.com/img/ebook/1711029511_630733f488172765377f.pdf

Prescribed Text Book					
Sl. No	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Entrepreneurship	Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd	10th	McGrawHill Education	2017
2	Effective Project Management	James P Clements, Jack Gido	4th	South Western	2009

Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Project Management: The Managerial Process	Gray, Clifford F., Larson, Eric W., and Desai, Gautam V	8th edition	McGraw Hill Education	2020
2.	Project Management and Appraisal	Kharua, Sitangshu	7th edition	Oxford Press University	2011

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Project management for Managers	SWAYAM/NPTEL	2025	https://nptel.ac.in/courses/110107081
2.	Entrepreneurship Management	SWAYAM/NPTEL	2024	https://onlinecourses.swayam2.ac.in/cec24_mg28/preview

Cyber Security

Semester	**VII**		
Course Code	**23DS7PCCYS**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to Cyber Security:** Basic Cyber Security Concepts, layers of security, Vulnerability, Harmful acts, Internet Governance – Challenges and Constraints, CIA Triad, Assets and Threat, motive of attackers, Software attacks, Hardware attacks, IP spoofing, Methods of defense, Security Models. Cybercriminals, Classifications of Cybercrimes, **Cyber Offenses:** Criminals Planning Them: Introduction, planning of Attacks, Social Engineering, Cyber stalking,Botnets,Attack vector.	**8**
2	**Cybercrime**: **Mobile and Wireless Devices**- Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.	**8**
3	**Tools and Methods Used in Cybercrime:** Introduction, Kali Linux, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horses and Backdoors, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Overflow, Attacks on Wireless Networks. **Phishing and Identity Theft:** Introduction, Phishing, Identity Theft (ID Theft).	**8**
4	**Understanding Computer Forensics:** Introduction, Historical Background of Cyber Forensics, Digital Forensics Science, The Need for Computer Forensics, Cyberforensics and Digital Evidence, Forensics Analysis of E-Mail, Digital Forensics Life Cycle, Chain of Custody Concept, Network Forensics, Approaching a Computer Forensics Investigation,	**8**

5	**Cybersecurity- Organizational Implications:** Introduction, Cost of Cybercrimes and IPR issues, Web Threats for organizations, Security and Privacy implications from Cloud Computing, Social Media marketing, Social Computing and the Associated Challenges for Organizations, Organizational guidelines, Incident Handling, **Cybersecurity Standards and Frameworks:** DFARS, ISO 22301, HIPAA, NIST CSF **Cybercrime and Cyberterrorism:** Intellectual Property in the Cyberspace, The Ethical Dimension of Cybercrimes, The Psychology, Mindset and Skills of Hackers and Cybercriminal, Sociology of Cybercriminals, Information warfare.	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Cyber Security: Understanding Cyber Crimes, Computer Forensics And Legal Perspectives	Sunit Belapure and Nina Godbole	1st	WILEY INDIA, .	2013
2.	Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives	B. B. Gupta, D. P. Agrawal, Haoxiang Wang	1st	CBS Publishers	2018

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Cyber SecurityEssentials,	James Graham, Richard Howard and Ryan Otson,	1st	CRC Press.	2010
2.	Introduction to Cyber Security	Chwan-Hwa(john) Wu,J.David Irwin.	1st	CRC Press.	2013

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	CyBOK: The Cyber Security Body of Knowledge	Awais Rashid,Howard Chivers ,George Danezis, Emil	1st	University of Bristol	2019	https://www.cybok.org/knowledgebase/

		Lupu, Andrew Martin -				
2.	Cybersecurity: The Beginner's Guide	Dr. Erdal Ozkaya	1st	Packt Publishing Ltd.	2019	https://www.jre-training.com/WebSecurity/Cybersecurity.pdf
3.	CyberSecurity for beginners	Heimdal Security team	-	heimdalsecurity	2011	https://heimdalsecurity.com/pdf/cyber_security_for_beginners_ebook.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Cyber Security	Swayam	2020	https://onlinecourses.swayam2.ac.in/cec20_cs15/preview
2.	Cyber Security and Privacy NPTEL	Swayam	2023	https://onlinecourses.nptel.ac.in /noc23_cs127/preview
3.	Introduction to Cyber Security	Swayam		https://onlinecourses.swayam2.ac.in/nou19_cs08/preview

Bio-inspired Algorithms

Semester	**VII**		
Course Code	**23DS7BSBIO**	**Total Contact Hours**	**24**
L-T-P	**0-0-1**	**Total Credits**	**1**

Sl. No.	Course Content
1	Introduction to Evolutionary Algorithms and Optimization Terminology, Different Types of Optimizations, Hill Climbing, Intelligence, Genetic Algorithms, Mathematical Models of Genetic Algorithms
2	Recent Evolutionary Algorithms-1 Simulated Annealing, Ant Colony Optimization, Particle Swarm Optimization, Differential Evolution
3	Recent Evolutionary Algorithms-2 Biogeography-based Optimization, Cultural Algorithms, Opposition-based Learning, The Firefly Algorithm, Bacterial Foraging Optimization
4	Combinatorial Optimization Travelling Salesman Problem (TSP), TSP Initialization, TSP Representation and Crossover, TSP Mutation, Graph Coloring Problem
5	Recent Trends in the Domain of Bio-inspired Algorithms

	Lab Programs
1	**Genetic Algorithm for Function Optimization** **Objective**: Maximize or minimize a mathematical function using a genetic algorithm. **Concepts Covered**: Initialization, selection, crossover, mutation, fitness function.
2	**Hill Climbing Algorithm for N-Queens Problem** **Objective**: Solve the N-Queens problem using a basic Hill Climbing approach. **Concepts Covered**: Local search, steepest ascent, fitness evaluation.
3	**Simulated Annealing for Traveling Salesman Problem (TSP)** **Objective:** Minimize the TSP path using simulated annealing. **Concepts Covered:** Temperature schedule, acceptance probability, path cost evaluation.
4	**Ant Colony Optimization for TSP** **Objective: Solve TSP using Ant Colony Optimization (ACO).** **Concepts Covered:** Pheromone update, path selection, evaporation rate.

5	**Particle Swarm Optimization for Global Minima** **Objective**: Find the global minimum of a function using Particle Swarm Optimization (PSO). **Concepts Covered**: Velocity update, position update, pBest and gBest.
6	**Differential Evolution for Function Optimization** **Objective**: Use Differential Evolution (DE) to find the minimum of a benchmark function. **Concepts Covered**: Mutation, crossover, selection strategies.
7	**Tabu Search for Job Scheduling Problem** **Objective**: Minimize job completion time using Tabu Search. **Concepts Covered**: Tabu list, aspiration criteria, neighborhood generation.
8	**Biogeography-Based Optimization (BBO) for Benchmark Function** **Objective**: Apply BBO to solve optimization problems. **Concepts Covered**: Habitat suitability index, migration, mutation
9	**Firefly Algorithm for Unconstrained Function Optimization** **Objective**: Use the firefly algorithm to optimize a multimodal function. **Concepts Covered**: Light intensity, attractiveness, randomization.
10	**Graph Coloring using Genetic Algorithm** **Objective**: Minimize colors used in coloring a graph using a GA approach. **Concepts Covered**: Chromosome encoding, constraint satisfaction, mutation strategies.

Prescribed Textbook

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Nature-Inspired Optimization Algorithms	A Vasuki	1st Edition	CRC Press, Taylor & Francis Group	2020
2.	Evolutionary Optimization Algorithms by	Dan Simon	1st Edition	John Wiley & Sons, Inc.	2013

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	Introduction to Evolutionary Computing	A. E. Eiben and J. E. Smith	2nd Edition	Springer-Verlag Berlin Heidelberg	2015
2.	Ant Colony Optimization - Techniques and Applications	Helio J.C. Barbosa	1st Edition	Intech	2013
3.	Swarm Intelligence: Principles, Advances, and Applications	Aboul Ella Hassanien and Eid Emary	1st Edition	CRC Press, Taylor & Francis Group	2016

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Bio-inspired Algorithms	Sándor Szénási, Gábor Kertész	-	MDPI	2025	https://www.mdpi.com/books/reprint/11135-bio-inspired-algorithms
2.	Genetic Algorithms in Search, Optimization, and Machine Learning	David E Goldberg	-	Addison-Wesley	1989	https://www2.fiit.stuba.sk/~kvasnicka/Free%20books/Goldberg_Genetic_Algorithms_in_Search.pdf

MOOC Courses			
Sl. No.	**Course name**	**Course Offered By**	**URL**
1.	Biology Meets Programming: Bioinformatics for Beginners	Coursera	https://www.coursera.org/learn/bioinformatics
2.	Bio-inspired Artificial Intelligence Algorithms	Udemy	https://www.udemy.com/course/bio-inspired-artificial-intelligence-algorithms-for-optimization/?srsltid=AfmBOoojXI8gwKeva_6V2L4I_28nKrWUrppVThwTINde3ne5WCWJUehn&couponCode=NVDIN35

Practical Data Analysis and Visualization

Semester	**VII/VIII**		
Course Code	**23DS7OEDAV/ 23DS8OCDAV**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit no.	Topics	Hours
1	**Introduction to Data Analysis:** Exploratory data analysis: Structured, semi-structured, and unstructured data; real-world datasets, Exploring Binary and Categorical Data: Mode, Expected value and Probability. Correlation: Pearson Correlation, Scatterplots. Data Cleaning: Handling missing values, outliers, and duplicates. Data Preparation: Data Transformation, Data Discretization.	**8**
2	**Descriptive Statistics for Insights:** Central Tendency: Mean, median, mode, and their practical uses, Variability: Variance, standard deviation, and range, Distribution Summaries: Percentiles and box-and-whisker plots, Introduction to Probability: Normal Distribution, Looking Ahead to Inferential Statistics, Applications: Using descriptive statistics in real-world contexts	**8**
3	**Data Visualization Techniques:** Visualizing data: Mapping data onto aesthetics: Aesthetics and types of data, Scales map data values onto aesthetics, Directory of visualizations: Amounts, Distributions, Proportions, X-Y Relationships, Geospatial data and Uncertainty, Visualizing associations among two or more quantitative variables: Scatter plots, Correlograms, Dimension reduction and Paired data.Visualizing time series and other functions of an independent variable: Individual time series, Multiple time series and dose–response curves, Time series of two or more response variables	**8**
4	**Basic Prediction and Forecasting:** Regression and Prediction: Simple Linear Regression, Multiple Linear Regression, Prediction Using Regression, Factor Variables in Regression, Interpreting the Regression Equation, Regression Diagnostics, Polynomial and Spline Regression, Time Series Analysis: Nature of Time Series Data, Time Series Statistical Models, Measures of Dependence, Stationary Time Series, Estimation of Correlation, Classical Regression in the Time Series Context, Smoothing in the Time	**8**

	Series Context, ARIMA Models: Forecasting, Estimation and Building ARIMA Models	
5	**Data-Driven Decisions and Ethics:** Business Problems and Data Science Solutions:From Business Problems to Data Mining Tasks, Supervised Versus Unsupervised Methods, Data Mining and Its Results,The Data Mining Process, Implications for Managing the Data Science Team, Decision Analytic Thinking I: What Is a Good Model?: Evaluating Classifiers, Generalizing Beyond Classification, Evaluation, Baseline Performance, and Implications for Investments in Data.	**8**

Prescribed Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1.	Statistics for the Behavioral Sciences	Frederick J Gravetter and Larry B. Wallnau	Tenth	Cengage Learning	2017
2.	Data Mining Concepts and Techniques	Han & Kamber	3rd	Elsevier	2013
3	Fundamentals of Data Visualization	Claus O. Wilke	First	O'REILLY	2022

Reference Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1	Practical Statistics for Data Scientists	Peter Bruce, Andrew Bruce & Peter Gedeck	Second	O'REILLY	2020
2	Data Science	Foster Provost & Tom Fawcett	First	O'REILLY	2013

	for Business				
3	Time Series Analysis and Its Applications	Robert H. Shumway David S. Stoffer	Fourth	Springer	2010

E-book

SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Data-Driven Decision Making	Palgrave Macmillan	1st Edition	Springer	2025	https://shorturl.at/tvZfj
2	Data Driven Decision Making using Analytics	Parul Gandhi, Surbhi Bhatia Khan, Kapal Dev	2nd Edition	O'Reilly	2022	https://shorturl.at/Vpr8V

MOOC Course

SI No	Course Name	Offered By	Year	URL
1	Data-driven Decision Making	Coursera	2024	https://www.coursera.org/learn/decision-making
2	Data-driven Decision Making	Next Learning	2024	https://nextlearningvalley.com/en/learnmore/mooc-data-driven-learning/
3	Business Analytics – The Science of Data Driven Decision Making	IIM-B	2024	https://eep.iimb.ac.in/course/business-analytics-science-of-data-driven-decision-making/

Project work – Phase II

Semester	**VII**		
Course Code	**23DS7PWPP2**	**Total Contact Hours**	**14 hours/Week**
L-T-P	**0-0-7**	**Total Credits**	**7**

The Project work is a comprehensive, two-semester course designed to enable students to apply their technical knowledge to solve real-world problems. The project carries a total of 9 credits, with 2 credits for Phase 1 and 7 credits for Phase 2.

In Project Phase-2, students will build upon their Phase-1 foundation and focus on developing more sophisticated and production-ready solutions. This phase involves the application of advanced modelling techniques and evaluating the developed models using robust metrics. Additionally, students are encouraged to deploy their models via lightweight web applications or cloud platforms for demonstration purposes. The final deliverables include a comprehensive LaTeX-based report, a project poster and a presentation. Supporting materials such as source code, datasets, and deployment links should be shared on GitHub. The outcome of the Project should be published in a reputed conference/journal.

Scheme of Evaluation

The continuous Evaluation of Project Phase-2 involves three review stages each assessed using well defined rubrics.

CIE and SEE Marks Distribution			
	Review-1	**Review-2**	**Review-3**
Evaluation By	Internal Committee		Project Guide and Industry Expert
Max Marks	30	30	50
Reduced CIE	15	15	20
Total CIE	**50 Marks**		
SEE	**50 Marks**		

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING (DATA SCIENCE)

Indian Knowledge Systems

Semester	**VII**		
Course Code	**25MA7HSIKL**	**Total Contact Hours: 15**	
L-T-P:	**1:0:0**	**Total Credits:**	**1**

Unit No.	Topics	Hours
1	**Introduction to Indian Knowledge Systems (IKS):** Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.	5
2	**Traditional Knowledge in Humanities and Science**s: Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.	5
3	**Traditional Knowledge in Professional domain:** Town planning and architecture- Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.	5

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Introduction to Indian Knowledge System- concepts and applications	Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N,	-	PHI Learning Private Ltd	2022
2	Traditional Knowledge System in India	Amit Jha	-	Atlantic Publishers and Distributors	2009
3	Knowledge Traditions and Practices of India	Kapil Kapoor, Avadesh Kumar Singh	-	DK Print World (P) Ltd	2005

Suggested Web Links:

- https://www.youtube.com/watch?v=LZP1StpYEPM
- http://nptel.ac.in/courses/121106003/
- http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)
- https://www.wipo.int/pressroom/en/briefs/tk_ip.html
- https://unctad.org/system/files/official-document/ditcted10_en.pdf
- http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf
- https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE

Blockchain Technology

Semester	**VIII/ VII**		
Course Code	**23DS8PEBCT/ 23DS7PEBCT**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	**Topics**	**Hours**
1	**Blockchain Essentials:** The history of Blockchain and Bitcoin, The Growth of Blockchain Technology, Blockchain- Definition, Architecture, Generic elements of a Blockchain, Benefits, Features and Limitations, Types of Blockchain, Consensus. **Decentralization:** Decentralization using Blockchain, Decentralized Applications	8
2	**Cryptographic Constructs in Blockchain:** Cryptographic primitives- Hash function, ECC Digital Signature, Zero Knowledge proof, Different types of digital signatures. **Applications of Cryptographic Hash Functions:** Merkel Trees, Patricia Trees, Distributed Hash Table. **Consensus Algorithms:** Introducing the Consensus Problem, Analysis and Design, Classification, Algorithms(Raft,Paxos,PBFT), Choosing an Algorithm.	8
3	**Bitcoin:** Overview, Cryptographic Keys, Bitcoin Network, Wallets, Bitcoin Payments, Innovation in Bitcoin, Alternative coins- Introduction, Theoretical Foundations- Alternative Proof of Work. **Transactions**: Transaction Life Cycle, Genesis block, Mining	8
4	**Ethereum** : An Overview, Ethereum Network, Components of Ethereum Ecosystem, Ethereum Virtual Machines **Smart Contracts:** History, Definition, Deploying Smart Contracts. **Decentralized Applications(**DApp), A Basic DApp Example	8
5	**Hyperledger:** Architecture, Projects under Hyperledger, Hyperledger Fabric **Tokenization:** Tokenization on a blockchain, Types of tokens, Process of Tokenization, Token offerings	8

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1	Mastering Blockchain	Imran Bashir	3rd	Packt	2020
2	Mastering Ethereum Building Smart Contracts and DApps	Andreas M. Antonopoulos and Dr. Gavin Wood	1st	O'Reilly	2018

MOOC Course			
Sl. No.	**Course Name**	**Course Offered by**	**URL**
1	Blockchain Specialization Course 1: Blockchain Basics Course 2: Smart contracts Course 3: Decentralized Applications	Coursera	https://www.coursera.org/specializations/blockchain
2.	Blockchain architecture, Design and Use cases	NPTEL	https://nptel.ac.in/courses/106/105/106105184/

Quantum Machine Learning

Semester	**VIII / VII**		
Course Code	**23DS8PEQML / 23DS7PEQML**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction and overview:** History of quantum computation, Quantum bits (Qubit), Quantum Gates **Quantum Machine Learning:** Introduction to Quantum Machine Learning, Quantum Machine Learning for Quantum Data , A Taxonomy of Quantum Machine Learning, Characteristics of Quantum Machine Learning Methods, The four big families of quantum machine learning. **Quantum Algorithms:** Deustch Jozsa , Grover's Algorithm CASE studies: Deutsch-Jozsa Algorithm for Database Validation, Grover's Algorithm for Password Recovery	**8**
2	**Quantum Kernel Methods:** The general idea behind quantum support vector machines, Quantum Feature maps. **Quantum support vector machines in PennyLane :** Setting the scene for training a qSVM , Penny Lane and scikit-learn, Reducing the dimensionality in qSVM , Implementing and using custom feature map **Hybrid quantum neural networks (QNN):** Definition of hybrid QNNs, Hybrid QNNs construction CASE studies- qSVM for Iris Classification Custom Feature Map for qSVM in Credit Risk Assessment	**8**
3	**Hybrid architectures-** **Using PennyLane:** Setting things up for a binary classification problem, Training the model. **A multi-class classification problem:** A general perspective on multi-class classification tasks, Implementing a QNN for a ternary classification problem	**8**

4	**Quantum Inspired Machine Learning :** Tang's Quantum Inspired Algorithm for Recommendation Systems , Quantum Inspired Data Clustering , Quantum Inspired Gravitational Search. **Quantum Enhanced Machine Learning :** Algorithms for Linear Algebra , Algorithms for Regression , Algorithms for Clustering , Algorithms for Nearest Neighbor Search , Quantum Principal Component Analysis (qPCA) , Algorithms for Classification , Quantum Boosting	**8**
5	**Applications of QML :** Quantum Finance , Quantum Chemistry and Drug Discovery , Pattern Recognition and NLP, Image Classification (with QML) **Tools and Frameworks:** Case Study on Qiskit , Pennylane , IBM Quantum Lab **Quantum Generative Adversarial Networks :** Case study on quantum GANs (QGANs**)** in Qiskit **Challenges & Future Research Directions**: Scalability, noise mitigation, quantum advantage	**8**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	A Practical Guide to Quantum Machine Learning and Quantum Optimization	Elías F. Combarro Samuel González-Castillo	1st	Packt Publishing Ltd.	2023
2.	Quantum Machine Learning State of the Art and Future Directions	Christian Bauckhage, Fraunhofer IAIS	1st	Federal Office for Information Security	2022

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1.	An Introduction to Quantum Machine Learning for Engineers	Osvaldo Simeone		Boston — Delft	2022

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1.	Quantum Machine Learning with Python	Santanu Pattanayak		Apress	2021	https://indico.cern.ch/event/1288913/attachments/2650941/4589882/Quantum%20machine%20learning%20with%20python.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1.	Quantum Computing and Quantum Machine Learning	Udemy	2021	https://www.udemy.com/course/quantum-computing-and-quantum-machine-learning-part-1/?srsltid=AfmBOoq1gXz5vGOz8I1Wi207Y3SM9HgQxgGWrAZ6njbxKO8RTBtXP6zu

Machine Learning Operations (MLOps)

Semester	**VIII / VII**		
Course Code	**23DS8PEMLO/ 23DS7PEMLP**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to MLOps:** MLOps Hierarchy - Maslow's hierarchy, ML engineering hierarchy, Implementation of DevOps, Steps involved in migration from DevOps to MLOps, DataOps and Data Engineering, MLOps - MLOps Feedback Loop, Machine learning model targets, Build an MLOps Pipeline from Zero, MLOps standards and best practices **The MLOps Workflow: MLOps** model lifecycle, Risks handled by MLOps workflow, Case Study: Real-World Example - The Story of Two Companies with (& without) MLOps Workflow,	8
2	**Quantifying success of MLOps project: Steps to get started,** Role of ML in your organisation, Objectives and Metrics, Actors in MLOps. MLOps Industrial Revolution **The MLOps Toolchain:** Model and Data Exploration, Metrics and Model Optimization, Productionalization - End to End Pipelines, Feature Stores, Testing, Deployment and Inferences.	8
3	**MLOps for Containers and Edge Devices - Overview of the needs and challenges** **Containers:** Container Runtime, Creating and Running Container **Edge Devices:** Coral, Azure Percept, TFHub **Containers for Managed ML Systems:** Containers in Monetizing MLOps, Build Once, Run many MLOps workflow	8
4	**From Development to Production in MLOps:** Developing Models (Theory vs. Practice), ML algorithms and their MLOps challenges, Feature selection impact on MLOps, Adaptation from Development to Production Environments, The Purpose of Model Validation, Deploying to Production, CI/CD Pipelines,ML artifacts: what and why Testing pipelines.	8

5	**Monitoring and Feedback Loop:** Understanding Model Degradation, Input Drift Detection & Techniques, The Feedback Loop **MLOps Tools:** AI Platforms on Kubernetes - Kubeflow, MLOps Frameworks - teraflow **Governance and Industrial Use Cases:** Introduction to Model Governance in MLOps, **Key** Elements of Responsible AI, A Template for MLOps Governance. Real-World MLOps Applications: **Case Study 1**: Credit Risk – Bias handling and deployment. **Case Study 2:** Recommendation Engines – Personalization, scalability, monitoring.	8

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Practical MLOps - Operationalizing Machine Learning	Noah Gift and Alfredo Deza	1st	O'Reilly	2021
2	Introducing MLOps- How to scale Machine Learning in the enterprise	Mark Treveil and the dataiku Team	1st	O'Reilly	2021

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Machine Learning Engineering in Action	Ben Wilson	1st	Manning Publications	2022
2	Designing Machine Learning Systems- An Iterative Process for Production-Ready Applications	Chip Huyen	1st	O'Reilly	2022

E-Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1	Practical MLOps - How to get ready for Production Mode	By Valohai , Sigopt, Tecton		Valohai , Sigopt, Tecton		https://valohai.com/mlops-ebook/

MOOC Course				
Sl. No.	**Course name**	**Course offered by**	**Year**	**URL**
1	MLOps | Machine Learning Operations Specialization	Coursera - Duke University	2024	https://www.coursera.org/specializations/mlops-machine-learning-duke#outcomes
2	Machine Learning Operations (MLOps): Getting Started	Coursera	2025	https://www.coursera.org/learn/mlops-fundamentals

READING ARTICLE				
Sl. No.	**Article name**	**Author**	**Year**	**Published at**
1	Industrial Edge MLOps: Overview and Challenges	Rani, Fatima	2024	Computer Aided Chemical Engineering 53 : 3019-3024

Robotic Process Automation

Semester	**VIII/VII**		
Course Code	**23DS8PERPA/ 23DS7PERPA**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction:** Introduction to Robotic Process Automation. **Scope and Techniques of Automation:** Process to be automated. Techniques of automation. **Robotic Process Automation:** Tasks RPA can perform, Benefits of RPA, Components of RPA, RPA platforms, The future of Automation. **Record and Play:** About RPA IDE, Downloading and Installing IDE, IDE Stack, Learning IDE, Task Recorder, Emptying trash in Gmail, Emptying Recycle Bin.	**8**
2	**Sequence, Flowchart and Control Flow**: Sequencing the Workflow, Activities, Control flow, various types of loops, and decision making, how to use a sequence, how to use a flowchart, step by step example using sequence and control flow. **Data Manipulation**: Variables and scope, Collections, Arguments-purpose and use, Data table usage with examples, Clipboard management, File operation with step-by-step example. CSV/Excel to data table and vice versa examples.	**8**
3	**Taking control of the controls:** Finding and attaching windows, Finding the control, Techniques for waiting for a control, Act on controls-mouse and keyboard activities, working with RPA IDE explorer, Handling events, Revisit recorder, Screen scraping, Uses of OCR, Types of OCR available, How to use OCR?, Avoiding typical failure points. **Tame that Application with Plugins:** Mail plugin, PDF plugin, web integration, Excel and Word plugins, Credential management.	**8**
4	**Handling User Events and Assistant Bots:** Assistant bots, Monitoring system event triggers, Monitoring image and element triggers, Launching an assistant bot on a keyboard event.	**8**

	Exception Handling, Debugging, and Logging Exception handling: Common exceptions and ways to handle them, Logging and taking screenshots, Debugging techniques, Collecting crash dumps, Error reporting.	
5	**Managing and Maintaining the Code:** Project Organization, Nesting workflows, Reusability of workflows, Commenting techniques, State Machine, Appropriate usage of Flowcharts, State Machines or sequences, Using config files and examples of a config file. **Deploying and Maintaining the Bot:** Publishing using publish utility, Overview of Orchestration Server, Using Orchestration Server to control bots, Using Orchestration Server to deploy bots.	**8**

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Learning Robotic Process Automation	Alok Mani Tripathi	1st	Packt	2018
Reference Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Tom Taulli	1st	A Press	2020
2.	Introduction to Robotic Process Automation: a Primer	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston			

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1	https://www.uipath.com/rpa/robotic-process-automation					
2	https://www.packtpub.com/product/learning-robotic-process-automation/9781788470940					

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1	Robotic Process Automation	UiPath Academy	2025	https://www.uipath.com/learning/video-tutorials
2	UiPath RPA	Guru99	2025	https://www.guru99.com/uipath-tutorial.html

Data-Driven Decision Making and Business Intelligence

Semester	**VIII**		
Course Code	**23DS8OEDBI/ 23DS7OEDBI**	**Total Contact Hours**	**40**
L-T-P	**3-0-0**	**Total Credits**	**3**

Unit No.	Topics	Hours
1	**Introduction to Business Intelligence:** Managerial Decision Making, Information Systems Support for Decision Making, An Early Framework for Computerized Decision Support, The Concept of Decision Support Systems (DSS), A Framework for Business Intelligence (Bl), Business Analytics Overview, Descriptive analytics, Predictive analytics and Prescriptive analytics. **Case Study:** APPLICATION CASE: Sabre Helps Its Clients Through Dashboards and Analytics, Moneybal: Analytics in Sports and Movies, Analyzing Athletic Injuries	**8**
2	**Foundations and Technologies for Decision Making:** Decision Making: Introduction and Definitions, Phases of the Decision-Making Process, Decision Making: The Intelligence Phase, Decision Making: The Design Phase, Decision Making: The Choice Phase, Decision Making: The Implementation Phase, How Decisions Are Supported, Decision Support Systems: Capabilities, DSS Classifications, Components of Decision Support Systems **Case Study:** Station Casinos Wins by Building Customer Relationships Using Its Data, SNAP DSS Helps OneNet Make Telecommunications Rate Decisions	**8**
3	**Data Warehousing for BI:** Data Warehousing Definitions and Concepts, Data Warehousing Process Overview, Data Warehousing Architectures, Data Integration and the Extraction, Transformation, and Load (ETL) Processes, Data Warehouse Development, Data Warehousing Implementation Issues, Real-Time Data Warehousing, Data Warehouse Administration, Security Issues, and Future Trends. **Case study:** A Better Data Plan: Well-Established TELCOs Leverage Data Warehousing and Analytics to Stay on Top in a Competitive Industry, Egg Pie Fries the Competition in Near Real Time	**8**

4	**BI Reporting and Visualization:** Business Reporting Definitions and Concepts, Data and Information Visualization, Different Types of Charts and Graphs, The Emergence of Data Visualization and Visual Analytics, Performance Dashboards, Business Performance Management, Performance Measurement, Balanced Scorecards, Six Sigma as a Performance Measurement System **Case Study:** Expedia.com's Customer Satisfaction Scorecard, IBM Cognos Express Helps Mace for Faster and Better Business Reporting	**8**
5	**Business Analytics: Emerging Trends and Future Impacts:** Location-Based Analytics for Organizations, Analytics Applications for Consumers, Recommendation Engines, Web 2.0 and Online Social Networking, Cloud Computing and Bl, Impacts of Analytics in Organizations, ssues of Legality, Privacy, and Ethics **Case Study**: Great Clips Employs Spatial Analytics to Shave Time in Location Decisions, Quiznos Targets Customers for Its Sandwiches, Southern States Cooperative Optimizes Its Catalog Campaign	**8**

Prescribed Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1	Business Intelligence And Analytics Systems For Decision Support	Ramesh Sharda, Dursun Delen, Efraim Turban	Tenth	Pearson	2015
2	Business Intelligence Data Mining and Optimization for Decision Making	Carlo Vercellis	First	Wiley	2011

Reference Textbook

SI No	Book Title	Authors	Edition	Publisher	Year
1	Practical Data Analysis	Hector Cuesta	First	Packt	2013
2	Making Sense of Data II: A Practical Guide to Data Visualization, Advanced	Glenn J. Myatt, Wayne P. Johnson	Second	Wiley	2009

E-book

SI No	Book Title	Authors	Edition	Publisher	Year	URL
1	Business Intelligence: Making Better Decisions Faster	Elizabeth Vitt, Michael Luckevich, Stacia Misner	1st Edition	Microsoft Press	2002	https://shorturl.at/Xw2UE
2	Fundamentals of Business Intelligence	Wilfried Grossmann, Stefanie Rinderle-Ma	2nd Edition	Springer	2015	https://shorturl.at/SxDem

MOOC Course

SI No	Course Name	Offered By	Year	URL
1	Business Intelligence & Analytics	NPTEL	2024	https://onlinecourses.nptel.ac.in/noc24_cs65/preview
2	Foundations of Business Intelligence	Google	2024	https://www.coursera.org/learn/foundations-of-business-intelligence
3	Business Intelligence & Analytics	Coursera	2024	https://www.coursera.org/learn/mooc-business-intelligence