HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

M.Sc. Data Science

(Duration:2 Years)

CURRICULUM and SYLLABUS

(Applicable for Students admitted from Academic Year 2023-24)

DEPARTMENT OF COMPUTER SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

HINDUSTAN INSTITUTE OF TECHNOLOGY AND SCIENCE

MOTTO

To Make Every Man a Success and No Man a Failure

VISION

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research, and strategic partnership blended with values and commitment to society.

MISSION

➢ To create an ecosystem for learning and world class research.

➢ To nurture a sense of creativity and innovation.

➢ To instill highest ethical standards and values with a sense of professionalism.

➢ To take up activities for the development of Society.

➢ To develop national and international collaboration and strategic partnership with industry and institutes of excellence.

➢ To enable graduates to become future leaders and innovators.

VALUE STATEMENT

Integrity, Innovation, and Internationalization.

DEPARTMENT OF COMPUTER SCIENCE

VISION

To excel in Computer Science and Engineering education, research and project management by empowering the students with strong conceptual knowledge.

MISSION

M1. To educate the students with basic foundation blocks of core and allied disciplines of Computer Science.

M2. To provide practical skills in the advancements of the Computer Science field required for the growing dynamic IT and ITES industries.

M3. To sculpt strong personal, technical, research, entrepreneurial, and leadership skills.

M4. To inculcate knowledge in lifelong learning, professional ethics and contribution to the society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO I Excel in their professional career by applying advanced knowledge and/or pursue higher education including research by applying the knowledge of Data Science.

PEO II To provide practical skills in the advancements of Data Science field required for the growing dynamic IT and ITES industries.

PROGRAMME'S OUTCOMES (PO'S)

1. Computational knowledge: Apply knowledge of computing fundamentals, computing specialization, mathematics, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

2. Problem analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

3. Design/development of solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

6. Societal and Environmental Concern: Understand and assess societal, environmental, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

7. Innovation and Entrepreneurship: Identify a timely opportunity and using innovation to pursue that opportunity to create value and wealth for the betterment of the individual and society at large.

8. Professional Ethics: Understand and commit to professional ethics and cyber regulations, responsibilities, and norms of professional computing practice.

9. Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively with the computing community, and with society, about complex computing activities by being able to comprehend and write effective

reports, design documentation, make effective presentations, and give and understand clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the computing and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

PROGRAMME'S SPECIFIC OUTCOMES (PSO'S)

PSO-1: Ability to understand and solve complex problems in the domain of Data Science and Data Analytics using the Artificial Intelligence and Machine Learning Techniques.

PSO-2: Apply the concepts of Data Wrangling, Data Visualization in multidisciplinary fields using scientific and mathematical computing tools and technologies.

PSO-3: Design and Model Descriptive, Predictive and Prescriptive analytics and apply in Real World applications.

M.SC. DATA SCIENCE CURRICULUM									
SEMESTER-I									
S.NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	CMA02001	Statistical Modelling for Computer Science	3	0	2	4	0	5
2	PC	CAD02003	Advanced Algorithms and Analysis	2	1	2	4	2	5
3	PC	ADS02001	Applied Artificial Intelligence	3	0	2	4	0	5
4	PC	ACS02002	Advanced-Data Base Management Systems	3	0	0	3	1	3
5	PC	ADS02002	Data Visualization & Interpretation	3	1	0	4	0	4
PRACTICAL									
6	PC	ADS02400	Data Visualization & Interpretation lab	0	0	2	1	0	2
7	PC	ACS02400	Advanced-Data Base Management System Lab	0	0	2	1	0	2
			Total	**14**	**2**	**10**	**21**	**3**	**26**
L–Lecture; T–Tutorial; P–Practical; C–Credit; S-Self Study; TCH-Total Contact Hours									

SEMESTER-II									
S.NO	COURSE CATEGORY	COURSE CODE	NAMEOFTHE COURSE	L	T	P	C	S	TCH
1	PC	ADS02003	Machine Learning	3	0	0	3	0	3
2	PC	ADS02004	Foundation for Data Analytics	3	0	0	3	1	3
3	PC	ADS02005	Information Retrieval and Text Mining	3	0	2	4	0	5
4	PC	ADS02006	Cyber Security and Data Protection	3	1	0	4	0	4
5	DE	ADS025**	Elective-1	2	1	2	4	0	5

			PRACTICAL						
6	PC	ADS02401	Machine Learning Lab using Python	0	0	2	1	0	2
7	PC	ADS02402	FOSS Lab for Data Science	0	0	2	1	0	2
			Total	14	2	8	20	4	24

L–Lecture; T–Tutorial; P–Practical; C–Credit; S-Self Study; TCH-Total Contact Hours

SEMESTER-III									
S.NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	ADS02007	Ethics for Data Science	3	0	0	3	0	3
2	PC	ADS02008	Data Wrangling	3	0	2	4	0	5
3	PC	ACS02010	Research Paper reviews	3	0	0	3	0	3
4	DE	ADS025**	Elective-2	2	1	2	4	0	5
5	DE	ADS025**	Elective-3	2	1	2	4	0	5
PRACTICAL									
6	PC	ADS02801	Internship*		*		1		*
			Total	**13**	**2**	**6**	**19**	**0**	**21**

L–Lecture; T–Tutorial; P–Practical; C–Credit; S-Self Study; TCH-Total Contact Hours
* 15 days internship carried out in the end of SEM II and evaluated in the SEM III

SEMESTER-IV									
SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	PC	ADS02009	Big Data Science	3	0	2	4	1	5
2	PC	ADS02010	Neural Network	3	0	2	4	1	5
PRACTICAL									
3	PC	ADS02802	Project	0	0	24	12	0	24
			Total	**6**	**0**	**28**	**20**	**0**	**34**

TOTAL CREDITS: 80

LIST OF DEPARTMENTAL ELECTIVES – SEMESTER WISE

DEPARTMENTAL ELECTIVES									
ELECTIVE-I									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
2	DE1	ADS02500	Social Media Analytics	2	1	2	4	0	5
2	DE1	ADS02501	Time Series Analytics	2	1	2	4	0	5
ELECTIVE-II									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
3	DE2	ADS02502	Spatial Analytics	2	1	2	4	0	5
3	DE2	ADS02503	IoT Data Analytics Using Cloud Computing	2	1	2	4	0	5
ELECTIVE-III									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
3	DE3	ADS02504	Multimedia & Graph Analytics	2	1	2	4	0	5
3	DE3	ADS02505	Optimization Techniques	2	1	2	4	0	5

SEMESTER	**COURSE CATEGORY**	**DESCRIPTIVE ANALYTICS & PREDICTIVE MODELLING**	**PRESCRIPTIVE ANALYTICS**
Semester2	Elective 1	Social Media Analytics	--
		Time Series Analytics	--
Semester3	Elective 2	Spatial Analytics	--
	Elective2	IOT Data Analytics Using Cloud Computing	--
Semester3	Elective3	--	Multi Media & Graph Analytics
	Elective3	--	Optimization Techniques

Department Elective courses will be registered in semester 2 and 3. These courses are arranged in sequential manner and listed in groups called verticals that represents a particular specialization/ diversified group. In M.Sc. there are three verticals as Descriptive Analytics, Predictive Modelling and Prescriptive Analytics. Students are permitted to choose all departmental elective courses from a particular vertical or from different verticals. Only one departmental elective course can be chosen in the semester horizontally. However, if the students wish to choose courses from different verticals, it must be made sure the requisite prerequisite for the courses is completed.

SEMESTER I					
COURSE TITLE	**STATISTICAL MODELLING FOR DATA SCIENCE**		**CREDITS**	**4**	
COURSE CODE	CMA02001	**COURSE CATEGORY**	BS	**L-T-P-S**	**3-0-2-1**
VERSION	**1.0**	**APPROVAL DETAILS**	**38-ACM 13-05-2023**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test/ Quiz**	**Attendance**	**ESE**
15%	15%	10%	5%	5%	50%
Course Description	The course focuses on the statistical modelling for computer science and the applications of statistics in the field of areas like Artificial intelligence and Data Analytics				
Course Objective	1. To understand the concepts of Statistics Methods and probability distribution. 2. To understand the sampling inference and testing of hypothesis. 3. To learn correlation and regression in non-parametric method. 4. To understand curve fitting and decision theory. 5. To understand the analysis of variance in statistical problems.				
Course Outcome	Upon successful completion of this course, students will be able to: CO1 Explain the concept, properties, and important models of discrete random variables and use them to analyse suitable random phenomena. CO2 Summarize the properties and relevant models of continuous random variables and use them to analyse suitable random phenomena. CO3 Make use of concepts of sampling and theory of estimation to solve application-level problems. CO4 Organize the basic concepts in hypothesis testing and develop decision procedures for the most frequently encountered testing problems gnitive Knowledge Level: Apply). CO5 Build statistical methods like correlation and regression analysis to interpret experimental data				

PREREQUISITES: Mathematics

| S.No | CO | Program Outcomes & Program Specific Outcomes | | | | | | | | | | | | | | |
		PO1 EK	PO2 PA	PO3 DS	PO4 IOC	PO5 MT	PO6 ES	PO 7 ESU	PO 8 ETH	PO9 IT	PO10 COM	PO11 PF	PO12 LL	PSO1	PSO2	PSO3
1	CO-1	1	3	1	2	1	-	2	1	2	1	-	3	1	-	1
2	CO-2	2	3	1	2	1	-	2	1	2	1	-	3	2	1	1
3	CO-3	3	0	2	0		1	0	2	-	-	1	-	1	-	3
4	CO-4	2	1	1	1		1	1	1	1	-	1	1	1	3	-
5	CO-5	2	1	3	1		2	1	1	1	-	2	1	1	1	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STATISTICAL METHODS	(9L+6P)
Introduction – steps of statistical methods – Measures of central tendency – Measures of dispersion – coefficient of variation – skewness – kurtosis. Introduction – Definition of probability – addition and multiplication law of probability – conditional probability – Theorem of total probability – Bayes' theorem – RV – Discrete & continuous probability distributions – Binomial, Poisson, uniform & normal distribution. **Practical Component:** Implement calculation of simple statistical measures using MATLAB	CO-1 BTL-3
MODULE 2: SAMPLING INFERENCE AND TESTING OF HYPOTHESIS	(9L+6P)
Introduction – One sample test – Two sample tests – Small sample test – t-test – F-test – Chi-square test. **Practical Component:** Implement various sampling tests using MATLAB	CO-2 BTL-3
MODULE 3: CORRELATION AND REGRESSION	(9L+6P)
Simple, Multiple Regression and correlation – Non parametric methods. **Practical Component:** Implement regression and correlation analysis using MATLAB	CO-3 BTL-3
MODULE 4: CURVE FITTING AND DECESION THEORY	(9L+6P)
Empirical laws and Curve Fitting – Decision Theory **Practical Component:** Implement curve fitting using MATLAB	CO-4 BTL-3
MODULE 5: CORRELATION AND REGRESSION ANALYSIS	(9L+6P)
Analysis of variance – One-way & Two-way classification – Time series and forecasting. **Practical Component:** Implement analysis of variance using MATLAB	CO-5 BTL-3
TEXTBOOKS	
1	Dirk P. Kroese, Joshua, C. C. Chan (2016), Statistical Modelling and Computation, Publisher, Springer
2	RichardI. Levin, David S. Rubin (2017), Statistics for Management, PearsonEducationPrentice-Hall8thEdition.
REFERENCE BOOKS	

1.	Kroese, Dirk P., C. C. Chan, Joshua (2014), Statistical Modelling and Computation, Springer-Verlag New York.
2.	T. Veera Rajan, Probability, Statistics and Random processes, Tata McGraw Hill,2008.
3.	Levin R. I. and Rubin D. S., Statistics for Management, 7th edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2001.
4.	Srivastava TN, Shailaja Rego, Statistics for Management, Tata McGraw Hill, 2008.
E-BOOKS	
1.	https://www.datasciencecentral.com/forum/topics/free-book-probabilistic-and-statistical-modelling-in-computer
2.	https://machinelearningmastery.com/statistics-books-for-machine-learning/
MOOC	
1.	https://www.mooc-list.com/tags/statistical-modeling
2.	https://www.edx.org/course/statistics-computation-and-applications

COURSE TITLE	ADVANCED ALGORITHMS AND ANALYSIS		CREDITS	4	
COURSE CODE	CAD02003	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test /Quiz	First Periodical Assessment	Second Periodical Assessment
15%	15%	10%	5%	15%	15%
Course Description	This course introduces basic methods for the design and analysis of efficient algorithms emphasizing methods useful in practice. Different algorithms for a given computational task are represented and their relative merits are evaluated based on performance measures. The following important computational problems will be discussed: sorting, searching, elements of dynamic programming and greedy algorithms, advanced data structures, graph.				
Course Objective	The course is intended to provide the foundations of the practical implementation and usage of Advance Algorithms and Data Structures. To ensure that the student evolves into a competent programmer capable of designing and analysing implementations of algorithms and data structures for different kinds of problems. The students are exposed to the algorithm analysis techniques, to the theory of reductions, and to the complexity classes like NP.				

Course Outcome	Upon successful completion of this course, students will be able to:
	CO1: Describe, explain and use abstract data types including stacks, queues and linked list.
	CO2: Design and Implement Tree data structures and Sets.
	CO3: Able to understand and implement nonlinear data structures - Graphs.
	CO4: To apply advanced search techniques for real word situations.
	CO5: Able to evaluate various algorithms for NP hard and NP Complete problems.

PREREQUISITES: Data Structures

S.No	CO	Program Outcomes & Program Specific Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO-1	3	3	2	3	-	1	-	-	-	1	-	1	1	1	1
2	CO-2	2	3	1	2	1	-	2	1	2	1	-	3	2	1	1
3	CO-3	3	0	2	0	1	1	0	2	-	-	1	-	1	-	3
4	CO-4	2	1	1	1	2	1	1	1	1	-	1	1	1	3	-
5	CO-5	2	1	3	1	2	2	1	1	1	-	2	1	1	1	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	(9L+3P)
Introduction – Algorithms – Analysing and Designing Algorithms - Growth of Functions – Asymptotic notation - Probabilistic Analysis and Randomized Algorithms - Indicator random variables - Randomized algorithms - Probabilistic analysis and further uses of indicator random variables Practical component: 1. Calculate complexity of algorithms using step count method. 1.Suggested Readings: https://onlinecourses.nptel.ac.in/noc18_cs20	CO-1 BTL-2
MODULE 2: DIVIDE AND CONQUER	**(9L+3P)**
The maximum- Subarray problem - Strassen's algorithm for matrix multiplication - The substitution method for solving recurrences- The recursion-tree method for solving recurrences – Heapsort - Quicksort - Priority queues. **Practical component:** Solve problems using divide and conquer approach and analyze its complexity. 1.Suggested reading: https://onlinecourses.nptel.ac.in/noc18_cs20	CO-2 BTL-3
MODULE 3: DYNAMIC PROGRAMMING	**(9L+6P)**
Dynamic Programming - Elements of dynamic programming - Optimal binary search trees - Greedy Algorithms - An activity-selection problem - Huffman codes Practical component: 1. Solve problem using Greedy approach and analyze its complexity	CO-3 BTL-3

2. Solve problem using dynamic programming approach and analyze its complexity. 1. Suggested reading:https://onlinecourses.nptel.ac.in/noc18_cs20	
MODULE 4: ELEMENTARY GRAPH ALGORITHMS (9L+3P)	
Representations of graphs - Breadth-first search - Depth-first search - Minimum Spanning Trees - The algorithms of Kruskal and Prim – Single Source Shortest Paths - Single-source shortest paths in directed acyclic graphs - Dijkstra's algorithm - All-Pairs Shortest Paths - The Floyd Warshall algorithm Practical component: 1. Implement Single source shortest path algorithm and Analyze its complexity 2. Implement All source shortest path algorithm and Analyze its complexity 3. Implement Minimum spanning tree algorithm and analyze its complexity Suggested reading :https://onlinecourses.nptel.ac.in/noc18_cs20	
MODULE 5: LINEAR PROGRAMMING (9L+3P)	
Formulating problems as linear programs - The simplex algorithm - NP- CO-5 Completeness - NP-completeness and reducibility – Approximation Algorithms - The traveling-salesman problem - The set-covering problem Practical component: Implement Approximation algorithms for Traveling salesman problem and analyze its complexity Suggested Readings: https://www.edutechlearners.com/design-analysisalgorithms.	

TEXTBOOK	
1.	Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein. (2012). Introduction to Algorithms, Third Edition, PHI Learning Private Limited.

REFERENCE BOOK	
1	Anany Levitin, (2017). Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson Education.
2	Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman. (2006). Data Structures and Algorithms, Pearson Education.
3	Donald E. Knuth. (2008). The Art of Computer Programming, Volumes 1&3 Pearson Education, 2009. Steven S. Skiena, "The Algorithm Design Manual", Second Edition, Springer

E BOOKS	
1	https://www.edutechlearners.com/design-analysis-algorithms.

MOOC	
1	https://www.edutechlearners.com/design-analysis-algorithms.

COURSE TITLE	APPLIED ARTIFICIAL INTELLIGENCE		CREDITS		4	
COURSE CODE	ADS02001	COURSE CATEGORY	PC		L-T-P-S	3-0-2-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL		BTL3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test /Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. To understand and create algorithms capable of human-like solutions.
Course Objective	1. Learn the basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning. 2. To Investigate applications of AI techniques in intelligent agents, expert systems, and machine translation.
Course Outcome	Upon successful completion of this course, the student shall be able to: 1. Demonstrate fundamental understanding of artificial intelligence (AI) and its foundations. 2. Use appropriate search algorithms for any AI problem. 3. Represent knowledge using propositional logic and apply reasoning under uncertainty. 4. Ability to apply first order logic and resolutions for problem solving. 5. Ability to evaluate expert system and create machine translation using NLP.

PREREQUISITES: Mathematics

S. No	CO	Program Outcomes & Program Specific Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	CO-1	1	3	1	2	1	-	2	1	2	1	-	3	1	2	1
2	CO-2	2	3	1	2	1	-	2	1	2	1	-	3	2	1	1
3	CO-3	3	0	2	0	-	1	0	2	-	-	1	-	1	-	3
4	CO-4	2	1	1	1	-	1	1	1	1	-	1	1	1	3	-
5	CO-5	2	1	3	1	-	2	1	1	1	-	2	1	1	1	3
1: Weakly related, 2: Moderately related and 3: Strongly related																

MODULE 1: INTRODUCTION TO ARTIFICIAL INTELLIGENCE	(9L+6P)

AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.
 	
Practical Component:
    1. Case study on reactive or proactive agents.
    2. Case study on single or multi-agent systems.
Any of the following applications can be used: -
Smart homes and buildings/Healthcare/Finance/Games/Cybersecurity/Environmental monitoring/social media
	CO-1
	BTL-3

MODULE 2: SEARCHING TECHNIQUES	**(9L+6P)**
Searching - Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Hill climbing, A*, AO* Algorithms, Problem reduction, Game Playing- Adversial search, Games, mini-max algorithm, optimal decisions in multiplayer games, Problem in Game playing, Alpha-Beta pruning, Evaluation functions. **Practical Component**: 1)Write a python program to implement Breadth First Search Traversal/Depth First Search 2)Write a python program to implement Water Jug Problem? 3) Write a python program to implement Tic Tac Toe/8 Queen problem?	**CO-2** **BTL-3**
MODULE 3: KNOWLEDGE REPRESENTATION	**(9L+6P)**
Knowledge representation issues, predicate logic – logic programming, semantic nets - frames and inheritance, constraint propagation, representing knowledge using rules, rules-based deduction systems. Reasoning under uncertainty, review of probability, Bayes' probabilistic interferences and Dempster Shafer theory. **Practical Component**: Knowledge Representation Using Propositional Logic in python for the following: - King "X" has just been found dead in his Palace. There were only Three people in "X" Palace The prime suspects: Prince France; Prof. Hate; Ms. Jade. Police found Three Weapons in the mansion: Knife; Revolver; Rope. The murder has happened in one of the Three Rooms of the Palace: Dressing Room; Kitchen; Bed Room. Identify the person who was responsible for the King death?	**CO-3** **BTL-3**
MODULE 4: FIRST ORDER LOGIC	**(9L+6P)**
First order logic. Inference in first order logic, propositional vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution, learning from observation Inductive learning, Decision Trees, Explanation based learning, Statistical Learning method. **Practical Component:** Solve First Order Logic Problems using Python	**CO-4** **BTL-3**
MODULE 5: EXPERT SYSTEMS & NATURAL LANGUAGE PROCESSING	**(9L+6P)**

Expert systems: - Introduction, basic concepts, structure of expert systems- Natural language Processing –language models –Text Classification-Information Retrieval- Information extraction- natural language for communication -Machine Translation- speech recognition- Image formation- Image processing Operation **Practical Component:** 1. Case study on Expert System. 2. Write a python program to remove stop words for a given passage from a text file using NLTK? 3. Write a python program to implement stemming for a given sentence using NLTK? 4. Write a python program to POS (Parts of Speech) tagging for the given sentence using NLTK	**CO-5** **BTL-3**

TEXTBOOKS	
1	S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Second Edition, Pearson Education.
2	David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press.

REFERENCE BOOKS	
1.	1. Dan W. Patterson, "Introduction to Artificial Intelligence and Expert Systems", Pearson Education, 2007.
2.	2. Kevin Night, Elaine Rich, and Nair B., "Artificial Intelligence", McGrawHill,2008
3.	3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education,2006

E-BOOKS	
1.	https://readyforai.com/article/best-books-on-artificial-intelligence-for-beginner-with-pdf-download/
2.	https://readyforai.com/download/artificial-intelligence-a-modern-approach-3rd-edition/

MOOC	
1.	https://www.edx.org/course/artificial-intelligence-ai
2.	https://www.coursera.org/learn/introduction-to-ai

COURSE TITLE	ADVANCED DATABASE SYSTEMS		CREDITS		3	
COURSE CODE	ACS02002	COURSE CATEGORY	PC		L-T-P-S	3-0-0-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL3	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/assignments/ Project	Surprise Test / Quiz	Attendance	ESE	
15%	15%	10%	5%	5%	50%	

Course Description	This module builds on the introductory modules in databases. It intends to Introduce more advanced topics in databases such as object-oriented, temporal, data mining and data warehousing, distributed databases.
Course Objective	This module aims to give students in depth information about system database system architecture, transaction processing concepts, concurrency control techniques, database recovery techniques, database security and authorization, and enhanced data models. In depth knowledge about advanced applications, like parallel, OODB, Temporal databases, Mobile databases.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: To Understand Parallel & Distributed Databases and appreciate various transaction types. CO2: To analyse Object based databases and appreciate OODBS with ORDBS. CO3: Able of analyse advanced data models and learn emerging databases like XML, OLAP. CO4: To understand the advancement in Databases. CO5: Able to apply the data base security concepts.

PREREQUISITES: Fundamentals of DBMS

S. No	CO	Program Outcomes & Program Specific Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	**CO-1**	3	2	2	1	1	2	2	3	2	3	2	-	2	3	-
2	**CO-2**	2	2	3	1	2	2	2	3	2	3	2	-	2	-	2
3	**CO-3**	2	3	2	2	3	3	2	3	2	-	2	-	1	1	2
4	**CO-4**	2	2	2	1	2	3	2	3	2	-	2	-	2	1	2
5	**CO-5**	3	-	2	1	2	2	3	3	2	3	2	-	2	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PARALLEL AND DISTRIBUTED DATABASES	**(9L)**

Centralized and Client – Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases & Architecture: I/O Parallelism – Inter and Intra Query Parallelism Design of Parallel Systems - Distributed Database Concepts - Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Transaction Processing –Transaction-processing monitors, transactional workflows, main-memory databases, real-time transaction systems, long-duration transactions, transaction management in multi-databases.	**CO-1** **BTL-2**
MODULE 2: OBJECT-BASED DATABASES AND XML	**(9L)**
Object-based databases – Complex data types, structured types and inheritance in SQL, table inheritance, array and multi set types in SQL, object identity and reference types in SQL, implementing O-R features, Persistent programming languages, OO vs OR.XML – Structure of XML, Document Schema, Querying and Transformation, API in XML, XML applications.	**CO-2** **BTL-3**
MODULE 3: OLAP AND DATA MINING	**(9L)**
On-line Analytical Processing – OLAP Bench Marks, applications, benefits, tools, categories, extensions to SQL, Data mining – introduction, techniques, predictive modelling tools. Data mining algorithms– Apriori, Decision Tree, K Means, Bayesian classifier.	**CO-3** **BTL-3**
MODULE 4: TRENDS IN DBMS	**(9L)**
More Recent Applications Mobile databases; Multimedia databases; Geographical Information Systems; Genome data management. Introduction to Data Warehousing – Concepts, Benefits and Problems, DW Architecture, DW admin and management tools, data marts – reasons and issues, Data Warehousing using Oracle. Data Warehousing Design–Designing, Dimensionality modelling, Design methodology, DW design using Oracle. Introduction to NoSQL databases.	**CO-4** **BTL-2**
MODULE 5: DATABASE SECURITY	**(9L)**
Security and integrity threats, Defense mechanisms, Statistical database auditing & control. Security issue based on granting/revoking of privileges, Introduction to statisticaldatabasesecurity.PL/SQL Security –Locks–Implicit locking, types and Levels of locks, explicit locking, Oracles' named Exception Handlers.	**CO-5** **BTL-3**
TEXTBOOKS	
1	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts",6th edition, Tata McGraw Hill, 2011
2	Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addison Wesley, 2007
REFERENCE BOOKS	
1.	Hector Garcia-Molina, Jeff Ullman, and Jennifer Wisdom, "Database Systems: The Complete Book", Pearson,2011.
2.	Niall O'Higgins, "MongoDB and Python", O'Reilly,2011.

E-BOOKS	
1.	https://www.coursera.org/projects/fundamentals-database-systems
MOOC	
1.	https://www.coursera.org/specializations/database-systems

COURSE TITLE	DATA VISUALISATION & INTERPRETATION		CREDITS		4	
COURSE CODE	ADS02002	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL-2	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/Quiz	Attendance	ESE	
15%	15%	10%	5%	5%	50%	

Course Description	This course introduces data literacy required as a key twenty-first-century skill. To understand the nature of data across different domains and the concepts and skills of data visualization by understanding, questioning, and problematizing how data are generated, analysed and examined the impacts of data-driven decisions.
Course Objective	To analyse visual representation methods and techniques that increases the understanding of complex data. To apply good design practices for visualization, and to learn tools for visualization of data using software like Tableau.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: To understand the basic principles of data visualisation. CO2: To evaluate data with different visual methods. CO3: To understand Graphical formats for various data types. CO4: Explore data visualizations and handling high dimensional data. CO5: Apply Tableau tool to understand various plots for real time applications

PREREQUISITES: NIL

S. N o	CO	Program Outcomes & Program Specific Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	CO-1	3	2	2	1	1	2	2	3	2	3	2	-	2	3	-
2	CO-2	2	2	3	1	2	2	2	3	2	3	2	-	2	-	2
3	CO-3	2	3	2	2	3	3	2	3	2	-	2	-	1	1	2

4	CO-4	2	2	2	1	2	3	2	3	2	-	2	-	2	1	2
5	CO-5	3	-	2	1	2	2	3	3	2	3	2	-	2	-	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	(9L+3T)
Introduction-How visualization affects data interpretation- Role of visualization in data science- Relationship between Visualization and Other Fields – The Visualization Process- Types of Data- Structure within and between Records- Data Preprocessing - Perception in Visualization Two flavours of data visualization: exploratory and communicative	CO1 BTL-2

MODULE 2: DESIGN PRINCIPLES	(9L+3T)
The Visualization Process in Detail-Semiology of Graphical Symbols -The Eight Visual Variables- Historical Perspective -Taxonomies	CO2 BTL-2

MODULES 3: VISUALIZATION TECHNIQUES FOR SPATIAL AND GEO SPATIAL DATA	(9L+3T)
One-Dimensional Data -Two-Dimensional Data - Three-Dimensional Data- Dynamic Data-Combining Techniques -Visualizing Spatial Data- Visualization of PointData - Visualization of Line Data -Visualization of Area Data- Other Issues in Geospatial Data Visualization	CO3 BTL-2

MODULE 4: VISUALIZATION TECHNIQUES FOR MULTIVARIATE DATA, TREES, GRAPHS, AND NETWORKS	(9L+3T)
Point-Based Techniques-Line-Based Techniques- Region-Based Techniques - Displaying Hierarchical Structures -Displaying ArbitraryGraphs/Networks -Levels of Text Representations - The Vector SpaceModel- Single Document Visualizations -Document Collection Visualizations	CO4 BTL-2

MODULE 5: DESIGNING EFFECTIVE VISUALIZATIONS USING TABLEAU	(9L+3T)
Steps in Designing Visualizations- Problems in Designing Effective Visualizations-Case studies: biology, healthcare, cyber security, climate science.	CO5 BTL-2

TEXTBOOKS	
1.	Ward, Grinstein Keim, Interactive Data Visualization: Foundations, Techniques, and Applications. Natick: A K Peters, Ltd, 1st Edition, 2010.
2.	Kieran Healy, Data Visualization: A Practical Introduction, 1st Edition, 2018
3.	Andy Krik, Data Visualization: a successful design process 1st Edition, 20124. Corey Lanum, Visualizing Graph Data1st Edition, 2016

REFERENCE BOOKS	
1.	Data Visualisation: A Handbook for Data Driven Design, Andy Kirk SAGE Publications,21-Jun-2016
2.	Effective Data Visualization, The Right Chart for the Right Data second edition Stephanie D. H. Evergreen - Evergreen Data & Evaluation, LLC, April 2019 SAGE Publications, Inc.

E-BOOKS	
1.	https://archive.org/details/the-visual-display-of-quantitative-information-2ed-by-tufte-edward-r.-z-lib.org/page/n85/mode/2up
MOOC	
1.	https://www.coursera.org/learn/fundamentals-of-data-visualization
2.	https://www.coursera.org/specializations/data-visualization

COURSE TITLE	ADVANCED DATABASE MANAGEMENT SYSTEMS LAB		CREDITS	1	
COURSE CODE	ACS02400	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNIG LEVEL	BTL3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This module builds on the introductory module in databases. It intends to introduce more advanced topics in databases such as data mining and data warehousing, distributed databases, and client server architecture after introducing the DBMS implementation.				
Course Objective	This module aims to give students in depth information about system implementation techniques, data storage, representing data elements, database system architecture, the system catalog, query processing and optimization, transaction processing concepts, concurrency control techniques, database recovery techniques, database security and authorization, and enhanced data models for advanced applications, temporal databases, deductive databases, database technology for decision support systems, distributed databases and client-server architecture, advanced database concepts, and emerging technologies and applications like XML databases.				
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Understand the basics of SQL and construct queries using SQL. CO2: Apply Advance SQL Query like Cursors, Procedures and Triggers. CO3: Ability to validate and store data in XML Data Base. CO4: Evaluate partitioned sort and joins on Parallel data base design. CO5: To create ODL Schema for OODBS.				
PREREQUISITES: DBMS					

S. No	CO	Program Outcomes & Program Specific Outcomes														
		PO 1 EK	PO 2 PA	PO 3 DS	PO 4 IOC	PO 5 MT	PO 6 ES	PO 7 ESU	PO 8 ETH	PO 9 IT	PO 10 COM	PO 11 PF	PO 12 LL	PSO 1	PSO 2	PSO 3
1	CO- 1	3	2	2	1	1	2	2	3	2	3	2	-	2	3	-
2	CO- 2	2	2	3	1	2	2	2	3	2	3	2	-	2	-	2
3	CO-3	2	3	2	2	3	3	2	3	2	-	2	-	1	1	2
4	CO-4	2	2	2	1	2	3	2	3	2	-	2	-	2	1	2
5	CO-5	3	-	2	1	2	2	3	3	2	3	2	-	2	-	3
1: Weakly related, 2: Moderately related and 3: Strongly related																

Design, develop, and implement the specified queries for the following problems using Oracle, MySQL, MS SQL Server, or any other DBMS under LINUX/Windows environment. Create a Schema and insert at least 5 records for each table. Add appropriate database constraints.

1. Consider the following schema for a Library Database:

BOOK(Book_id, Title, Publisher_Name, Pub_Year)

BOOK_AUTHORS(Book_id, Author_Name)

PUBLISHER(Name, Address, Phone)

BOOK_COPIES(Book_id,Programme_id,No-of_Copies)

BOOK_LENDING(Book_id,Programme_id,Card_No,Date_Out,Due_Date)

LIBRARY_PROGRAMME(Programme_id, Programme_Name, Address)

Write SQL queries to

    a) Retrieve details of all books in the library–id, title, name of publisher, authors, number of copies in each program, etc.

    b) Get the particulars of borrowers who have borrowed more than 3 books, but from Jan 2017 to Jun 2017.

    c) Delete a book in BOOK table. Update the contents of other table store reflect this data manipulation operation.

    d) Partition the BOOK table based on year of publication. Demonstrate its working with a simple query.

    e) Create a view of all books and its number of copies that are currently available in the Library.

2. Consider the following schema for Order Database:	

SALESMAN (Salesman_id, Name, City, Commission)
CUSTOMER(Customer_id,Cust_Name,City,Grade,Salesman_id)
ORDERS(Ord_No,Purchase_Amt,Ord_Date,Customer_id,Salesman_id)
Write SQL queries to
  a) Count the customers with grades above Bangalore's average.
  b) Find the name and numbers of all salesman who had more than one customer.
  c) List all the salesman and indicate those who have and do not have customers in their cities (Use UNION operation.)
  d) Create a view that finds the salesman who has the customer with the highest order of a day.
  e) Demonstrate the DELETE operation by removing salesman with id 1000. All his orders must also be deleted.

3. To understand stored procedures (PL/SQL block, Cursors, Functions and Procedures)

4. To understand the concept of triggers in oracle
        a. To create a Triggers.
        b. Write SQL code for Types of triggers.

5. To write XML documents and store in database

        a. To understand how to create a simple xml file for note and catalog.
        b. To create a simple internal and external DTD.
        c. To create a xml schema for note and ship order.
        d. To display the xml through CSS and XSL for catalog.
        e. To fetch the xml data through scripts and by using a parsers.

6. Case study to Evaluate and Design Partitioned sort and Fragment and replicate joins Queries on Parallel data base design. -Employee Relation

7. Case study to create ODL Schema for the University Data Base.

TEXTBOOKS	
1.	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 6th edition, Tata McGraw Hill, 2011.
2.	Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", 4th Edition, Pearson/Addision Wesley, 2007
REFERENCE BOOKS	
1	Hector Garcia - Molina, Jeff Ullman, and Jennifer Wisdom, "Database Systems: The Complete Book", Pearson, 2011.
2	XML: The Complete Reference, by Heather Williamson, McGraw Hill Education 2001.
E-BOOKS	
1.	https://github.com/mariush2/tdt4145/blob/master/Fundamentals%20of%20Database%20Systems%20(7th%20edition).pdf
2.	https://www.doc-developpement-durable.org/file/Projets-informatiques/cours-&-manuels-informatiques/Sql/SQL-%20A%20Beginner's%20Guide,%203rd%20Edition.pdf
3	https://riptutorial.com/Download/xml.pdf
MOOC	

1.	https://cosmolearning.org/courses/database-design-417/video-lectures/
2.	https://freevideolectures.com/course/2668/database-management-system
3	https://archive.nptel.ac.in/courses/106/105/106105175/

COURSE TITLE	DATA VISUALISATION & INTERPRETATION LAB		CREDITS		1	
COURSE CODE	CDS02400	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL2	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE	
15%	15%	10%	5%	5%	50%	

Course Description	This course introduces data literacy required as a key twenty-first century skill. You will learn the nature of data across different domains and the concepts and skills of data visualization by understanding, questioning, and problematizing how data are generated, analyzed, and used. You will be able to apply its concepts and skills to visualize your own data, interpret the findings, and examine the Impacts of data - driven decisions.
Course Objective	This course enables the students: ● To interpret data plots and understand core data visualization concepts such as correlation, linear relationships, and log scales. ● To explore the relationship between two continuous variables using scatterplots and line plots. ● To translate and present data and data correlations in a simple way, data Analysts use a wide range of techniques — charts, diagrams, maps, etc.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Understand basic Data Visualisation tools. CO2: Design effective data visualizations in order to provide new insights using various plots. CO3: Find and select appropriate data that can be used in order to create a visualization that answers a particular real time Example. CO4: Able to understand different frameworks for data visualizations. CO5: Design and implement various dash boards using Tableau.

PREREQUISITES: NIL

S. No	CO	Program Outcomes & Program Specific Outcomes														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	CO-1	3	2	2	1	1	2	2	3	2	3	2	-	2	3	-
2	CO-2	2	2	3	1	2	2	2	3	2	3	2	-	2	-	2
3	CO-3	2	3	2	2	3	3	2	3	2	-	2	-	1	1	2

| 4 | **CO-4** | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | - | 2 | - | 2 | 1 | 2 |
| 5 | **CO-5** | 3 | - | 2 | 1 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | - | 2 | - | 3 |

1: Weakly related, 2: Moderately related and 3: Strongly related

LAB Work

List of Programs

Uses the data visualisation tools like Tableau, Open heatmap, Microsoft Power BI, Google Data Studio to create the following

1. Loading and Distinguishing Dependent and Independent parameters.

2. Exploring Data Visualization tools.

3. Drawing Charts like pie chart, bar chart, histogram using matplotlib in python.

4. Drawing Graphs.

5. Creating Scatter Plot maps.

6. Create a choropleth map colour, shading, and other patterns to visualize numerical values across geographic regions of India

7. Understanding Data Visualization frameworks 4

8. Installations of Tableau tool and understanding the basic Aggregation Methods in Tableau.

9. Create Basic Dashboards using Tableau for HR data analysis.

10. Create a heatmaps to analyse which time of day are tail store makes the most sales.

TEXTBOOKS

| 1 | E. Tufte, The Visual Display of Quantitative Information, Graphics Press. 2nd Edition, 2001. |
| 2 | Alexandru C Telea, Data Visualization: Principles and Practice, 2nd Edition, 2014 |

REFERENCE BOOKS

| 1 | Wang Kaining, Infographic & Data Visualizations, sew Edition, 2013. |
| 2 | Andy Krik, Data Visualisation: A Handbook for Data Driven Design, 1st Edition. |

E-BOOKS

| 1. | https://www.perceptualedge.com/articles/beye/visual_multivariate_analysis.pdf |
| 2. | https://pdfs.semanticscholar.org/6b2a/08d0085c5513c76fb110fb4c7b554eee9344.pdf |

MOOC

| 1. | https://towardsdatascience.com/the-art-ofeffective-visualization-of-multi-dimensional-data6c7202990c57 |
| 2. | https://uxdesign.cc/multivariate-datavisualization-and-the-limits-of-human-perception60ad47b4f59f |

SEMESTER II					
COURSE TITLE	**MACHINE LEARNING**		**CREDITS**	**3**	
COURSE CODE	**ADS02003**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
VERSION	**1.0**	**APPROVAL DETAILS**	**38-ACM 13-05-2023**	**LEARNING LEVEL**	**BTL3**
ASSESSMENT SCHEME					

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ assignments/ Project**	**Surprise Test/ Quiz**	**Attendance**	**ESE**
15%	15%	10%	5%	5%	50%

Course Description	This course deals with various algorithms to enable computers to learn data without being explicitly programmed. An insight into various types of machine learning algorithms, strategies for model generation and evaluation are given in this course. The fundamental machine learning algorithms required in industries are covered together with their concrete implementations.
Course Objective	To understand the concepts of Machine Learning and appreciate supervised learning, unsupervised and learning algorithms and its applications and their applications in real world situations.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Design a learning model using classification algorithms for different types of classes and understand its measures. CO2: Apply advance clustering techniques for any real time applications and use Dimensionality reduction techniques like UMap. CO3: Understand and evaluate Clustering algorithms. CO4: Design probabilistic graphic models. CO5: Able to understand reinforcement learning and its applications in real world scenarios.

PREREQUISITES: NIL

S. No	CO	Program Outcomes & Program Specific Outcomes													
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	**CO-1**	2	2	1	1	1	-	1	-	-	1	-	2	2	2	1
2	**CO-2**	2	2	1	1	1	-	1	-	1	-	-	1	1	1	1
3	**CO-3**	2	1	1	1	2	-	1	-	-	-	-	2	1	2	1
4	**CO-4**	2	2	1	2	1	2	2	3	2	3	-	2	3	-	-
5	**CO-5**	2	2	2	3	3	1	3	2	2	-	1	3	2	2	2
1: Weakly related, 2: Moderately related and 3: Strongly related																

MODULE 1: INTRODUCTION	**(9L)**

Machine Learning – Types of Machine Learning – Machine Learning process-preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning Probability theory –Probability Distributions – Decision Theory	**CO1** **BTL2**

MODULE 2: SUPERVISED LEARNING	**(9L)**
Classification models- Binary, Multi-class, Multi-Label Classifier. Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Over fitting and Underfitting. Bayesian Learning, Naïve Bayes. Stochastic Gradient Descent, Ensemble Methods, Bagging, Boosting, Neural Networks, Support Vector Machine, Self-Organising Maps.	**CO2** **BTL3**

MODULE 3: UNSUPERVISED LEARNING	**(9L)**
Clustering- K-means – Methods to identify the value of 'K' in K-mean Density Based Clustering, EM Algorithm - Gaussians Mixture Model, BIRCH algorithm, Affinity Propagation clustering algorithm, Mean-Shift clustering algorithm, OPTICS. Dimensionality Reduction-IDA, PCA, UMAP Clustering Evaluation strategies - Clustering tendency, Number of clusters 'k', Clustering quality Measures.	**CO3** **BTL3**

MODULE 4: PROBABILISTIC GRAPHICAL MODELS	**(9L)**
Graphical Models– Undirected Graphical Models – Markov Random Fields – Directed Graphical Models–Bayesian Networks–Conditional Independence properties – Markov Random Fields Hidden Markov Models – Conditional Random Fields (CRFs).	**CO4** **BTL3**

MODULE 5: ADVANCED LEARNING	**(9L)**
Sampling - Basic Sampling methods, Monte Carlo, Gibbs Sampling – Computational Learning Theory – Mistake Bound Analysis – Reinforcement learning – Markov Decision processes, Deterministic and Non-deterministic Rewards and Actions, Temporal Difference Learning Exploration.	CO5 BTL3

TEXTBOOKS	
1.	Christopher Bishop, "Pattern Recognition and Machine Learning" Springer, 2007
2.	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, C R C Press, Second Edition, 2014.

REFERENCE BOOKS	
1.	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
2.	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
3.	Tom Mitchell, "Machine Learning", McGraw-Hill,1997.

E-BOOKS	
1.	https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf

MOOC	
1.	https://nptel.ac.in/courses/106106139
2.	https://www.coursera.org/specializations/machine-learning-introduction

COURSE TITLE	FOUNDATION FOR DATA ANALYTICS		CREDITS		3	
COURSE CODE	ADS02004	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL3	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance		ESE
15%	15%	10%	5%	5%		50%

Course Description	This course helps to understand the foundational principles of Data Analytics, its tools and techniques.
Course Objective	To understand the various concepts in Data analytics its applications. To understand the data analytics tools environment and implementation in Python and R.
Course Outcome	Upon successful completion of the course, the student will be able to: CO1: Demonstrate the basic knowledge of data. CO2: To understand data typologies and its governance. CO3: Apply optimization and forecasting techniques to real world business applications. CO4: To understand Business statistics. CO5: Create and analyse real world applications using tools like R, Python.

PREREQUISITES: NIL

MODULE 1: DATA AND WORKING WITH DATA	9L+3T
Analysis of data has led to discovery and innovation. Data can be used to reduce uncertainty and risk related to organizational decisions. Risks of poor data management. Examples of data sources. Types of analytics and its uses - Descriptive, predictive and Prescriptive Data Analytics. Data exploration using Microsoft Excel. Collation and Analysis of data from multiple sources.	CO1 BTL2

MODULE 2: DATA TYPOLOGIES AND GOVERNANCE	(9L+3T)
Data representation. Classification of data captured and formatted. Differentiate common data typologies. Capture, store and retrieve information from unstructured data. data warehouses vs data lakes. Dimensions of data quality. Data cleaning and preparation methods. Online Transaction Processing (OLTP) vs Online Analytical Processing (OLAP). Stages of the data life cycle. Case study on data collection system - To efficiently prepare, explore, and interpret data.	CO2 BTL2

MODULE 3: BUSINESS STATISTICS	(9L+3T)
Measurement scales applied to data. Summarization of data using statistical terminologies. Data sampling techniques. Probability rules to apply on data. Application of the Central Limit Theorem. Hypothesis testing to a scenario.	CO3 BTL2

MODULE 4: OPTIMIZING AND FORECASTING	(9L+3T)
Differentiate correlation and causation - Linear regression and its usage in organizations. Interpretation of regression analysis - Microsoft excel, Python-Pandas. Linear programming problems. Interpret the output of a linear programming optimization simulation.	**CO4** **BTL3**
MODULE 5: DATA MANIPULATION TOOLS AND TECHNIQUES	**(9L+3T)**
Data Manipulation using pandas: Installing and using Pandas – Introducing pandas objects – Data indexing and selection – handling missing data, merging, and joining sets, aggregation, and grouping – R programming Overview – Loading data into R– Modelling methods. NoSQL database – Working of Apache Hadoop's Map Reduce.	**CO5** **BTL3**

TEXTBOOKS	
1	Foundations of Data Analytics, 1st Edition John W. Foreman, Ken Black, R. Kelly Rainer, Brad Prince, Hugh J. Watson, Steve Wexler, Jeffrey Shaffer, Andy Cotgrave ISBN: 978-1-119-55056-3 July 2018.Oreilly publications
2	J. Grus, Data Science from Scratch: First Principles with Python,1st edition. Sebastopol, CA: O'Reilly Media, 2015.
3	N. Zumeland J. Mount, Practical data science with R. Shelter Island, NY: Manning Publications Co, 2014.

REFERENCE BOOKS	
1.	L. Pierson and J. Porway, Data science, 2nd edition. Hoboken, N J. John Wiley And Sons, Inc, 2017.
2.	C. O'Neiland R. Schutt, Doing Data Science: Straight Talk from the Frontline, 1st edition. Beijing; Sebastopol: O'Reilly Media, 2013.
3.	J. Vander Plas, Python Data Science Handbook: Essential Tools for Working with Data, First edition. Shroff / O'Reilly,2016.
4.	S. R. Das, Data Science: Theories, Models, Algorithms, and Analytics. https://srdas.github.io/MLBook/.

E-BOOKS	
1.	http://www.deeplearningbook.org
2.	https://spark.apache.org/docs/latest/rdd-programming-guide.html#transformations.
3.	http://cs229.stanford.edu/notes/cs229-notes1.pdf

MOOC	
1.	https://nptel.ac.in/courses/106101224

COURSE TITLE	INFORMATION RETRIEVAL AND TEXT MINING			CREDITS	4
COURSE CODE	ADS02005	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-23	LEARNING LEVEL	BTL–3

ASSESSMENT SCHEME

First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Assignment	Seminar	Attendance	ESE(Theory)
15%	15%	10%	5%	5%	50%

Course Description	This course aims to introduce the domain of Information Retrieval and examine the theoretical and practical issues involved in design, implementation and evaluation of IR systems. To understand Text Mining Concepts.
Course Objective	• Learn the information retrieval models and familiarize Web Search Engines. • To Learn document text mining techniques.
Course Outcome	Upon completion of this course, the students will be able to: CO1: Understand the basics of Information Retrieval and Techniques of Text Mining. CO2: To understand web search basics, web crawling, indexing and link analysis. CO3: To analyse different Ranking algorithms. CO4: Implement retrieval systems for web search tasks. CO5: Ability to design different document clustering and classification algorithms.

PREREQUSITE: PROGRAMMING KNOWLEDGE

S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
							Program Outcomes & Program Specific Outcomes								
1	**CO-1**	2	2	1	1	1	-	1	-	1	-	2	2	2	1
2	**CO-2**	2	2	1	1	1	-	1	-	-	-	1	1	1	1
3	**CO-3**	2	1	1	1	2	-	1	-	-	-	2	1	2	1
4	**CO-4**	2	2	1	2	1	2	2	3	3	-	2	3	-	-
5	**CO-5**	2	2	2	3	3	1	3	2	-	1	3	2	**2**	2
	1: Weakly related, 2: Moderately related and 3: Strongly related														

MODULE 1: INTRODUCTION	9L+6P
Introduction – History of IR – Components of IR – Issues – Open-source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search – Components of a Search engine -Characterizing the web. **Practical Component:** 1. Case Study on any Domain Specific Search Engine.	CO-1 BTL-2

2. Case Study of IR system for Micro blogging	
MODULE 2: INFORMATION RETRIEVAL	**9L+6P**

Boolean and vector-space retrieval models - Term weighting - TF-IDF weighting-cosine similarity – Pre-processing - Inverted indices - efficient processing with sparse vectors – Language Model based IR - Probabilistic IR –Latent Semantic Indexing - Relevance feedback and query expansion.
 	
Practical Component:
Write the program for the following:
   1. To count word frequency in a given text file.
   2. To measure the rank of the specific word for its relevancy within a text document using IDF.
   3. To implement text-vectorization using TF-IDF model.
	CO-2
	BTL-3

MODULE 3: WEB SEARCH ENGINE & CRAWLING	**9L+6P**
Web search overview, web structure, the user, paid placement, search engine optimization/spam-Web size measurement -search engine optimization/spam – Web Search Architectures - crawling - meta-crawlers- Focused Crawling - web indexes –- Near-duplicate detection - Index Compression - XML retrieval **Practical Component:** 1. To implement web crawling using Breadth First Search/Depth First Search. 2. Write a program to crawl a given webpage and find most frequently used words. 3. Write a program to crawl a given web page and scrap the complete content of the URL.	**CO-3** **BTL-3**
MODULE 4: WEB SEARCH–LINK ANALYSIS AND SPECIALIZED SEARCH	**9L+6P**
Link Analysis –hubs and authorities – Page Rank and HITS algorithms -Searching and Ranking – Relevance Scoring and ranking for Web – Similarity - Hadoop & Map Reduce – Evaluation – Personalized search – Collaborative filtering and content-based recommendation of documents and products – handling "invisible" Web – Snippet generation, Summarization, Question Answering, Cross-Lingual Retrieval. **Practical Component:** 1. Write a Program to implement Power Method for computing Page Rank. 2. Write a Program to implement Random Walk method for computing Page Rank. 3. Write a program to display top three websites for a given keyword using Page Ranking Algorithm.	**CO-4** **BTL-3**
MODULE 5: DOCUMENT TEXT MINING	**9L+6P**
Information filtering; organization and relevance feedback – Text Mining -Text classification and clustering - Categorization algorithms: naive Bayes; decision trees; and nearest neighbour - Clustering algorithms: agglomerative clustering; k-means; expectation maximization (EM). **Practical Component:** 1. Write a Program to convert multiple text documents into clusters based on types using clustering algorithm (use TD-IDF approach for feature extraction).	**CO-5** **BTL-3**

	2. Write a Program to convert multiple text documents into clusters based on topics using clustering algorithm (use bag of words approach for feature extraction).	

TEXTBOOKS		
1.	C. Manning, P. Raghavan, and H. Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2.	Ricardo Baeza – Yates and Berthier Ribeiro - Neto, Modern Information Retrieval: The Concepts and Technology behind Search 2nd Edition, ACM Press Books 2011.
3.	Bruce Croft, Donald Metzlerand Trevor Strohman, Search Engines: Information Retrieval in Practice, 1st Edition Addison Wesley, 2009.
REFERENCE BOOKS	
1.	Mark Levene, An Introduction to Search Engines and Web Navigation, 2nd Edition Wiley, 2010.
2.	Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010.
3.	Ophir Frieder "Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series ", 2nd Edition, Springer, 2004.
4.	Manu Konchady, "Building Search Applications: Lucene, Ling Pipe", and First Edition, Gate Mustru Publishing, 2008.
EBOOKS	
1.	https://nlp.stanford.edu/IR-book/
MOOC	
1.	https://www.coursera.org/learn/text-retrieval
2.	https://www.coursera.org/learn/search-engine

COURSE TITLE	CYBER SECURITY AND DATA PROTECTION		CREDITS		4	
COURSE CODE	CDS02006	COURSE CATEGORY	PC	L-T-P-S	3-1-0-0	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL2	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE	
15%	15%	10%	5%	5%	50%	
Course Description	This course introduces the key components and principles of security. The security attacks and management roles are presented and their relative merits are evaluated based on performance measures. Explains the cyber security policies and procedures for organizations. Describes the importance of data protection.					

Course Objective	Understand cyber security and apply its principles. Understand the risk management and risk assessment. Learn different policies and security standards for security. Apply data protection strategies. Able to analyse the laws required for data protection.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Describe, explain and use cyber security principles. CO2: Design and Implement risk management and assessment frameworks. CO3: Able to understand and implement security policies and testing. CO4: Able to understand various data protection techniques. CO5: Able to apply the laws required for data protection.

PREREQUISITES: NIL

Program Outcomes & Program Specific Outcomes															
S No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO-1	1	1	1	1	1	-	-	-	-	-	-	-	1	1	1
2	CO-2	2	1	2	2	2	2	-	-	-	-	-	-	2	3	1
3	CO-3	2	2	2	2	3	3	1	2	2	-	1	2	2	3	2
4	CO-4	2	2	2	3	3	-	-	-	1	-	2	2	2	3	3
5	CO-5	3	3	3	3	3	3	-	-	1	-	2	-	1	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO CYBER SECURITY	(9L+3T)
Introduction – Need for cyber security – types of cyber-attacks – Malware-based Attacks – Phishing attacks – Denial of Service (DOS) and Distributed Denial of Service (DDoS)– Man-in-the-middle attack(MitM)– Fundamental principles of	CO1 BTL2

Security – Cyber security Architecture – Features of Cyber security Architecture Elements of Cybersecurity –Application Security – Information Security–Network Security – Disaster Recovery Planning – Operational Security – End-user Security.	
MODULE 2: SECURITY MANAGEMENT AND ASSESSMENT	**(9L+3T)**
Cybersecurity Risk Management – Need for Risk Management – risk management process – Cyber Risk Management Frameworks – cyber risk assessment – Importance of risk assessment in cybersecurity – Component sofa Cybersecurity risk assessment – Cyber risk assessment framework(RAF).	CO2 BTL2
MODULE 3: SECURITY POLICIES AND TESTING	**(9L+3T)**
Cyber Security Policy - Need of Security policies - cybersecurity policies for any organization – Statutory policies against Cyber Crimes - Threat to E-Commerce - Security Standards – ISO-Intellectual Property in the Cyber world - Certification and Accreditation – C & A Tasks – Tools Used for Certification and Accreditation – Security Testing – Types of Security Testing – Techniques in Security Testing.	CO3 BTL2
MODULE 4: INTRODUCTION TO DATA PROTECTION	**(9L+3T)**

Data Protection – Principles of Data Protection - Data Protection Strategy – Why is Data Security Important? - Data Security Consideration – Types of Data Security Controls – Trends in Enterprise Data Protection. The convergence of disaster recovery and backup – Archival Storage – Disposal of Data – Data portability – Data protection Trends.	CO4 BTL2

MODULE 5: DATA PROTECTION AND PRIVACY LAWS	**(9L+3T)**
Data Protection Act – Eight Principles of the Data Protection Act - International Transfer of Data – Data Privacy Laws – Organizations Protect Their Data – Information Technology Act 2000 – Digital Signature – Electronic Governance – Secure electronic records.	CO5 BTL2

TEXTBOOKS	
1.	Lawrence C. Miller, "Cybersecurity for Dummies"-Palo Alto Network, by John Wiley & Sons, Inc., 2nd Edition, 2016.
2.	Chuck Easttom, Jeff Taylor, "Computer Crime, Investigation and the Law", Course Technology, 2018.

REFERENCE BOOKS	
1.	Christopher J Hodson "Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls", 2017.
2.	Garima Tiwari, "Understanding Cyber Laws and Cyber Crimes", Lexis Nexis

E-BOOKS	
1.	http://www.uou.ac.in/sites/default/files/slm/Introduction-cyber-security.pdf
2.	https://www.upguard.com/blog/cyber-security-risk-assessment

MOOC	
1.	https://www.edx.org/course/cybersecurity-fundamentals
2.	https://www.udemy.com/course/cyber-security-risk-management/
3.	https://www.coursera.org/specializations/cyber-security

COURSE TITLE	MACHINE LEARNING LAB USING PYTHON		CREDITS		1	
COURSE CODE	ADS02401	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BT L3	
ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/Quiz	Attendance	ESE	
15%	15%	10%	5 %	5%	50 %	

Course Description	This course deals with various algorithms to enable computers to learn data without being explicitly programmed. An insight into various types of machine learning algorithms, strategies for model generation and evaluation are given in this course. The fundamental machine learning algorithms required in industries are covered together with their concrete implementations.
Course Objective	• To understand fundamental concepts of machine learning and its various algorithms. • To understand various strategies of generating models from data and evaluating them. • To apply ML algorithms on given data and interpret the results obtained • To design appropriate ML solution to solve real world problems in AI domain.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Develop a good understanding of fundamental principles of machine learning. CO2: Formulation of a Machine Learning problem. CO3: Develop a model using supervised/unsupervised machine learning algorithms for classification/prediction/clustering. CO4: Evaluate performance of various machine learning algorithms on various data sets of a domain. CO5: Design and Concrete implementations of various machine learning Algorithms to solve a given problem using languages such as Python.

PREREQUISITES: Basic Python Programming

Program Outcomes & Program Specific Outcomes

S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PS O 2	PSO 3
1	CO-1	1	1	1	1	1	-	-	-	-	-	-	-	1	1	1
2	CO-2	2	1	2	2	2	2	-	-	-	-	-	-	2	3	1
3	CO-3	2	2	2	2	3	3	1	2	2	-	1	2	2	3	2
4	CO-4	2	2	2	3	3	-	-	-	1	-	2	2	2	3	3
5	CO-5	3	3	3	3	3	3	-	-	1	-	2	-	1	1	2
Weakly related, 2: Moderately related and 3: Strongly related																

Lab Work

List of Lab Practical

1. Solving Regression & Classification using Decision Trees.

2. Root Node Attribute Selection for Decision Trees using Information Gain.

3. Bayesian Inference in Gene Expression Analysis.

4. Pattern Recognition Application using Bayesian Inference.

5. Bagging in Classification.

6. Bagging, boosting applications using Regression Trees.

7. Data & Text Classification using Neural Networks.

8. Using Wekatool for SVM classification for chosen domain application.

9. Data & Text Clustering using K-means algorithm.

10. Data & Text Clustering using Gaussian Mixture Models.

11. Dimensionality Reduction Algorithms in Image Processing applications.

12. Application of CRFs in Natural Language Processing.

TEXTBOOKS	
1	Introduction to Machine learning, Nils J. Nil
2	Machine learning for dummies, IBM Limited ed, by Judith Hurwitz and Daniel

REFERENCE BOOKS	
1	20175. Andreas Muller and Sarah Guido, "Introduction to Machine Learning With Python: A Guide for Data Scientists", Shroff/O'Reilly, 2016.
2	Aurolien Geron, "Hands – On Machine Learning with Scikit-Learn and Tensor Flow, Shroff/O'Reilly",
3	Alejandro Barredo Arrieta, Natalia D´ıaz-Rodr´ıguez, Javier Del Ser, et.al.," Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI, Information Fusion", Volume 58, 2020, Pages82-115, ISSN1566-2535.

E-BOOKS	
1.	https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/understanding-machine-learning-theory-algorithms.pdf

MOOC	
1.	https://ocw.mit.edu/courses/6-036-introduction-to-machine-learning-fall-2020/
2.	https://www.my-mooc.com/en/categorie/machine-learning

COURSE TITLE	FOSS LAB FOR DATA SCIENCE		CREDITS		1	
COURSE CODE	ADS02402	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0	
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL3	

ASSESSMENT SCHEME						
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments / Project	Surprise Test/ Quiz	Attendance	ESE	
15%	15%	10%	5%	5%	50%	

Course Description	Data science requires a vast array of tools. The tools for data science are used for analysing data, creating interactive visualizations. These tools help to know the powerful predictive models using machine learning algorithms.
Course Objective	To understand data science tools that cater to the application domains of data science. To Understand data science tools like SAS, Apache Spark, ggplot and Tensor Flow.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Demonstrate the basic knowledge of data science process. CO2: Demonstrate the software environment and apply various techniques to work with data. CO3: Able to use and visualize the data using tools like tensor flow. CO4: Develop simple data science applications. CO5: Able to use visualize data using MATLAB.

PREREQUISITES: NIL

Program Outcomes & Program Specific Outcomes															
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO-1	1	1	1	1	1	-	-	-	-	-	-	-	1	1	1
2	CO-2	2	1	2	2	2	2	-	-	-	-	-	-	2	3	1
3	CO-3	2	2	2	2	3	3	1	2	2	-	1	2	2	3	2
4	CO-4	2	2	2	3	3	-	-	-	1	-	2	2	2	3	3
5	CO-5	3	3	3	3	3	3	-	-	1	-	2	-	1	1	2
1: Weakly related, 2: Moderately related and 3: Strongly related															

List of Practical	BTL2
1.Statistical modelling and organization of data using base SAS programming language.	

2.To handle batch processing and Stream Processing or to make prediction for a given data set using Apache Spark.

3. Predictive modelling using Big ML.

4. Use D3.js, java script library to make interactive visualizations on your web-browser.

5. MATLAB to simulate neural networks.

6. MATLAB to simulate fuzzy logic.

7. Use ggplot2 data science tool to style maps such as choropleths, cartograms etc. Introduction to Tensor Flow tool for advanced machine learning algorithms like Deep Learning. Experiment on speech recognition, image classification.

8. Case Study: Analysing death rates in the India due to Covid.

a) Data Gathering   b)Data Analysis   c)Data Visualization & Interpretation

9. Case Study: Analysing the sales data of any E-Commerce website

a) Data Gathering   b)Data Analysism   c)Data Visualization & Interpretation

TEXTBOOKS

1,	J. Janssens, Data science at the command line, First edition, Sebastopol, CA: O'Reilly,20
2.	N. Zumeland J. Mount, Practical data science with R. Shelter Island, NY: Manning Publications Co,2014.

REFERENCEBOOKS

1	L. Pierson and J. Porway, Data science, 2nd edition. Hoboken, N J: John Wiley and Sons, Inc, 2017.
2	C.O 'Neiland R. Schutt, Doing Data Science: Straight Talk from the Frontline, 1st edition. Beijing; Sebastopol: O'Reilly Media, 2013.
3	J. Vander Plas, Python Data Science Handbook: Essential Tools for Working with Data, 1st edition. Shroff/O'Reilly, 2016.

E-BOOKS

1	http://www.deeplearningbook.org
2	https://spark.apache.org/docs/latest/rdd-programmingguide.html#transformations.
3	http://cs229.stanford.edu/notes/cs229-notes1.pdf

MOOC

1	https://nptel.ac.in/courses/106101224

SEMESTER III					
COURSE TITLE	**ETHICS OF DATA SCIENCE**			**CREDITS**	**3**
COURSE CODE	**ADS02007**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
VERSION	**1.0**	**APPROVAL DETAILS**	**38-ACM 13-05-2023**	**LEARNING LEVEL**	**BTL–3**
ASSESSMENT SCHEME					

First Periodical Assessment (Theory)	**Second Periodical Assessment (Theory)**	**Assignment**	**Seminar**	**Attendance**	**End Semester Examination (Theory)**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	As the impact of data science continues to grow on society there is an increased need to discuss how data is appropriately used and how to address misuse. Yet, ethical principles for working with data have been available for decades. The course helps to understand the principles of ethics.
Course Objective	This course will help to recognize where ethical issues can arise when applying data science to real world problems. It will bring more analytic precision to ethical debates about the role that data science, machine learning, and artificial intelligence play in consequential decision-making in commerce, employment, finance, healthcare, education, policing, and other areas.
Course Outcome	Upon successful completion of this course, students will be able to: 1. Able to understand the potential harms of data collection, aggregation, and analysis typically found in applied data science contexts. 2. To know the most important terminology of ethics that applies to data science. 3. To understand writing ethical assessments (e.g., a memorandum)of a data science analysis or an automated system incorporating data science. 4. Analyse in articulating the reasoning behind the most important ethical challenges of data science. 5. Ability to apply ethics to course domains of privacy, bias/classification, provenance/aggregation and accountability/consequences.

S. No	CO	Program Outcomes & Program Specific Outcomes														
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	CO-1	2	2	1	1	1	-	1	-	-	1	-	2	2	2	1
2	CO-2	2	2	1	1	1	-	1	-	1	-	-	1	1	1	1
3	CO-3	2	1	1	1	2	-	1	-	-	-	-	2	1	2	1

| 4 | CO-4 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 3 | 2 | 3 | - | 2 | 3 | - | - |
| 5 | CO-5 | 2 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 2 | - | 1 | 3 | 2 | 2 | 2 |

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION AND DATA PRIVACY	(9L+3T)
Data Science Ethics - Data Science vs Privacy – Privacy – Respecting Data Science - Possibilities – The Five Cs-Consent, Clarity, Consistency and Trust, Control and Transparency, Consequences.	CO-1 BTL-2
MODULE 2: ETHICS AND SECURITY TRAINING	**(9L+3T)**
Ethics and Security Training Developing Guiding Principles, Building Ethics into a Data-Driven Culture, Regulation, Building Our Future	CO-2 BTL-2
MODULE 3: ACCOUNTABILITY AND GOVERNANCE	**(9L+3T)**
Controlling large, automated systems effectively. Responsibility of individual. Algorithm Auditing, External Auditing, and Reverse Engineering. Regressing/progressive acts in data science.	CO-3 BTL-2
MODULE 4: DATA PROVENANCE AND AGGREGATION	**(9L+3T)**
Challenges of "public" data - Sampling as an ethical problem - Ethical claims.	CO-4 BTL-2
MODULE 5: DATA ETHICS FOR BUSINESS	**(9L+3T)**
Principles of data ethics for business – Ownership – Transparency – Privacy – Intention - Outcomes Case study on Applications of Data Analytics in Business and Health care.	CO-5BTL-2

TEXTBOOKS	
1.	Ethics and Data Science by Mike Loukides, Hilary Mason, D J Patil Released July 2018 Publisher(s): O'Reilly Media, Inc. ISBN:9781492043881

REFERENCE BOOKS	
1.	Loukides, Mike, Hilary Mason, and D J Patil, 2018. Ethics and Data Science. Sebastopol, CA: O'Reilly Media. Chapter 1, "Doing Good Data Science".
2.	Wallach, Hanna, BigData, Machine Learning, and the Social Sciences: Fairness, Accountability, and Transparency. December 14, 2014. Medium.com.
3.	Ananny, Mike and Kate Crawford. (2018)"Seeing without knowing: Limitations of the transparency ideal and its application to algorithmic accountability." New Media & Society20.3:973-989.

MOOC	
1	https://www.coursera.org/learn/data-science-ethics

COURSE TITLE	DATA WRANGLING			CREDITS	4
COURSE CODE	ADS02008	COURSE CATEGORY	PC	L-T-P-S	3-0-2-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL–3

ASSESSMENT SCHEME

First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Assignment	Seminar	Attendance	End Semester Examination (Theory)
15%	15%	10%	5%	5%	50%

Course Description	This course introduces Data wrangling or data munging and its process of transforming data, to help improve data usability for the end system or for data analysis.
Course Objective	• Understand Data Wrangling and its principles. • Learn different Data Workflow framework. • Understand the dynamics of data wrangling.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Describe, explain and use data wrangling principles. CO2: Design and Implement data workflow frameworks. CO3: Able to understand profiling and transformation of data. CO4: Able to understand Exploratory modelling and forecasting. CO5: Able to apply the data wrangling tools.

PREREQUISITE: NIL

S. No	CO	PO1	Po2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PS10	PS11	PS12	PSO1	PSO2	PSO3
1	CO-1	1	1	1	1	1	-	-	-	-	-	-	-	1	1	1
2	CO-2	2	1	2	2	2	2	-	-	-	-	-	-	2	3	1
3	CO-3	2	2	2	2	3	3	1	2	2	-	1	2	2	3	2
4	CO-4	2	2	2	3	3	-	-	-	1	-	2	2	2	3	3
5	CO-5	3	3	3	3	3	3	-	-	1	-	2	-	1	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Wrangling and Data Sources	9L+6P

Introduction to Data Wrangling - What is the role of data wrangling and Why Do We Do It? - Data Wrangling Challenges - Tools for Data Wrangling - What are the data sources? - EMR, PRO (patient reported outcomes) File formats: JSON, XML, EXCEL, CSV, HTML, audio file - Cloud resources to databases: Amazon web services, Microsoft Azure cloud - Introduction to NOSQL. **Practical Components:** 1. Parsing CSV and Assessing the Quality of Data. 2. Practice on processing various data's formats and how merging, grouping, concatenating of a data is done. 3. Parsing an XML file.	**CO-1** **BTL-2**
MODULE 2: DATA WORKFLOW FRAMEWORK	**9L+6P**
How Data Flows During and Across Projects – Connecting Analytic Actions to Data Movement: A Holistic Workflow Framework for Data Projects - Raw Data Stage Actions: Ingest Data and Create Metadata - Ingesting Known and Unknown Data Creating Metadata - Refined Data Stage Actions: Create Canonical Data and Conduct Ad Hoc Analyses - Designing Refined Data - Refined Stage Analytical Actions - Production Data Stage Actions: Create Production Data and Build Automated Systems - Creating Optimized Data. **Practical Components:** 1. To create and store a metadata for a csv file. 2. Understanding Data workflow frameworks.	**CO-2** **BTL-2**
MODULE 3: THE DYNAMICS OF DATA WRANGLING	**9L+6P**
Data Wrangling Dynamics – Subsetting and Sampling – Core Transformation and Profiling Actions - Ingesting Data - Describing Data - Assessing Data Utility – Designing and Building Refined Data - Ad Hoc Reporting - Exploratory Modelling and Forecasting – Building an Optimized Dataset – Regular Reporting and Building Data-Driven Products and Services **Practical Components:** 1. Implement Exploratory Modelling for an Optimized Dataset. 2. Forecasting – Building on an Optimized Dataset.	**CO-3** **BTL-2**
MODULE 4: PROFILING & TRANSFORMATION	**9L+6P**
Overview of Profiling - Transformation: Structuring - Overview of Structuring Intra record Structuring: Extracting Values - Transformation: Enriching - Using Transformation to Clean Data - Addressing Missing/NULL Values - Addressing Invalid Values. **Practical Components:** 1. Data cleaning for missing values, and audit the data. 2. Pre-process of data using transformation techniques	**CO-4** **BTL-2**
MODULE 5: DATA WRANGLING TOOLS	**9L+6P**

Data Size and Infrastructure, Data Structures, Excel, Open Refine, data wrangling solution using tabula, CSVKit - SQL, Trifacta Wrangler	CO-5 BTL-2

Practical Components:

1. Data Wrangling solution using tools like Open Refine, Nano nets, Tabula, Google Data Prep, Trifacta.
2. Is Data Wrangling Automation Right for Your Business? Case Study.

TEXTBOOKS	
1.	Principles of Data Wrangling, by Joseph M. Hellerstein, Tye Rattenbury, Jeffrey Heer, Sean Kandel, Connor Carreras. Released July 2017.Publisher(s): O'Reilly Media, Inc.

REFERENCE BOOKS	
1.	Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython 2nd Edition by William McKinney O'Reilly Media, Inc.
2.	Data Wrangling with Python: Tips and Tools to Make Your Life Easier 1st Edition by Jacqueline Kazil., Katharine Jarmul. O'Reilly Media, Inc.

COURSE TITLE	RESEARCH PAPER FINDINGS			CREDITS	3
COURSE CODE	ACS02010	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL–4

ASSESSMENT SCHEME			
CIA			ESE
50%			50%

Course Description	The course provides students the opportunity to acquire and train skills and knowledge on how to independently assess the state of knowledge within a given narrow field of research. This course provides new insights or interpretation of a subject through thorough and systematic evaluation. In this project-based course, the students will outline a complete scientific paper based on Descriptive, Predictive or Prescriptive Modelling.
Course Objective	1. To write briefly the research and theories. 2. To understand the basics of the research. 3. To integrate and evaluate the research and theories 4. To provide a justification for the research proposed based on the previous research.

		Upon completion of this course, the students will be able to:
Course Outcome		1. Identify theories and empirical results within a field of research. 2. Evaluate research findings and implicit assumptions within a field of research. 3. Present the theories and empirical results in a way that combines precision with readability. 4. Design and write a literature review within the specified time limit. 5. Organise and present the research findings for various audiences.

PREREQUSITE: Research Methodology

		Program Outcomes & Program Specific Outcomes														
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	CO-1	3	3	3	3	1	-	-	1	-		-	1	1	1	2
2	CO-2	3	3	3	3	-	-	1	-	1	2	-	-	1	2	-
3	CO-3	3	3	3	3	-	1	-	-	-	-	-	-	1	1	2
4	CO-4	3	3	3	3	-	-	-	-	2	-	1	-	1		1
5	CO-5	3	3	3	3	-	1	-	-	-	-	-	-	1		1
1: Weakly related, 2: Moderately related and 3: Strongly related																

RESEARCH PAPER REVIEW

1. Find review articles and other basic information to use for background (outside of what is provided in textbook)

2. Find 3 empirical articles (papers have method/results sections)

3. Write the paper:-

a. Background information to topic; research question/hypotheses.

b. Describe/summarize empirical articles.

c. Critically analyse topic; synthesize findings from articles.

d. Propose future directions/research (be specific)

4. The paper must be written in APA format. There are 2 primary ways you will use APA formatting: referencing and use of section headers.

a. Referencing must be in APA style. Any ideas or conclusions that are not your own (information that you have learned), you must cite – give credit to the person that had that idea!

b. Section headers are required in your paper. These should be descriptive of the paragraph(s) in that section (e.g., "Overview of false memories and children" then "Theories for false memories" then "Examination of familiarity", etc.). The headers should be italicized and on their own line.

5. There is not a page requirement or limit, but typical papers are approximately 10 pages, double-spaced,12-pt font, with additional, separate title page and reference page. Please include page numbers. Other APA style formatting, such as running heads or an abstract, are not required but welcomed.

6. Reference page: Only include references of papers.

7. Finally Proofread, revise, check for plagiarism and publish in indexed journals.

Remarks	**Allocation of Marks**

Tentative Area, Topic selection	10%
Abstract, Introduction, Literature Review, Gap Identification, Objectives	10%
Methodology, (Materials and Methods, Design/Modelling/Analysis/Fabrication/Testing)	20%
Results and Discussion, Conclusion, Future Scope, References and Draft Project Report submission	20%
Project Report submission, PPT Preparation	20%
Internal and External Examiners Evaluation	20%
Total	**100%**

TEXTBOOKS

1.	Chris A. Mack (2018), How to Write a Good Scientific Paper, SPIE publications.

REFERENCE BOOKS

1.	James D. Lester Jr. (2001), Writing Research Papers: A Complete Guide, Pearson Education

EBOOKS

1.	http://thuvienso.bvu.edu.vn/bitstream/TVDHBRVT/15289/1/How-to-Write-a-Research-Paper.pdf

COURSE TITLE	INTERNSHIP			CREDITS	1
COURSE CODE	ADS02801	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL–4
ASSESSMENT SCHEME					
CIA					ESE
50%					50%
Course Description	The internship is guided by learning goals and reflective assignments. It is supervised academically by a faculty member and professionally by an internship supervisor. All academic internships must be approved in advance, and students must be concurrently enrolled in academic internship units.				

Course Objective	1. Gain an understanding of workplace dynamics, professional expectations, and the influence of culture on both. 2. Build proficiency in arrange of industry skills appropriate to the field of the internship 3. Refine and clarify professional and career goals through critical analysis of the internship experience or research project
Course Outcome	Upon completion of this course, the students will be able to: 1. Analyse the data. Describe main issues and challenges to be faced in the industry, both internally and on the market. 2. Accomplish to unfamiliar workplace, working culture and style. 3. Draw skills from experience and process challenges. 4. Develop an awareness of their skills and aspirations. 5. Recognize more thoroughly on their company and sector as well as on their own experience, perceptions, and career goals

PREREQUSITE: Programming Skills, Basic Database

Program Outcomes & Program Specific Outcomes															
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PO
1	CO-1	3	3	3	3	1	-	-	1	-		-	1	1	1	
2	CO-2	3	3	3	3	-	-	1	-	1	2	-	-	1	1	
3	CO-3	3	3	3	3	-	1	-	-	-	-	-	-	1	1	
4	CO-4	3	3	3	3	-	-	-	-	2	-	1	-	1	1	
5	CO-5	3	3	3	3	-	1	-	-	-	-	-	-	1	1	
1: Weakly related, 2: Moderately related and 3: Strongly related																

INTERNSHIP

The internship is guided by learning goals and reflective assignments. It is supervised academically by a faculty member and professionally by an internship supervisor. All academic internships must be approved in advance, and students must be concurrently enrolled in academic internship units. Students evaluate the worksite and supervisors evaluate the student's performance at the internship.

Procedure for applying for internships

For internship, look for the companies and organisations of the industry the students are interested in and search for training, internships or any links that allow to entry our details and upload professional resume with the website. If direct application is allowed, apply for the internship.

							SEMESTER IV						

COURSE TITLE	BIG DATA SCIENCE			CREDITS		4	
COURSE CODE	ADS02009	COURSE CATEGORY		PC		L-T-P-S	3-0-2-0
VERSION	1.0	APPROVAL DETAILS		38-ACM 13-05-2023		LEARNING LEVEL	BTL3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course covers the knowledge of bigdata science. It serves as a graduate level course for graduate students. The focus will be bigdata computer system, storage,
	processing, analysis, visualization, and applications. State-of-the-art computational frameworks for bigdata will be introduced to students.
Course Objective	The subject is intended to give the knowledge of BigData evolving in every real-time application and how they are manipulated using the emerging technologies. This course breaks down the walls of complexity in processing BigData by providing a practical approach to developing Java applications on top of the Hadoop platform. It describes the Hadoop architecture and how to work with the Hadoop Distributed File System (HDFS)and HBase in Ubuntu platform.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Able to understand the BigData concepts in real-time scenario. CO2: Understand the architecture of Hadoop with practical. CO3: Apply map reduce concept to implement in cloud. CO4: Understand Hadoop streaming techniques. CO5: Understanding Installation BigData Tools.

PREREQUISITES: Machine Learning

Program Outcomes & Program Specific Outcomes															
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO- 1	3	2	1	1	-	-	-	-	-	1	-	2	2	2	2
2	CO- 2	2	1	-	-	1	-	-	2	-	-	-	-	2	2	2
3	CO- 3	2	2	1	-	-	-	2	-	2	1	-	1	2	2	2
4	CO- 4	2	2	2	-	-	-	-	-	-	-	1	-	2	2	2
5	CO- 5	3	3	3	2	2	2	-	--	-	-	-	2	3	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	(6L+3T+6P)

Distributed file system – BigData and its importance, Four Vs, Drivers for Bigdata, Bigdata analytics, Bigdata applications, Algorithms using map reduce, Matrix-Vector Multiplication by Map Reduce. Apache Hadoop– Moving Data in and out of Hadoop – Understanding inputs and outputs of MapReduce - Data Serialization, Problems with traditional large-scale systems-Requirements for a new approach-Hadoop – Scaling-Distributed Framework-Hadoop v/s RDBMS- Brief history of Hadoop. **Practical Component:** 1. Word count application in Hadoop. 2. Sorting the data using Map Reduce.	**CO1** **BTL2**
MODULE 2: CONFIGURATIONS OF HADOOP	**(6L+3T+6P)**
Hadoop Processes (NN,SNN,JT,DN,TT) – Temporary directory – UI - Common errors when running Hadoop cluster, solutions. Setting up Hadoop on a local Ubuntu host: Prerequisites, downloading Hadoop, setting up SSH, configuring the	**CO2** **BTL2**
pseudo-distributed mode, HDFS directory, Name Node, Examples of Map Reduce, Using Elastic MapReduce, Comparison of local versus EMR Hadoop. Understanding MapReduce: Key/value pairs, The Hadoop Java API for MapReduce, Writing MapReduce programs, Hadoop-specific data types, Input/output. Developing Map Reduce Programs: Using languages other than Java with Hadoop, Analysing a large dataset. **Practical Component:** 1. Finding max and min value in Hadoop. 2. Implementation of decision tree algorithms using Map Reduce.	
MODULE 3: ADVANCED MAP REDUCE TECHNIQUES	**(6L+3T+6P)**
Simple, advanced, and in-between Joins, Graph algorithms, using language-independent data structures. Hadoop configuration properties – Setting up a cluster, Cluster access control, managing the Name Node, Managing HDFS, MapReduce management, Scaling. **Practical Component:** 1. Implementation of K-means Clustering using Map Reduce. 2. Generation of Frequent Itemset using Map Reduce.	**CO3** **BTL2**
MODULE 4: HADOOP STREAMING	**(6L+3T+6P)**
Hadoop Streaming – Streaming Command Options – Specifying a Java Class as the Mapper/Reducer – Packaging Files with Job Submissions – Specifying Other Plug-ins for Jobs. **Practical Component:** 1. Count the number of missing and invalid values through joining two large given datasets. 2. Using Hadoop's map-reduce, Evaluating Number of Products Sold in Each Country in the online shopping portal.	**CO4** **BTL3**
MODULE 5: HIVE & PIG	**(6L+3T+6P)**

	Architecture, Installation, Configuration, Hive vs RDBMS, Tables, DDL & DML, Partitioning & Bucketing, Hive Web Interface, Pig, Use case of Pig, Pig Components, Data Model, Pig Latin.	CO5 BTL3

Practical Component:

1. Analyse the sentiment for product reviews, this work proposes a MapReduce technique provided by Apache Hadoop.

2. Trend Analysis based on Access Pattern over Web Logs using Hadoop.

TEXTBOOKS	
1.	Borislublinsky, Kevint Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley,2015.
2.	Tom White, Hadoop: The Definitive Guide, O'Reilly MediaInc., 2015.
3.	Garry Turkington, Hadoop Beginner's Guide, Packt Publishing, 2013.

REFERENCE BOOKS	
1.	Pethuru Raj, Anupama Raman, Dhivya Nagaraj and Siddhartha Duggirala, High Performance Big-Data Analytics: Computing Systems and Approaches, Springer, 2015.
2.	Jonathan R. Owens, Jon Lentzand Brian Femiano, Hadoop Real – World Solutions Cookbook, Packt Publishing, 2013.

E-BOOKS	
1.	http://www.datameer.com/pdf/big-data-analytics-ebook.pdf?mkt_tok.

MOOC	
1.	https://www.sas.com/en_us/insights/analytics/big-data-analytics.html
2.	https://www.searchbusinessanalytics.techtarget.com/definition/big-data-analytics

COURSE TITLE	NEURAL NETWORKS		CREDITS		4
COURSE CODE	ADS02010	COURSE CATEGORY	PC	L-T-P-S	3-0-2-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	This course introduces the various concepts of neural network algorithms and their applications to solve real world problems				

Course Objective	● To understand the biological neural network and to model equivalent neuron models. ● To understand the architecture, learning algorithms ● To know the issues of various feed forward and feedback neural networks. ● To explore the Neuro dynamic models for various problems.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Understand the similarity of biological networks and Neural networks CO2: Understanding the concepts of forward and backward propagations. CO3: Design and apply Back Propagation Networks. CO4: Analyse and apply Self Organising Maps. CO5: Understand and Create Hopfield models.

PREREQUISITES: Machine Learning

Program Outcomes & Program Specific Outcomes

S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO-1	2	1	3	1	-	-	-	1	-	-	1	2	-	1	2
2	CO-2	1	1	3	1	-	-	-	-	-	1	-	-	-	2	2
3	CO-3	1	2	3	2	2	-	2	1	-	-	-	2	2	3	3
4	CO-4	1	3	3	2	1	3	3	2	2	2	-	2	2	3	3
5	CO-5	2	3	3	3	2	2	-	-	2	-	-	2	3	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	(6L+3T+6P)
Introduction: A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Credit Assignment Problem, Memory, Statistical Nature of the Learning Process. **Practical Components:** 1. Write a Program to implement MP Model. 2. Write a program to implement Hebb's rule. 3. Create a perceptron with appropriate number of inputs and outputs. Train it using delta learning algorithm until no change in weights is required. Output the final weights.	CO-1 BTL-2
MODULE 2: PERCEPTION CLASSIFIERS ON A SINGLE LAYER AND FF NON-MULTIPLE LAYERS	(6L+3T+6P)

Single Layer Perceptron's: Adaptive Filtering Problem, Unconstrained Organization Techniques, Linear Least Square Filters, Least Mean Square Algorithm, Learning Curves, Learning Rate Annealing Techniques, Perceptron – Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection **Practical Components:** 1. Write a program to implement artificial neural network without back propagation. 2. Generate AND NOT function using McCulloch-Pitts neural net. 3. Generate XOR function using McCulloch-Pitts neural net. 4. Perceptron net for an AND function with bipolar inputs and targets.	**CO-2** **BTL-2**
MODULE 3: BACK PROPAGATION NEURAL NETWORK	**(6L+3T+6P)**
Basic Concepts, Hopfield networks, Training & Examples. Associative memories: Linear Association, Basic Concepts of CNN, RNN. Back Propagation: Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning **Practical Components:** 1. Create the simple feed forward neural network. 2. Implement the Back propagation neural network. 3. Write a Program to calculate output in a multi-layer feed forward network.	**CO-3** **BTL-3**
MODULE 4: SELF ORGANISING MAPS	**(6L+3T+6P)**
Self-Organization Maps(SOM): Two Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Pattern Classification **Practical Components:** 1. Implement SOM for detecting fraud in credit card applications. 2. Apply Adaptive pattern classification for real-time application.	**CO-4** **BTL-3**
MODULE 5: NEURO DYNAMICS	**(6L+3T+6P)**
Neuro Dynamics: Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm Hopfield Models – Hopfield Models, restricted boltzmen machine. Practical Components: 1. Implement the Hopfield Network 2. Apply the restricted boltzmen machine for dimensionality reduction.	**CO-5** **BTL-3**
TEXTBOOKS	

1.	Introduction to Artificial Neural systems – Jacek M. Zurada, 1994, Jaico Publ. House

2	Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed.,. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed.2006.
REFERENCE BOOKS	
1	Neural Networks in Computer Intelligence, Li Min Fu TMH, 2003
2	Neural Networks – James A Freeman David MS Kapura Pearson Ed., 2004.
3	Artificial Neural Networks – B. Venkataraman Prentice Hall of India PLtd2005
E-BOOKS	
1	https://hagan.okstate.edu/NNDesign.pdf
2	https://cours.etsmtl.ca/sys843/REFS/Books/ebook_Haykin09.pdf
MOOC	
1	https://nptel.ac.in/courses/127105006

COURSE TITLE	PROJECT			CREDITS	12
COURSE CODE	ADS02802	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL–4
ASSESSMENT SCHEME					
CIA					ESE
50%					50%
Course Description	The project work is introduced to improve the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. The students in a group of 3 to 4 works on a topic under the guidance of a faculty member and prepares a comprehensive project report after completing the work. The progress of the project is evaluated based on a minimum of three reviews. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.				
Course Objective	1. Gain an understanding of workplace dynamics, professional expectations, and the influence of culture on both. 2. Build proficiency in a range of industry skills appropriate to the field of the internship 3. Refine and clarify professional and career goals through critical analysis of the Internship experience or research project.				

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

Course Outcome

Upon successful completion of this course, students will be able to:
CO1: To perform a literature review.
CO2: To undertake detailed technical work.
CO3: Develop a solution for the problem and develop an application by using relevant computer application concepts.
CO4: To produce progress reports or maintain a professional journal to establish work completed and deliver a seminar on the general area.
CO5: Able to provide an Analytical Report/Findings on an appropriate data.

PREREQUSITE: Data Analytics, Programming Skills

		Program Outcomes & Program Specific Outcomes														
SNO	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PS10	PS11	PS12	PSO1	PSO2	PSO3
1	CO-1	2	1	3	1	-	1	-	-	-	-	-	-	3	1	2
2	CO-2	1	1	3	1	-	-	1	-	1	2	-	-	-	2	2
3	CO-3	1	2	3	2	2	-	-	1	-	-	2	2	2	3	3
4	CO-4	1	3	3	2	2	2	-	1	-	-	-	-	2	3	3
5	CO-5	2	3	3	3	2	2	-	-	1	-	3	3	3	3	3
		1: Weakly related, 2: Moderately related and 3: Strongly related														

PROJECT

The students should finalize their Project immediately be for e-commencement of
4th semester.
The types of projects may include:

1. Industrial case study.
2. Preparation of a feasibility report.
3. Design and development of application.
4. The over hauling of existing application.
5. Creation of New facilities.

Identification of Topic:

The selection of topic is of crucial importance. It should be field of interest. It is advisable to choose the project can be completed on time and within the budget and resources. The topic should be clear, directional, focused and feasible. The project should be challenging but manageable within their sources and time available. Students should undergo reviews during the internal assessment. Time table or IA should include project review. The guide should monitor the progress of Project work periodically and it should be finally evaluated. The IA marks will be evaluated based on oral presentation and assessment by the internal guide by adopting Rubrics.
given. Real time problems, Industry related problems, should be chosen and it is the responsibility of the project committee/project coordinator.

S. No	RUBRICS FOR MAJOR PROJECT EVALUATION	CRITERIA	ASSESSMENT	OVERALL WEIGHTAGE
1	Synopsis and Project Evaluation	● Identification of Problem Domain and Detailed Analysis. ● Study of Existing systems and feasibility of project proposal. ● Objectives and Methodology of the proposed work	10%	50%
2	Mid Term Assessment Project	● Design methodology Planning of project work (timeframe). ● Demonstration of the work done so far and presentation.	10%	
3	Project and Project Report	● Incorporation of suggestions. ● Project demonstration presentation. ● Project report-description of concept and technical details. ● Conclusion & Discussion.	20%	
4	Evaluation by guide	● Self-motivation and determination. ● Working within a team. ● Technical knowledge and awareness related to the project. ● Regularity.	10%	
5	ESE Examination	Presentation & Viva Voce	50%	50%

DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTERWISE-II						
ELECTIVE-I						
COURSE TITLE	SOCIAL MEDIA ANALYTICS			CREDITS	4	
COURSE CODE	ADS02500		COURSE CATEGORY	DE	L-T-P-S	2-1-2-1
VERSION	1.0		APPROVAL DETAILS	38-ACM 13-05-	LEARNING LEVEL	BTL3

			2023		
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ assignments/ Project**	**Surprise Test/ Quiz**	**Attendance**	**ESE**
15%	15%	10%	5%	5%	50%

Course Description	Social media analytics is the ability together and find meaning in data gathered from social networks to support business decisions and measure the performance of actions based on those decisions through social media.
Course Objective	● To provide an overview of common text mining and social media data analytic activities. ● To understand the complexities of processing text and network data from different data sources.

	● To enable students to solve complex real-world problems for sentiment analysis and recommendation systems.
Course Outcome	Upon successful completion of the project students will be able to: CO1: Understand the terminologies, metaphors and perspectives of social media analytics. CO2: Apply a wide range of classification, clustering, estimation and prediction algorithms on textual data. CO3: Understand social network analysis to identify important social actors, subgroups and network properties in social media sites. CO4: Apply state of the art web mining tools and libraries on realistic data sets as a basis for business decisions and applications. CO5: Create solutions to the emerging problems with social media such as behaviour analytics and recommendation systems, sentiment classification.

PREREQUISITES: NIL

MODULE 1: AN OVERVIEW OF BUSINESS INTELLIGENCE, ANALYTICS, AND DECISION SUPPORT	**(6L+3T +6P)**
Analytics to Manage a Vaccine Supply Chain Effectively and Safely, Changing Business Environments and Computerized Decision Support, Information Systems Support for Decision Making, The Concept of Decision Support Systems (DSS), Business Analytics Overview, Brief Introduction to BigData Analytics. **Practical Component:** 1. Case Study on Decision Support System for Inventory/Sales 2. Case Study on Knowledge driven Decision Support System	**CO1 BTL2**

MODULE 2: TEXT ANALYTICS AND TEXT MINING	(6L+3T+6P)

Text Analytics and Text Mining Concepts and Definitions, Natural Language Processing, Text Mining Applications, Text Mining Process, Text Mining Tools.
 	
Practical Component:
 	
  1. Predicting Depression Levels Using Social Media Posts.
  2. Consider an appropriate dataset for Crime Prevention: Human Trafficking. Using text analytics and AI to create useful models for law enforcement organization
 	
     can use.
	CO2 BTL3

MODULE 3: SENTIMENT ANALYSIS	**(6L+3T+6P)**

Sentiment Analysis Overview, Sentiment Analysis Applications, Sentiment Analysis Process, Sentiment Analysis and Speech Analytics.
 	
Practical Component:
 	
  1. A clothing retail giant wants to analyze customer sentiments for changing industry trends and to stay ahead of competition. Find semantic insights from social media websites and do an appropriate sentiment analysis.
  2. Sentimental Analysis on Twitter Data.
	CO3 BTL2

MODULE 4: WEB ANALYTICS, WEB MINING	**(6L+3T +6P)**
Security First Insurance Deepens Connection with Policyholders, Web Mining Overview, Web Content and Web Structure Mining, Search Engines, Search Engine Optimization, Web Usage Mining (Web Analytics), Web Analytics Maturity Model and Web Analytics Tools. **Practical Component:** 1.Derive customer KPIs such as year-on-year percentage sales growth, revenue per customer and the average time customers take to pay bills for Amazon users. 2.Case Study on Search Engine optimization.	CO4 BTL3
MODULE 5: SOCIAL ANALYTICS AND SOCIAL NETWORK ANALYSIS	**(9L)**

Social Analytics and Social Network Analysis, Social Media Definitions and Concepts, Social Media Analytics. Descriptive Analytics - Optimization and Multi-Criteria Systems: Multiple Goals, Sensitivity Analysis, What-If Analysis, and Goal Seeking.
 	
Practical Component:
 	
  1. Is there Gender Discrepancies in usage of social media. Find out its influences on Students Academic Performance.
  2. Case study using SNA in identifying and isolating individuals and groups from
 	
     Transmission of Infectious Diseases.
	CO5 BTL3

TEXTBOOKS	
1.	Ramesh Sharda, Dursun Delen, Efraim Turban, business intelligence and analytics: systems for decision support, Pearson Education.
2.	Bing Liu, "Web Data Mining – Exploring Hyperlinks, Contents, and Usage Data", Springer, 2nd Edition, 2011.
REFERENCE BOOKS	
1	Social Media Analytics: Effective Tools for Building, Interpreting, and Using Metrics by Marshall Sponder Paperback.
E-BOOKS	
1.	An Introduction to Social Media Analytics by Marshall Sponder, Gohar F.Kha
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc21_cs74/preview

COURSE TITLE	TIME SERIES ANALYSIS		CREDITS	4	
COURSE CODE	ADS02501	COURSE CATEGORY	DE	L-T-P-S	2-1-2-1
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%
Course Description	The course will provide a basic introduction to modern time series analysis. Time series regression and exploratory data analysis, ARMA/ARIMA models, model identification/estimation/linear operators, Fourier analysis, spectral estimation, and state space models. The Analyses will be performed using Rand RStudio.				
Course Objective	Learn basic analysis of time series data. Learn basic concepts in time series regression. Understand auto-regressive and model averaging models. Understand basic concepts of spectral analysis and space-time models. Utilize R for computation, visualization, and analysis of time series data.				

Course Outcome	Upon completion of this course, the students will be able to:
	CO1: Understand basic concepts in time series analysis and forecasting.
	CO2: Apply time series models for forecasting in Business applications.
	CO3: Ability to criticize and judge time series regression models.
	CO4: Analyse and apply ARIMA modelling of stationary and nonstationary time series
	CO5: Apply multivariate times series in various real-world applications.

PREREQUISITES: Basic Mathematics and Programming

Program Outcomes & Program Specific Outcomes																	
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 1 2	PSO 1	PSO 2	PSO 3
1	CO-1	2	3	1	2	1	-	2	1	2	1	-	3	1	-	1
2	CO-2	2	3	1	2	1	1	2	1	2	2	-	3	2	2	1
3	CO-3	3	-	2	-	-	1	-	2	-	-	2	-	1	-	2
4	CO-4	2	2	1	1	-	1	2	2	1	-	1	1	2	3	-
5	CO-5	2	1	3	1	-	2	1	3	1	-	2	1	1	1	3
1: Weakly related, 2: Moderately related and 3: Strongly related																	

MODULE 1: INTRODUCTION OF TIME SERIES ANALYSIS	(6L+3T+6P)
Introduction to Time Series and Forecasting - Different types of data - Internal structures of time series - Models for time series analysis - Autocorrelation and Partial autocorrelation - Examples of Time series Nature and uses of forecasting – Forecasting Process – Data for forecasting – Resources for forecasting - Introduction to ARIMA. **Practical Component:** 1. Time Series Data Cleaning. 2. Loading and Handling Time series data. 3. Pre-processing Techniques.	CO1 BTL2
MODULE 2: STATISTICS BACKGROUND FOR FORECASTING	**(6L+3T+6P)**

Graphical Displays - Time Series Plots - Plotting Smoothed Data - Numerical Description of Time Series Data – Use of Data Transformations and Adjustments - General Approach to Time Series Modelling and Forecasting - Evaluating and Monitoring Forecasting Model Performance.
 	
Practical Component:
 	
1.How to Check Stationarity of a Time Series.
 	
2. How to make a Time Series Stationary?
 	
3. Estimating & Eliminating Trend.
    1. Aggregation
    2. Smoothing
    3. Polynomial Fitting
 	
4. Eliminating Trend and Seasonality.
    1. Differencing
    2. Decomposition
	CO2
	BTL2

MODULE 3: TIME SERIES REGRESSION MODEL	**(6L+3T+6P)**
Introduction - Least Squares Estimation in Linear Regression Models - Statistical Inference in Linear Regression - Prediction of New Observations - Model Adequacy Checking – Variable Selection Methods in Regression – Generalized and Weighted Least Squares - Regression Models for General Time Series Data - Exponential Smoothing - First order and Second order. **Practical Component:** 1. Moving Average time analysis data. 2. Smoothing the Time analysis Data. 3. Check out the Time series Linear and non-linear trends. 4. Create a modelling.	**CO3** **BTL3**
MODULE 4: AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS	**(6L+3T+6P)**

Autoregressive Moving Average (ARMA) Models - Stationarity and Invertibility of ARMA Models - Checking for Stationarity using Variogram - Detecting Nonstationary - Autoregressive Integrated Moving Average (ARIMA) Models - Forecasting using ARIMA Introduction - Finding the "BEST" Model - Example: Internet Users Data - Model Selection Criteria - Impulse Response Function to Study the Differences in Models - Comparing Impulse Response Functions for Competing Models .
 	
Practical Component:
    1. Modelling time series
    2. Exponential smoothing
    3. Seasonal autoregressive integrated moving average model (SARIMA)
	CO4
	BTL3

MODULE 5: MULTIVARIATE TIME SERIES MODELS AND FORECASTING	**(6L+3T+6P)**

Multivariate Time Series Models and Forecasting - Multivariate Stationary Process- Vector ARIMA. Models - Vector AR (VAR) Models - Neural Networks and Forecasting -Spectral Analysis – Bayesian . Methods in Forecasting.	CO5 BTL2

Practical Component:
1. Dependence Techniques
2. Multivariate Analysis of Variance and Covariance
3. Canonical Correlation Analysis
4. Structural Equation Modeling
5. Inter-Dependence Techniques
   ·Factor Analysis
   ·Cluster Analysis

TEXTBOOKS

1.	Introduction To Time Series Analysis and Forecasting, 2nd Edition, Wiley Series In Probability and Statistics, By Douglas C. Montgomery, Cheryl L. Jen (2015) https://b-ok.cc/book/2542456/2fa941
2.	Master Time Series Data Processing, Visualization, And Modelling Using Python Avishek Pal (2017) https://b-ok.cc/book/3413340/2eb247
	Time Series Analysis and Forecasting by Example Søren Bisgaard Murat Kulahci Technical University of Denmark Copyright © 2011 By John Wiley &Sons, Inc. All Rights Reserved. https://b-ok.cc/book/1183901/9be7ed

REFERENCE BOOKS

1.	Peter J. Brockwell Richard A. Davis Introduction to Time Series and Forecasting 3rd Edition. (2016). https://b-ok.cc/book/2802612/149485
2.	Multivariate Time Series Analysis and Applications William W.S. Wei Department of Statistical Science Temple University, Philadelphia, PA, SA. This edition first published 2019 John Wiley & Sons Ltd. https://bok.cc/book/3704316/872fbf
3.	Time Series Analysis by James D Hamilton Copyright ©1994 by princetown university press. https://b-ok.cc/book/3685042/275c71

E-BOOKS

1.	https://www.stat.ipb.ac.id/en/uploads/KS/S2%20%20ADW/3%20Montgomery%20%20Introduction%20to%20Time%20Series%20Analysis%20and%20Forecasting.pdf
2	https://ru.b-ok2.org/terms/?q=forecasting
3.	https://otexts.com/fpp2/
4	http://home.iitj.ac.in/~parmod/document/introduction%20time%20series.pdf

MOOC

1.	https://www.coursera.org/learn/practical-time-series-analysis
2.	https://ocw.mit.edu/courses/economics/14-384-time-series-analysis-fall-2013/downloadcourse-materials/
3	https://swayam.gov.in/nd1_noc19_mg46/preview

ELECTIVE-II

COURSE TITLE	SPATIAL ANALYSIS			CREDITS	4
COURSE CODE	ADS02502	COURSE CATEGORY	DE	L-T-P-S	2-1-2-1
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-2023	LEARNING LEVEL	BTL–3

ASSESSMENTSCHEME

First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Assignment	Seminar	Attendance	End Semester Examination(Theory)
15%	15%	10%	5%	5%	50%

Course Description	This course introduces the key components and principles of Spatial Analytics. High computational architectures and the availability of high-resolution spatial data are the driving reasons behind the growth of geo-intelligence and business intelligence, respectively. Explains the technique of using data science to observe spatial data while generating hypotheses, testing those hypotheses, creating models, and looking for hidden patterns. Describes the importance of The Spatial database management system.
Course Objective	Understand spatial analytics and apply its applications. Understand the types of spatial analytics. Learn different types of Geospatial Technologies. Understand Spatial database management system. Able to analyze the Spatial BigData System with real-time examples.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: Describe, explain and use of spatial analytics. CO2: Design and Implement types of spatial analytics frameworks. CO3: Able to understand and implement Geospatial Technologies. CO4: Able to understand Spatial database management system. CO5: Design a Spatial BigData System.

PREREQUISITES: NIL

Program Outcomes & Program Specific Outcomes															
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	2	-	1	-	-	2	-	-	-	2	1	1	-
CO-2	3	3	3	-	-	2	-	-	2	-	-	2	1	1	-
CO-3	3	3	3	-	3	-	-	-	-	3	-	-	1	1	-

CO-4	3	3	3	-	2	-	3	-	-	-	-	-	1	1	-
CO-5	3	3	3	-	-	-	-	-	-	-	2	-	1	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO SPATIAL ANALYTICS	(6L+3T+6P)
Introduction – History of Spatial Analytics – Need for Spatial Analytics – Understanding Spatial Data Science – The Function of Spatial Analysis – Crucial spatial analysis workflows capabilities –Examples of Spatial Analysis – Urban planning & development – Public health management – Agriculture & farming – Spatial Data Types Raster, Vector and Models. **Practical Component:** 1. To use open-source Software tools Grass GIS, GeoDa, ArcGIS, QGis Online etc. Model raster and Vector data using any of the above open-source Geospatial tools. 2. Case Study on Spatial Analysis Examples in Smart Agriculture & Precision Farming like Crop Yield Prediction, Farm-Level Nutrient Analysis, Crop Detection & Monitoring.	**CO-1** **BTL-2**

MODULE 2: TYPES OF SPATIAL ANALYTICS	(6L+3T+6P)
Spatial data analysis – Spatial autocorrelation – How Spatial Autocorrelation works – Spatial heterogeneity – Types and models of Spatial heterogeneity – Spatial interpolation – proximity techniques and inverse distance weighted techniques – Spatial regression – Spatial interaction– Simulation and modelling – Multiple-point geo statistics (MPS). **Practical Component:** 1. Predictive Modelling Through Spatial Analysis. Eg) for Traffic Accidents. Data Set - CARTO's Data Observatory. 2. Case Study on Spatial Analysis in Public Health like Disease Mapping with Location, Population Density Mapping for Vaccination.	**CO-2** **BTL-3**

MODULE 3: INTRODUCTION TO GEOSPATIAL TECHNOLOGY	(6L+3T+6P)
Geospatial Technology - Need of Geospatial Technology – Applications of geospatial technologies – Types of geospatial technologies – Remote Sensing – Remote sensing related research – Geographic Information Systems (GIS) – Five Layers of GIS – Geographic Information Systems (GIS) related research – Global Positioning System (GPS) – Global Positioning System (GPS) related research – Geo visualization (GVis) – Geographic knowledge discovery (GKD). **Practical Component:** 1. To visualize and inspect the statistical results and models through linked charts and maps (DB Pedia, Genomes). 2. GIS helps in exhibiting the spatial characteristics of population data on a macro level. A Case study on Enable Population Clustering.	**CO-3** **BTL-3**

MODULE 4: SPATIAL DATABASE MANAGEMENT	(6L+3T+6P)

Spatial database management system – key components of an SDBMS– Normalization – Spatial Relationships – Types of Spatial model and techniques– Spatial Model – Vector Model – Raster Model – Spatial Techniques – Spatial Operators, Dynamic Spatial Operators and Spatial Queries in DBMS – Applications of Spatial database – Geodatabase vs. Geospatial Database.	CO-4 BTL-3	

Practical Component:

A Spatial index is used by a spatial database to optimize spatial queries. Binary space partitioning (BSP-Tree), Bounding volume hierarchy (BVH), Geohash, Grid (spatial index, HH Code. kd-tree. Case study on uses of these spatial index.

MODULE 5: SPATIAL BIGDATA SYSTEMS	(6L+3T+6P)

Spatial BigData System – MapReduce – Hadoop – Hadoop Ecosystem – Practical Applications of Spatial Data Science – pros and cons for spatial bigdata management and processing – Urban applications of big spatial data analysis – Surface temperature mapping for heat wave risk management Spatial heat – wave assessments using Geo-tagged Twitter data.	CO-5 BTL-3

Practical Component:

1. Spatial-social network analysis of the patent data.
2. Spatial-social network analysis for urban planning.

TEXTBOOKS	
1.	Manfred M. Fischer, Arthur Getis, "Handbook of Applied Spatial Analysis-Software Tools, Methods and Applications – Springer Berlin Heidelberg, January 2010 - ISBN : 978-3-642-03646-0
2.	Yoshiki Yamagata, Hajime Seya, "Spatial Analysis Using BigData -Methods and Urban Applications",1st Edition - Academic Press, 03-Nov-2019. eBook ISBN:9780128131329

REFERENCE BOOKS	
1.	Joyce Maphanyane, Read Mapeo, Modupe Akinola "Handbook of Research on Geospatial Science and Technologies (Advances in Geospatial Technologies)", 10 August 2017. ISBN-10 1522534407.
2.	Darmofal, D.(2015)."Spatial Heterogeneity .In Spatial Analysis for the Social Sciences" (Analytical Methods for Social Research, pp. 119-138). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139051293.008

E-BOOK	
1	https://www.esri.com/content/dam/esrisites/sitecore-archive/
2	https://humangeography.pressbooks.com/chapter/1-5/

MOOC	
1	https://www.coursera.org/learn/spatial-data-science#abo
2	https://onlinecourses.nptel.ac.in/noc22_hs140/preview

COURSE TITLE	IOT DATA ANALYTICS USING CLOUD COMPUTING		CREDITS			4
COURSE CODE	ADS02503	COURSE CATEGORY	DE	L-T-P-S		2-1-2-1
VERSION	1.0	APPROVAL DETAILS	38-ACM 13-05-23	LEARNING LEVEL		BTL–3

ASSESSMENT SCHEME

First Periodical Assessment (Theory)	Second Periodical Assessment (Theory)	Assignment	Seminar	Attendance	End Semester Examination (Theory)
15%	15%	10%	5%	5%	50%

Course Description	This is a course suitable for M.Sc. students. It deals with basics of IoT and Cloud computing. This course helps in developing IoT platform. Also, from this course students are able to understand the concepts of cloud services and virtualization.
Course Objective	- Vision and Introduction to IoT. - Understand IoT Market perspective. - Data and Knowledge Management and use of Devices in IoT Technology. - Understand State of the Art – IoT Architecture. - Real World IoT Design Constraints, Industrial Automation and Commercial Building Automation in IoT.
Course Outcome	Upon completion of this course, the students will be able to: CO1: Understand the IoT and its Infrastructures. CO2: To understand – An Architectural Overview M2M to IoT. CO3: Appy IoT technologies in various industries/ sectors. CO4: Understand IoT and cloud computing. CO5: Analyse cloud Infrastructure and storage.

PREREQUISITES: Fundamentals of computer network, wireless sensor network, communication & internet technology, web technology, information security.

Program Outcomes & Program Specific Outcomes

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1		3	2	-	1	-	-	-	-	-	2	1	1	-
CO-2		3	3	-	-	2	-	2	-	-	2	1	1	-
CO-3		3	3	-	3	-	-	-	3	-	-	1	1	-
CO-4		3	3	-	2	-	3	-	-	-	-	1	1	-
CO-5		3	3	-	-	-	-	-	-	2	-	1	1	-

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: IoT & Web Technology	(6L+3T+6P)

The Internet of Things Today - Time for Convergence - Towards the IoT Universe – Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.	**CO-1** **BTL-2**
Practical Component: 1. Consider a Medical IoT data and Implement Perspective analysis. 2. Consider an Education IoT data and Implement Perspective analysis. 3. Case study on IoT standardization.	
MODULE 2: M2M to IoT- An Architectural Overview	**6L+3T+6P)**
Introduction - Some Definitions - M2M Value Chains - IoT Value Chains - Building an architecture - Main design principles and needed capabilities - An IoT architecture outline - standards considerations - Functional View - Information View - Deployment and Operational View - Other Relevant architectural views.	**CO-2** **BTL-3**
Practical Component: Enterprises choose a range of IoT connectivity options to support their IoT deployment. Case study on what type of connectivity is best suited for?	
MODULE 3: IoT Applications for Value Creations	**(6L+3T+6P)**
Introduction, IoT applications for industry: Future Factory Concepts, Brown field IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from BigData and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	**CO-3** **BTL-3**
Practical Component: 1. A Case Study on Internet of Things Platforms - Reality in Marketing/Telecommunication. 2. Case study on Performance Evaluation of Distributed Database Strategies for Industrial Data.	
MODULE 4: CLOUD COMPUTING	**(6L+3T+6P)**
Cloud Enabling Technologies, Characteristics of Cloud Computing - Benefits of Cloud Computing, Cloud Service Models, Cloud Deployment models, Cloud computing Infrastructure, Cloud Challenges, Understanding IaaS-Improving performance through Load balancing, Server Types within IaaS solutions, utilizing cloud based NAS devices, Understanding Cloud based data storage, Cloud based backup devices.	**CO-4** **BTL-3**
Practical Component: 1. Case study on IoT Cloud Computing for Mobile Apps.	

	2. Case study on IoT Cloud data storage and issues.	
MODULE 5: CLOUD INFRASTRUCTURE		**(6L+3T+6P)**
Cloud Storage - Overview, Cloud Storage Providers. Virtualization- Understanding Virtualization, History, Leveraging Blade Servers, Server Virtualization, Data Storage Virtualization. Developing Applications- Google, Microsoft, Cast Iron Cloud, Bungee Connect, Development. Migrating to the Cloud-Cloud Services for Individuals, Cloud Services Aimed at the Mid-Market, Enterprise-Class Cloud Offerings, and Migration. Designing Cloud Based Solutions-System Requirements, Design Is a Give-and-Take Process. Coding Cloud Based Applications- **Practical Component:** Is cloud computing necessary for IoT? A Case Study on business world Perspective		**CO-5** **BTL-3**

TEXTBOOKS	
1.	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014
2.	Francisda Costa, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, A press Publications, 2013
3.	Cloud Computing: A Practical Approach by Anthony T. Velte Toby J. Velte, Robert Elsenpeter, 2010 by The McGraw-Hill.6.
REFERENCE BOOKS	
1.	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Aves and, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2.	Cloud Computing: SaaS, PaaS, IaaS, Virtualization and more by Dr. Kris Jamsa
3.	Cuno P fister, Getting Started with the Internet of Things, O "ReillyMedia,2011, ISBN: 978-1-4493- 9357-1

DEPARTMENTAL ELECTIVES WITH GROUPING – SEMESTER-III					
ELECTIVE -III					
COURSE TITLE	**Multi Media and Graph Analytics**		**CREDITS**	**4**	
COURSE CODE	**ADS02504**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**2-1-2-1**
VERSION	**1.0**	**APPROVAL DETAILS**	**38-ACM 13-05-2023**	**LEARNING LEVEL**	**BTL3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ assignments/ Project	Surprise Test/ Quiz	Attendance	ESE
15%	15%	10%	5 %	5%	50%

Course Description	The course Multimedia analytics and Graph Mining an interdisciplinary field helps the students to understand image processing, computer vision, data mining, and pattern recognition, Graphs and algorithms related to multi-media and Graph Data.
Course Objective	This Course helps to understand processing multimedia large-scale data such as text, image, audio, video, and graphics and the new challenges of these data types. The course helps to know Graph Mining tools and techniques used to analyse real-world graphs, predict how the structure and properties of a given graph might affect real time application.
Course Outcome	Upon successful completion of this course, students will be able to: CO1: To understand the Multimedia data types. CO2: To understand the retrieval techniques of Multimedia. CO3: To learn the basic concepts and important properties of graphs. CO4: To understand and explore several methods on algorithms such as graph traversal, shortest paths, minimum spanning tree. CO5: To analyse and apply concept of graph mining and its application in various domains.

PREREQUISITES: Machine Learning

Program Outcomes & Program Specific Outcomes															
S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO-1	2	1	3	1	-	-	-	1	-	-	1	2	-	1	2
2	CO-2	1	1	3	1	-	-	-	-	-	1	-	-	-	2	2
3	CO-3	1	2	3	2	2	-	2	1	-	-	-	2	2	3	3
4	CO-4	1	3	3	2	1	3	3	2	2	2	-	2	2	3	3
5	CO-5	2	3	3	3	2	2	-	-	2	-	-	2	3	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION MULTIMEDIA	(6L+3T+6P)

What is Multimedia? - Components of Multimedia - Overview of Mu1timedia Software Tools - Graphics and Image Data Representations - basics of Digital Audio and Video. **Practical Component:** 1. To retrieve and store an image, audio and video files. 2. To create and store a Graph data.	**CO1** **BTL 2**
MODULE 2: MULTIMEDIA DATA COMPRESSION & RETRIEVAL	**(6L+3T+6P)**
Lossless Compression Algorithms - Lossy Compression Algorithms - Image Compression Standards Basic Video Compression Techniques – Search for Motion Vectors, Multimedia information retrieval - an overview. **Practical Component:** 1. To classify the Image file using classification algorithm using neural network. 2. To compress and store an image data. 3. To compress and store an audio and video file.	**CO2** **BTL 2**
MODULE 3: INTRODUCTION TO GRAPHS	**(6L+3T+6P)**
Introduction to graphs - Basic terminologies - Types and Representation of a graph - decomposing graphs into parts - connectivity of graphs - matching on graphs. **Practical Component:** 1. Analyse a graph and estimate how important a node is for the connectivity of the network. 2. Connectivity analysis: Determine how strongly or weakly connected two nodes are in a graph. 3. Use Path analysis to examine the relationships between nodes in a graph.	**CO3** **BTL 2**
MODULE 4: GRAPH ALGORITHMS	**(6L+3T+6P)**
Graph colouring - graphs on surface - directed graphs - Shortest path algorithms - algorithms to discover minimum spanning tree - Flows in Networks and some important flow algorithms - Algorithms for Searching Graphs. **Practical Component:**	**CO4** **BTL 2**
1. Case study on how Graph analytics are used to spot frauds or criminals and unlawful actions such as money laundering. 2. Case study on Graph analytics use in identifying influencers and communities in social media networks like Instagram, Spotify and LinkedIn.	
MODULE 5: Graph Mining	**(6L+3T+6P)**
Motivation for Graph Mining - Applications of Graph Mining - Mining Frequent Subgraphs –Transactions - BFS/Apriori Approach - DFS Approach - Diagonal and Greedy Approaches - Constraint-based mining and new algorithms - Mining Frequent Subgraphs - graph visualizations - Application of Graph Mining. 1. Case Study on Link analysis algorithms 2. Implement Frequent subgraphs.	**CO5** **BTL2**
TEXTBOOKS	
1.	J. Hanand M. Kamber, Data mining – Concepts and Techniques, 2nd Edition, Morgan Kaufman Publishers, 2006

2	Fundamentals of Multimedia, 3rd ed. By Ze-Nian Li, Mark S. Drew, Jiangchuan Liu. ISBN:978-3-030-62123-0Springer, 2013
REFERENCE BOOKS	
1	Bing Liu, Web Data Mining: Exploring Hyperlinks, Contents, and Usage Data, Springer publishing, 2009.
2	David Easley and Jon Kleinberg - Networks, Crowds, and Markets. Cambridge University Press, 2010.
3	Diestel R. (2010). Graph Theory, 4th ed. Springer-Verlag, Heidelberg
4	https://www.cse.unsw.edu.au/~cs9314/07s1/lectures/Jian_Intro_L5.pdf
E-BOOKS	
1	https://users.dimi.uniud.it/~antonio.dangelo/MMS/materials/Fundamentals_of_Multimedia.pdf
MOOC	
1	https://in.coursera.org/learn/big-data-graph-analytics

COURSE TITLE	OPTIMIZATION TECHNIQUES		CREDITS	4	
COURSE CODE	ADS02505	**COURSE CATEGORY**	DE	**L-T-P-S**	**2-1-2-1**
VERSION	1.0	**APPROVAL DETAILS**	**38-ACM 13-05-2023**	**LEARNING LEVEL**	**BTL3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ assignments/ Project**	**Surprise Test/Quiz**	**Attendance**	**ESE**
15%	15%	10%	5 %	5%	50%
Course Description	Prescriptive analytics helps businesses identify the best course of action for any organization goal. Data Scientist needs to understand the concept of optimization to achieve the best solution or most favourable set of solutions of one or more given criteria.				
Course Objective	● To understand the concept of search space and optimality for solutions of engineering problems. ● To understand some computation techniques for optimizing single variable functions. ● To carry out various computational techniques for optimizing severable variable functions.				

Course Outcome	Upon successful completion of this course, students will be able to:
	CO1: Understand different types of Optimization Techniques in engineering problems.
	CO2: Apply Learn Optimization methods such as Bracketing methods, Region elimination methods, Point estimation methods.
	CO3: Understand Optimizations Techniques in single variables problems. CO4: Apply unconstrained Optimizations Techniques in single variables problems.
	CO5: Analyse constrained optimization techniques and Kuhn-Tucker conditions.

PREREQUISITES: NIL

S. No	CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PS 10	PS 11	PS 12	PSO 1	PSO 2	PSO 3
1	CO-1	2	1	3	1	-	-	-	1	-	-	1	2	-	1	2
2	CO-2	1	1	3	1	-	-	-	-	-	1	-	-	-	2	2
3	CO-3	1	2	3	2	2	-	2	1	-	-	-	2	2	3	3
4	CO-4	1	3	3	2	2	2	-	-	-	2	-	2	2	3	3
5	CO-5	2	3	3	2	2	-	-	2	-	-2	2	3	3	3	

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	(6L+3T+6P)

Introduction: Optimization – optimal problem formulation - engineering optimization problems - optimization algorithms - numerical search for optimal solution. **Practical Component:** Study of MATLAB optimization Toolbox.	CO1 BTL2

MODULE 2: SINGLE VARIABLE OPTIMIZATION	(6L+3T+6P)

Optimality criteria - bracketing methods – exhaustive search method - bounding phase method - region elimination methods – interval halving - Fibonacci search - golden section search - point estimation method - successive quadratic search -gradient based methods. **Practical Component:** 1. Solve single variable optimization problem using MATLAB. 2. Solve point estimation method using MATLAB.	CO2 BTL2

MODULE 3: MULTIVARIABLE OPTIMIZATION	(6L+3T+6P)

Multivariable Optimization with No Constraints - Multivariable Optimization with Equality Constraints - Multivariable Optimization with Inequality Constraints - Convex Programming Problem.
 	
Practical Component:
   1. Solve multivariable optimization problem with equality constraints using MATLAB.
   2. Solve multivariable optimization problem with inequality constraints using MATLAB.
	CO3
	BTL3	

MODULE 4: UNCONSTRAINED OPTIMIZATION TECHNIQUES	**(6L+3T+6P)**	

Introduction - Grid Search Method - Powell's Method - Simplex Method - Steepest Descent (Cauchy) Method - Newton's Method - Davidon–Fletcher–Powell Method, Broyden–Fletcher–Goldfarb–Shanno Method.
 	
Practical Component:
 	
   1. Write a code to solve Random Search Methods.
   2. Write a code to solve Grid Search Method.
	CO4
	BTL2	

MODULE 5: CONSTRAINED OPTIMIZATION TECHNIQUES	**(6L+3T+6P)**	
Introduction, Random Search Methods, Basic Approach in the Methods of Feasible Directions, Zoutendijk's Method of Feasible Directions, Basic Approach of the Penalty Function Method, Extrapolation Techniques in the Interior Penalty Function Method, Extended Interior Penalty Function Methods. **Practical Component:** Solve multivariable minimization problems, with inequality and equality constraints, using the MATLAB.	**CO5** **BTL3**	
TEXTBOOKS		
1.	S .S. Rao, "Optimization Theory and Applications", 2nd Edition, NewAge International (P) Limited Publishers, 1995	
REFERENCE BOOKS		
1	Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India, New Delhi, 2004.	
2.	Edwin K.P. Chong and Stanislaw H. Zak, "An Introduction to Optimization", Second Edition, Wiley-Series in Discrete Mathematics and Optimization, 2004.	
3.	M. Asghar Bhatti, "Practical Optimization Methods: with Mathematics Applications", Springer Verlag Publishers, 2000.	
E-BOOKS		
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