SRI KRISHNA COLLEGE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution | Approved by AICTE | Affiliated to Anna University | Accredited by NAAC with A++ Grade
Kuniamuthur, Coimbatore – 641008
Phone : (0422)-2678001 (7 Lines) | Email : info@skcet.ac.in | Website : www.skcet.ac.in

DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

CURRICULUM AND SYLLABI

B.TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATION 2022 (BATCH: 2022 - 2026)

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DEPARTMENT OF
ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATION 2022 (BATCH: 2022 - 2026)

B.TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

ABOUT THE DEPARTMENT

VISION

To produce globally competitive professionals in Artificial Intelligence and Data Science by imparting cognitive learning and encouraging industry collaboration towards serving the greater cause of society.

MISSION

1. Impart knowledge in cutting edge Artificial Intelligence and Data Science technologies in par with industrial standards.
2. Inculcate research and lifelong learning that benefit society at large.
3. Promote ethical values and entrepreneurial skills.

PROGRAMME OUTCOMES (POs)

Artificial Intelligence and Data Science Graduates will be able to:

PO1 - **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 - **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 - **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.

PO5 - **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of thelimitations.

PO6 - **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 - **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 - **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clearinstructions.

PO11- Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 - **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1:

To build a successful career in IT/relevant industry or carryout research in advance areas of Artificial Intelligence, Data Science and address various issues in the society.

PEO 2:

To develop problem solving skills and ability to provide solution for real time problems.

PEO 3:

To develop the ability and attitude of adapting themselves to emerging technological Challenges.

PEO 4:

To excel with excellent communication skills, leadership qualities and social responsibilities.

PROGRAMME SPECIFIC OBJECTIVES (PSO)

PSO 1:
Understand, analyze and develop innovative solutions for real world problems in industry and research establishments related to Artificial Intelligence and Data Science.

PSO 2:
Ability to choose or develop the right tool for Data analysis and develop high end intelligent systems.

PSO 3:
Apply programming principles and practices for developing software solutions to meet future business and society needs.

Mapping of PO's to PEO's

Programme Educational Objectives (PEO)	Program Outcomes (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
PEO1	3	3	3	3	3	3	3	2	1	2	2	3
PEO2	3	3	3	3	3	2	2	2	2	3	3	3
PEO3	1	3	1	2	3	2	3	1	1	2	2	2
PEO4	1	1	3	2	1	3	3	3	3	3	3	1

Mapping of PO's to PSO's

Programme Specific Outcomes (PSO)	Programme Outcomes (PO)											
	1	2	3	4	5	6	7	8	9	10	11	12
PSO1	3	3	3	3	1	2	1	1	1	2	2	2
PSO2	3	3	3	1	3	1	1	1	2	2	2	3
PSO3	3	3	3	1	1	3	3	2	3	2	2	3

Mapping of PSO's & PEO's

Programme Specific Outcomes (PSO)	Programme Educational Objectives (PEO)			
	PEO1	PEO2	PEO3	PEO4
PSO1	3	3	2	2
PSO2	3	3	2	1
PSO3	3	2	3	3

1	Reasonably agreed	2	Moderately agreed	3	Strongly agreed

B. TECH ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

REGULATION 2022 (BATCH: 2022 – 2026)

SEMESTER I

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1.	22AD101	Introduction to Artificial Intelligence	3/0/0	3	3	60/40	PC
2.	22MA102	Mathematics I	3/1/0	4	4	60/40	BSC
3.	22IT101	Application Development Practices	3/0/2	5	4	50/50	PC
4.	22CS101	Problem Solving using C++	3/0/2	5	4	50/50	PC
5.	22EN101	Technical Communication Skills	2/0/2	4	3	50/50	HSMC
6.	22CH101	Engineering Chemistry	3/0/2	5	4	50/50	BSC
7.	22MC101	Mandatory Course-I (Induction Programme)	3 weeks				MC
Total				**26**	**22**	**700**	

SEMESTER II

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1.	22MA202	Mathematics II	3/1/0	4	4	60/40	BSC
2.	22EE111	Basics of Electrical and Electronics Engineering	2/1/0	3	3	60/40	ESC
3.	22TA101	Heritage of Tamils	1/0/0	1	1	60/40	HSMC
4.	22CS201	Data Structures and Algorithms	3/0/2	5	4	50/50	PC
5.	22IT201	Data Base Management Systems	3/0/2	5	4	50/50	PC
6.	22AD201	Java Programming	3/0/2	5	4	50/50	PC
7.	22PH201	Physics	3/0/2	5	4	50/50	BSC
8.	22EE114	Basics of Electrical and Electronics Engineering Laboratory	0/0/2	2	1	40/60	ESC
9.	22MC102	Mandatory Course-II (Environmental Sciences)	2/0/0	2	0	0/100	MC
			Total	**32**	**25**	**900**	

SEMESTER III							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1.	22GE201	Universal Human Values	3/0/0	3	3	60/40	HSMC
2.	22MA302	Random Variables and Statistics	3/1/0	4	4	60/40	BSC
3.	22TA201	Tamils and Technology	1/0/0	1	1	60/40	HSMC
4.	22AD301	Design and Analysis of Algorithms	1/0/4	5	3	50/50	PC
5.	22IT302	Web Technology	1/0/4	5	3	50/50	PC
6.	22CS301	Advanced Java Programming	1/0/4	5	3	50/50	PC
7.	22AD302	Python Essentials	2/0/2	4	3	50/50	PC
8.	22MCXXX	Mandatory Course-III	2/0/0	2	0	0/100	MC
Total				**29**	**20**	**800**	

SEMESTER IV							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1.	22MA401	Optimization and Project Management	3/1/0	4	4	60/40	BSC
2.	22IT402	Software Testing	1/0/4	5	3	50/50	PC
3.	22AD401	Cloud Computing	1/0/4	5	3	50/50	PC
4.	22CS402	Web Frameworks	1/0/4	5	3	50/50	PC
5.	22AD402	Data Warehousing and Data Mining	2/0/2	4	3	50/50	PC
6.	22CS403	Operating Systems	3/0/2	5	4	50/50	PC
7.	22MCXXX	Mandatory Course-IV	2/0/0	2	0	0/100	MC
Total				**30**	**20**	**700**	

SEMESTER V							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1.	22AD501	Signals, Systems and Networks	3/0/0	3	3	60/40	ESC

2.	22AD502	Machine Learning	3/0/0	3	3	60/40	PC
3.	22AD9XX	Professional Elective – I	3/0/0 or 0/0/6	3/6	3	60/40 or 40/60	PEC
4.	22AD9XX	Professional Elective – II	3/0/0	3	3	60/40	PEC
5.	22XXXXX	Open Elective – I	3/0/0	3	3	60/40	OEC
6.	22AD503	Data Science using R	2/0/2	4	3	50/50	PC
7.	22AD504	Machine Learning Laboratory	0/0/3	3	1.5	40/60	PC
8.	22AD505	Mini Project	0/0/2	2	1	40/60	PW
Total				**24**	**20.5**	**800**	

SEMESTER VI

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1.	22CS701	Internet of Everything	3/0/0	3	3	60/40	ESC
2.	22AD9XX	Professional Elective – III	3/0/0 or 0/0/6	3/6	3	60/40 or 50/50 or 40/60	PEC
3.	22AD9XX	Professional Elective – IV	3/0/0	3	3	60/40	PEC
4.	22ADXXX	Emerging Elective – I	3/0/0	3	3	60/40	EEC
5.	22AD601	Deep Learning and its Applications	3/0/2	5	4	50/50	PC
6.	22AD602	Natural Language Processing	3/0/2	5	4	50/50	PC
7.	22CS702	Internet of Everything Laboratory	0/0/3	3	1.5	40/60	ESC
Total				**25**	**21.5**	**700**	

SEMESTER VII

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Ext/Int	Category
1.	22AD701	Data Analytics	3/0/0	3	3	60/40	PC
2.	22AD702	Data visualization using Tableau	3/0/0	3	3	60/40	PC
3.	22AD9XX	Professional Elective – V	3/0/0	3	3	60/40	PEC

4.	22AD9XX	Professional Elective – VI	3/0/0	3	3	60/40	PEC
5.	22XXXXX	Open Elective – II	3/0/0	3	3	60/40	OEC
6.	22ADXXX	Emerging Elective – II	3/0/0	3	3	60/40	EEC
7.	22AD703	Data Analytics Laboratory	0/0/2	2	1	40/60	PC
8.	22AD704	Data Visualization Laboratory	0/0/2	2	1	40/60	PC
9.	22EES01	Employability Enhancement Skills (Summer Internship / Summer Training – 4 weeks)			2	0/100	EES
Total				**22**	**22**	**900**	

SEMESTER VIII							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	22AD801	Project	0/0/24	24	12	40/60	PW
Total				**24**	**12**	**100**	

HUMANITIES (8 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1	22GE201	Universal Human Values	2/0/0	2	3	HSMC
2	22EN101	Technical Communication Skills	2/0/2	4	3	HSMC
3	22TA101	Heritage of Tamils	1/0/1	1	1	HSMC
4	22TA201	Tamils and Technology	1/0/1	1	1	HSMC

BASIC SCIENCES (24 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1	22MA102	Mathematics I	3/1/0	4	4	BSC
2	22CH101	Engineering Chemistry	3/0/2	4	4	BSC
3	22PH201	Physics	3/0/2	4	4	BSC
4	22MA202	Mathematics II	3/1/0	4	4	BSC

5	22MA302	Random Variables and Statistics	3/1/0	4	4	BSC
6	22MA401	Optimization and Project Management	3/1/0	4	4	BSC

ENGINEERING SCIENCE (11.5 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	22EE111	Basics of Electrical and Electronics Engineering	2/1/0	3	3	ESC
2.	22EE114	Basics of Electrical and Electronics Engineering Laboratory	0/0/2	2	1	ESC
3.	22AD501	Signals, Systems and Networks	3/0/0	3	3	ESC
4.	22CS701	Internet of Everything	3/0/0	3	3	ESC
5.	22CS702	Internet of Everything Laboratory	0/0/3	3	1.5	ESC

PROFESSIONAL CORE (74.5 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	22AD101	Introduction to Artificial Intelligence	3/0/0	3	3	PC
2.	22IT101	Application Development Practices	3/0/2	5	4	PC
3.	22CS101	Problem Solving using C++	3/0/2	5	4	PC
4.	22CS201	Data Structures and Algorithms	3/0/2	5	4	PC
5.	22IT201	Data Base Management Systems	3/0/2	5	4	PC
6.	22AD201	Java Programming	3/0/2	5	4	PC
7.	22AD301	Design and Analysis of Algorithms	1/0/4	5	3	PC
8.	22IT302	Web Technology	1/0/4	5	3	PC
9.	22AD302	Python Essentials	2/0/2	4	3	PC
10.	22CS301	Advanced Java Programming	1/0/4	5	3	PC
11.	22AD402	Data Warehousing and Data Mining	2/0/2	4	3	PC

12.	22IT402	Software Testing	1/0/4	5	3	PC
13.	22AD401	Cloud Computing	1/0/4	5	3	PC
14.	22CS402	Web Frameworks	1/0/4	5	3	PC
15.	22CS403	Operating Systems	3/0/2	5	4	PC
16.	22AD502	Machine Learning	3/0/0	3	3	PC
17.	22AD503	Data Science using R	2/0/2	4	3	PC
18.	22AD504	Machine Learning Laboratory	0/0/3	3	1.5	PC
19.	22AD601	Deep Learning and its Applications	3/0/2	5	4	PC
20.	22AD603	Natural Language Processing	3/0/2	5	4	PC
21.	22AD702	Data visualization using Tableau	3/0/0	3	3	PC
22.	22AD704	Data Visualization Laboratory	0/0/2	3	1	PC
23.	22AD701	Data Analytics	3/0/0	3	3	PC
24.	22AD703	Data Analytics Laboratory	0/0/2	2	1	PC

PROFESSIONAL ELECTIVES (18 CREDITS)

VERTICAL - I CLOUD COMPUTING AND DATA STORAGE TECHNOLOGIES

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22CD901	Data Virtualization	0/0/6	3	3	PEC
2.	22IT901	Cloud Services and Integration	3/0/0	3	3	PEC
3.	22CY901	Security and Privacy in Cloud	3/0/0	3	3	PEC
4.	22AD902	Storage Technologies	3/0/0	3	3	PEC
5.	22CS901	Software Defined Networks	3/0/0	3	3	PEC
6.	22CB901	Stream Processing	3/0/0	3	3	PEC
7.	22CD903	Multimedia and Animation	3/0/0	3	3	PEC

VERTICAL - II APPLIED AI

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22IT911	Intelligent Multiagent and Expert Systems	3/0/0	3	3	PEC
2.	22AD901	App Development	0/0/6	6	3	PEC
3.	22CY911	ETL Tools	3/0/0	3	3	PEC
4.	22CS911	Statistical Pattern Recognition	3/0/0	3	3	PEC
5.	22CD911	Stochastic and Network Control	3/0/0	3	3	PEC
6.	22AD911	Bayesian Data Analysis	3/0/0	3	3	PEC
7.	22AD917	Virtual Reality and Augmented Reality	3/0/0	3	3	PEC

VERTICAL - III INFORMATION SECURITY

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22IT921	Cyber Threats and Vulnerabilities	3/0/0	3	3	PEC
2.	22IT923	Cyber Physical Systems	3/0/0	3	3	PEC
3.	22IT924	Ethical Hacking and Auditing Frameworks	3/0/0	3	3	PEC
4.	22CY921	Data Privacy and Security	3/0/0	3	3	PEC
5.	22CY944	Cyber Crime and Forensics	3/0/0	3	3	PEC
6.	22CY922	Digital and Mobile Forensics	3/0/0	3	3	PEC

VERTICAL – IV NEXT GENERATION AI

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22AD931	Generative AI	3/0/0	3	3	PEC
2.	22AD932	Quantum Artificial Intelligence	3/0/0	3	3	PEC

3.	22AD933	Prompt Engineering	3/0/0	3	3	PEC
4.	22AD934	Intelligent Robotic Automation	3/0/0	3	3	PEC
5.	22AD935	Advanced Machine Learning	3/0/0	3	3	PEC
6.	22AD936	Explainable AI	3/0/0	3	3	PEC
7.	22AD937	AI for Humanity	3/0/0	3	3	PEC
8.	22AD938	Autonomous Vehicles and Drones	3/0/0	3	3	PEC
9.	22AD939	AI for Remote Sensing	3/0/0	3	3	PEC

VERTICAL - V DATA SCIENCE

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22AD941	Predictive Analytics	3/0/0	3	3	PEC
2.	22AD942	Information Extraction and Retrieval	3/0/0	3	3	PEC
3.	22AD943	Computational Statistics for Data Science	3/0/0	3	3	PEC
4.	22AD944	Ethics in Data Science	3/0/0	3	3	PEC
5.	22AD945	Video Analytics	3/0/0	3	3	PEC
6.	22AD946	Web and Social Media Mining	3/0/0	3	3	PEC
7.	22AD947	Business Analytics	3/0/0	3	3	PEC
8.	22AD948	Speech Processing	3/0/0	3	3	PEC
9.	22AD949	Risk Analytics	3/0/0	3	3	PEC

VERTICAL - VI EXTENDED REALITY

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credits	Category
1.	22AD951	Virtual Reality in Game Development	3/0/0	3	3	PEC
2.	22AD952	Augmented Reality and Video Streaming	3/0/0	3	3	PEC

3.	22AD953	APP Development using VRAR	3/0/0	3	3	PEC
4.	22AD954	Extended Reality for UX/UI Design	3/0/0	3	3	PEC
5.	22AD955	Metaverse Technologies	3/0/0	3	3	PEC
6.	22AD956	Virtual Reality Design and Communication	3/0/0	3	3	PEC
7.	22AD957	3D Modeling using VR	3/0/0	3	3	PEC
8.	22AD958	Sensors and Actuators in AR/VR	3/0/0	3	3	PEC
9.	22AD959	Mixed Reality and Advanced Systems	3/0/0	3	3	PEC

OPEN ELECTIVE COURSES (6 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	22AD001	Fundamentals of Database Systems	1/0/4	5	3	OEC
2.	22AD002	Information Retrieval Techniques	3/0/0	3	3	OEC
3.	22AD003	Machine Learning Algorithms in Python	3/0/0	3	3	OEC
4.	22AD004	Data Visualization using R	3/0/0	3	3	OEC
5.	22AD005	Introduction to Data Analytics	3/0/0	3	3	OEC
6.	22AD006	Introduction to Deep Learning	3/0/0	3	3	OEC

EMERGING ELECTIVE COURSES (6 CREDITS)

S.No	Course Code	Course	L/T/P	Contact hrs/week	Credit	Category
1.	22AD007	Autonomous Systems and Drones	3/0/0	3	3	EEC
2.	22AD008	Crypto currencies	3/0/0	3	3	EEC
3.	22AD009	AI in Healthcare Applications	3/0/0	3	3	EEC
4.	22AD010	Scalable System for Data Science	3/0/0	3	3	EEC
5.	22AD011	Brain and Neuroscience	3/0/0	3	3	EEC

6.	22AD012	Data Engineering	3/0/0	3	3	EEC

EMPLOYABILITY ENHANCEMENT SKILLS (2 CREDITS)

S.No	Course Code	Course	Duration	Credit	Category
1.	22EES01	Employability Enhancement Skills (Summer Internship / Summer Training)	4 WEEKS	2	EES

MANDATORY COURSES (NON-CREDIT)

S.No	Course Code	Course	Category
1.	22MC101	Induction Programme	MC
2.	22MC102	Environmental Sciences	MC
3.	22MC103	Soft Skills	MC
4.	22MC104	Management Organizational Behaviour	MC
5.	22MC105	General Aptitude	MC
6.	22MC106	Life Skills and Ethics	MC
7.	22MC107	Stress Management	MC
8.	22MC108	Constitution of India	MC
9.	22MC109	Essence of Indian Traditional Knowledge	MC
10.	22MC110	Biology	MC

VALUE ADDED COURSES

S.No	Course Code	Course	Category
1.	22VA701	Data Representation and Interpretation using Python	VAC
2.	22VA702	Android Enterprise	VAC
3.	22VA703	Chatbot Development	VAC
4.	22VA704	Hardware and Troubleshooting	VAC
5.	22VA705	Rapid Development for AI	VAC
6.	22VA706	Robotic Process Automation	VAC
7.	22VA707	Spark and Scala	VAC
8.	22VA130	Effective Communication Skills	VAC

Scheme of Distribution

S.NO	Stream	Credits/Semester								Credits	AICTE Norms
		I	II	III	IV	V	VI	VII	VIII		
1.	Humanities (HSMC)	3	1	4						8	12
2.	Basic Sciences(BSC)	8	8	4	4					24	24
3.	Engineering Sciences(ESC)		4			3	4.5			11.5	29
4.	Professional Core (PC)	11	12	12	16	7.5	8	8		74.5	49
5.	Professional Electives(PEC)					6	6	6		18	18
6.	Open Elective(OEC)					3		3		6	12
7.	Emerging Electives(EEC)						3	3		6	
8.	Project work (PW)					1			12	13	15
9.	Employability Skills							2		2	
10.	Mandatory Course (MC)									-	
Total		**22**	**25**	**20**	**20**	**20.5**	**21.5**	**22**	**12**	**163**	
AICTE(CSE)		17.5	20.5	23	22	21	22	20	15		159

22AD101	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	3 / 0 / 0 / 3
Nature of Course:	H (Theory technology)	
Pre requisites:	NIL	

Course Objectives:

1	To learn the basic concepts of Artificial intelligence.
2	To explore areas of application based on knowledge representation.
3	To develop abilities to apply, build and modify decision models to solve real world problems.
4	To familiarize the artificial intelligence techniques for building well-engineered and efficient intelligent systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Understand the concepts of AI and the agent environment.	[U]
C101.2	Imparting the basic principles of AI in solutions that require problem solving, inference, perception and learning.	[A]
C101.3	Acquire knowledge to solve constraint satisfaction problems, make optimal decisions and strategies in games using adversarial search.	[A]
C101.4	Recognize the knowledge representation and learning methods of artificial intelligence.	[U]
C101.5	Apply AI techniques to real-world problems to develop intelligent systems.	[A]
C101.6	Examining the challenges and considerations involved in deploying AI applications and perception.	[AP]

Course Contents:

MODULE I - Overview of Artificial Intelligence and Agents **(15 hrs)**

Introduction to AI, Types of AI, Intelligent Agents, Agents & environment Problem Solving: Defining the problem as state space search, production system, problem characteristics and issues in the design of search programs. Problem solving agents, searching for solutions.Case Study:State space search.

MODULE II- Search techniques **(15 hrs)**

Search strategies: Uniformed and informed, breadth first search, depth first search. Heuristic search strategies: Greedy best-first search, A* search, AO* search, Optimization problems: Hill climbing search, simulated annealing search, local beam search. Constraint satisfaction problems: Adversarial search, optimal decisions & strategies in games, alpha-beta pruning. Knowledge & reasoning: Knowledge representation issues, Baye's probabilistic interferences and dempstershafer theory, An Expert system Shell in LISP. Case Study:AI powered contextual intelligence

MODULE III- Applications of AI	**(15 hrs)**
AI applications – Language Models – Information Retrieval- Information Extraction – Natural Language Processing - Machine Translation – Speech Recognition –Facial Recognition- Healthcare -Robot – Hardware – Perception – Planning – Moving. Case study: Text to speech.	
	Total Hours: 45

Text Books:	
1.	Utpal Chakraborty,"Artificial Intelligence for All: Transforming Every Aspect of Our Life", BPB Publications, February 2020.
2.	Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2018.
3.	S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2015.
Reference Books:	
1.	Abhivardhan, "Artificial intelligence: Ethics & International Law", 3rd edition, BPB Publications, January 2019.
2.	Luger George F, Artificial Intelligence: Structures and Strategies for Complex Problem solving, 6th edition, Pearson Education, 2015.
3.	I. Bratko, "Prolog: Programming for Artificial Intelligence", Fourth edition, Addison-Wesley Educational Publishers Inc., 2018.
Web References:	
1.	http://www.nptelvideos.in/2012/11/artificial-intelligence.html
2.	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm
3.	https://nptel.ac.in/courses/106105077/
Online Resources:	
1.	http://www.nptelvideos.in/2012/11/artificial-intelligence.html
2.	https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_expert_systems.htm
3.	https://nptel.ac.in/courses/106105077/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C101.1	Understand	Quiz	20
C101.2	Analyze	Tutorial	20
C101.3	Analyze		
C101.4	Understand	Group Assignment	20
C101.5	Analyze		
C101.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C101.1	2	2	2	2	2	3				1		1	3	1	2
C101.2	2	3	2	2	2	3				1	1	1	2	2	2
C101.3	2	2	2	2	2	3				1	1	1	1	2	2
C101.4	2	2	2	2	2	3				2	2	2	2	1	2
C101.5	2	2	2	2	2	3				1	1	2	1	1	2
C101.6	2	2	2	2	2	3				1	1	2	1	1	2

22MA102	MATHEMATICS I	3/1/0/4

Nature of Course	B (100% Analytical)
Pre requisites	-

Course Objectives:

1	To develop the skill to use matrix techniques that are needed by engineers for practical applications.
2	To acquaint with the knowledge of vector space needed for problems in all engineering disciplines.
3	To acquire further skills in the techniques of linear algebra.
4	To gain knowledge in calculus, which are needed in engineering applications.
5	To impart the knowledge of Laplace transform, to find solutions of initial value problems for linear ordinary differential equations.

Course Outcomes(Theory)
Upon completion of the course, students shall have ability to

C102.1	Recall the basic concepts of linear algebra and calculus.	[R]
C102.2	Understand the concepts of vectors to find the dimension and basic differentiation and integration to synthesise the function.	[U]
C102.3	Apply the concepts of linear algebra to solve linear systems of equations both numerically and analytically.	[AP]
C102.4	Apply the differential techniques to solve ordinary differential equations and numerical methods to solve the integral functions.	[AP]
C102.5	Apply Laplace transform methods for solving linear differential equations.	[AP]

Course Contents:

MODULE I - LINEAR ALGEBRA (20 Hrs)

VECTOR SPACE: Vector space: Dimension – Basis – Orthogonality – Projections - Gram-Schmidt orthogonalization and QR decomposition. **- MATRICES:** Definition – Types of matrices – Characteristic equation – Eigenvalues and Eigenvectors of a real matrices and their properties (excluding proof) – Eigenvalues of a matrix by power method - Solution of system of linear equations by Gauss Elimination and Gauss Jordan method - Iterative methods: Gauss Jacobi method and Gauss Seidel method- Inverse of a matrix by Gauss Jordan method.

MODULE II – CALCULUS (20 Hrs)

DIFFERENTIAL CALCULUS: Solution of First order ordinary differential equations: Taylor's series method – Rungekutta method of fourth order – Second and Higher order Linear differential equations with constant coefficients – Method of Variation of Parameters – Higher order Linear differential equations with variable coefficients: Euler Cauchy's equation. **INTEGRAL CALCULUS:** Evaluation of definite integrals using Bernoulli's formula – Beta and Gamma functions – Evaluation of Integrals using Beta and Gamma Functions – Numerical integration: Trapezoidal rule and Simpson's rule for single and double integrals.

MODULE III - LAPLACE TRANSFORM (20 Hrs)

Convergence of Laplace transform – Transform of some standard functions –Unit step function- Unit Impulse function – Properties –Shifting theorem- transforms of derivatives and integrals - Initial and final value theorem – Laplace Transform of periodic functions – Inverse Laplace transform – Partial fraction method – Convolution theorem (Excluding Proof) – Solving second order ordinary differential equations using Laplace Transform.

Total Hours:	**60**

Text Books:

1	G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry, 14thEdition, Pearson, Reprint,2018.

2	Howard Anton and Chris Rorrs, "Elementary Linear Algebra", 9th Edition, John Wiley & Sons, 2000.
3	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2014.
Reference Books:	
1	Veerarajan. T, "Engineering Mathematics II",Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2018.
2	Glyn James, — Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
3	N.P.Bali and Dr.ManishGoyal,"A Textbook of Engineering Mathematics", 9th edition, Laxmi publications ltd, 2014.
4	Gilbert Strang, "Linear Algebra and its Applications", Third Edition, Harcourt College Publishers, 1988.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc21_ma16/preview
2	https://onlinecourses.nptel.ac.in/noc22_ma72/preview
3	https://archive.nptel.ac.in/courses/111/106/111106139/
4	http://nptel.ac.in/video.php?subjectId=117102060/
Online Resources:	
1	https://www.coursera.org/learn/ordinary-differential-equations
2	https://www.coursera.org/learn/linearalgebra1/
3	https://www.classcentral.com/course/swayam-laplace-transform-19925
4	https://www.edx.org/course/algebra-lineal-mexicox-acf-0903-1x/

Assessment Methods & Levels (based on Blooms' Taxonomy)

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C102.1	Remember	Quiz	20
C102.2	Understand	Case study	20
C102.3 – C102.5	Apply	Tutorial	20
C102.3 – C102.5	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20

Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)(Theory)

COs	POs												PSOs		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
C102.1	1	1											1		
C102.2	2	2											1		
C102.3	3	3													
C102.4	3	3											1		
C102.5	3	3													

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22IT101	APPLICATION DEVELOPMENT PRACTICES	3/0/2/4
Nature of Course	F (Theory programming)	
Pre requisites	Nil	
Course Objectives:		
1.	To discuss the essence of agile developmentmethods.	
2.	Ability to understand and applyScrumframework.	
3.	To set up and create a GitHub repository.	
4.	To impart the knowledge of web application development platforms.	
5.	To create interactive websites using HTML, CSS.	
6.	To recognize the user experience design methodologies like Java script for responsive web design.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C101.1	Make use of the concept of agile software engineering and its advantages in software development.	[AP]
C101.2	Demonstrate the values and practices of Scrum and how to setup the GitHub repository.	[U]
C101.3	Find the working model and learn basic web concepts to develop Static and Dynamic websites.	[R]
C101.4	Utilize the knowledge of HTML, CSS and Bootstrap to build modern interactive web applications.	[AP]
C101.5	Develop dynamic web pages with validation using Java Script objects and by applying different event handling mechanisms.	[AP]

Course Contents:

Module - I: **15 Hours**

History of Traditional Software Development Model, Software Development Model and SDLC, "Waterfall Model" – An Overview, Waterfall or Sequential Based Development Model, "Real Life" – Waterfall Model, "Waterfall Model" – Advantages, "Waterfall Model" – Disadvantages, Agile Software Development – Definition, Agile Development Model, Graphical Illustration of Agile Development Model, Why use Agile?, Agile Manifesto and Principles, 12 Principles of Agile Methods, Agile Values, What is NOT an Agile software development?, Foundation of an Agile software development Method, Common Characteristics of Agile Methods, Agile Methods and Practices, When to use Agile Model?, Advantages of Agile Model, Disadvantages of Agile Model, Difference between Agile and Waterfall Model, Agile – Myths and Reality, Agile Market Insight. Introduction to SCRUM, Scrum Roles and Responsibilities, Scrum Core Practices and Artifacts, User Story, Sprint, Release Planning Meeting, Sprint Planning Meeting, Daily Scrum Meeting (Daily Stand up), Sprint Review Meeting, Retrospective, Product Backlog, Sprint Backlog, Burn-Down Chart, Velocity, Impediment Backlog. Definition of "Done", Splitting User Story into Task, Why to Split User Story into Task?, Guidelines for Breaking Down a User Story into Tasks, Examples of Scrum Task Board, Planning Poker®, Planning Poker - Process/Steps, What are Story Points?, How do We Estimate in Story Points?, What Goes into Story Points? Introduction to Extreme Programming, The Rules of Extreme Programming, Extreme Programming (XP) – Principles, Extreme Programming (XP) – Key Terms, Introduction to Lean Software Development, Principles of Lean Software Development, What is Kanban? Introduction to Git - Getting a Git Repository, Recording Changes to the Repository, Viewing the Commit History, Undoing Things, Working with Remotes, Tagging, Git Aliases, Git Branching, Branches in a Nutshell, Basic Branching and Merging, Branch Management, Remote Branches, Rebasing. Introduction to GitHub – Introduction, Set up Git, Create a repository, GitHub Flow, Contribution to Projects, Communicating on GitHub. Linux Basic Commands - Linux Basic Commands, Linux File Permissions, Basic System Administration, Process Management, Archival. Linux Shell Script - Shell Basics, Writing first script, Conditional statements, Loops, Command line arguments, Functions & file manipulations, Background processes, Scheduling processes -At, batch & Cron - Networking.

Module - II: **15 Hours**

HTML Basics - Understand the structure of an HTML page, New Semantic Elements in HTML 5, Learn to apply physical/logical character effects, Learn to manage document spacing. Tables - Understand the structure of an HTML table, Learn to control table format like cell spanning, cell spacing, border. List - Numbered List, Bulleted List, Working with Links, Understand the working of hyperlinks in web pages, Learn to create hyperlinks in web pages, Add hyperlinks to list items and table contents. Image Handling - Understand the role of images in web pages, Learn to add images to web pages, Learn to use images as hyperlinks. Frames - Understand the need for frames in web pages, Learn to create and work with frames. HTML Forms for User Input - Understand the role of forms in web pages, Understand various HTML elements used in forms, Single line text field, Text area, Check box, Radio buttons, Password fields, Pull-down menus, File selector dialog box. New Form Elements - Understand the new HTML form elements such as date, number, range, email, search and data list, Understand audio, video, article tags.

Module - III: **15 Hours**

Introduction to Cascading Style Sheets - What CSS can do, CSS Syntax, Types of CSS. Working with Text and Fonts - Text Formatting, Text Effects, Fonts. CSS Selectors - Type Selector, Universal Selector, ID Selector, Class selector. Colors and Borders – Background, Multiple Background, Colors RGB and RGBA, HSL and HSLA, Borders, Rounded Corners, Applying Shadows in border, Implementing CSS3 in the "Real World" – Modernizr, HTML5 Shims, SASS, and Other CSS Preprocessors, CSS Grid Systems, CSS Frameworks. Introduction to Bootstrap – Introduction, Getting Started with Bootstrap, Bootstrap Basics, Bootstrap grid system, Bootstrap Basic Components, Bootstrap Components, Page Header, Breadcrumb, Button Groups, Dropdown, Nav & Navbars. JavaScript Essentials - Var, Let and Const keyword, Arrow functions, default arguments, Template Strings, String methods, Object de-structuring, Create, apply, prototype, bind method, Spread and Rest operator, Typescript Fundamentals, Types & type assertions, Creating custom object types, function types, Typescript OOPS - Classes, Interfaces, Constructor, Decorator & Spread Operator, Difference == & === , Asynchronous Programming in ES6, Promise Constructor, Promise with Chain, Promise Race.

Total Hours	**45**

Lab Component:

S. No	List of Experiments
1	Design a web page using HTML basic tags.
2	Develop web site with suitable contents and links.
3	Design web pages using lists and tables.
4	Build a web client-side Login, Registration form and Dashboard with drop down menus.
5	Develop a HTML form and validation using HTML5 features.
6	Create a website using HTML:
7	To embed an image map in a web page.
8	To fix the hot spots.
Total Hours	**30**

Text Books:

1.	Roman Pichler, “Agile Product Management with Scrum Creating Products that Customers Love”, Pearson Education, 1st Edition, 2010.
2.	Jeff Sutherland, “Scrum the Art of Doing Twice the Work in Half the Time”, Random House Publisher, 1st Edition, 2014.

3.	Scott Chacon, Ben Straub, “Pro GIT”, Apress Publisher, 3rd Edition, 2014.
4.	Richard Blum, Christine Bresnahan, “Linux Command Line and Shell Scripting BIBLE”, Wiley India Pvt. Limited, 5th Edition, 2008.
5.	Jennifer Niederst Robbins., “Learning Web Design, A beginner's guide to HTML, CSS, JavaScript, and Web Graphics”,O'Reilly Media, 5th Edition,2018.
6.	Jennifer Smith and the AGI Creative Team, “Web Design with HTML and CSS”,Wiley Publisher,1st Edition, 2011.
7.	Stephen Blumenthal, “JavaScript: JavaScript for Beginners - Learn JavaScript Programming with ease”,1st Edition, 2017.
Reference Books:	
1.	Robert C. Martin, “Agile Software Development, Principles, Patterns and Practices”, Prentice Hall, 2nd Edition, 2014.
2.	Mike Cohn, “User Stories Applied: For Agile Software”, Addison Wesley, 2nd Edition, 2016.
3.	Thomas a Powell, “HTML & CSS: The Complete Reference”, 5th Edition, Tata McGraw Hill Education Private Limited, 2010.
4.	Russ Ferguson, “Beginning JavaScript: The Ultimate Guide to Modern JavaScript Development”, Apress Publishers, 3rd Edition, 2019.
5.	Deitel, Deitel, Goldberg, “Internet and World Wide Web – How to program”, 5th Edition, Prentice Hall Publishers, 2012.
Web References:	
1.	https://www.coursera.org/specializations/agile-development
2.	https://www.edx.org/learn/agile
3.	https://nptel.ac.in/courses/106/105/106105182/
4.	https://developer.mozilla.org/en-US/docs/Web/HTML
5.	https://developer.mozilla.org/en-US/docs/Web/CSS
6.	https://developer.mozilla.org/en-US/docs/Web/JavaScript
Online Resources:	
1.	http://www.agilenutshell.com/
2.	https://www.atlassian.com/agile/scrum
3.	https://www.youtube.com/user/AgileMikeCohn
4.	https://www.coursera.org/learn/html-css-javascript-for-web-developers
5.	https://online-learning.harvard.edu/subject/javascript

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C101.1	Apply	Quiz & Assignment	20
C101.2	Apply	Assignment	20
C101.3	Understand	Case study	20
C101.4	Apply	Group Assignment	20
C101.5	Apply		

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	10	10	10
Understand	40	40	40
Apply	40	40	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-
Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C101.1	2	2	1	1								2	1	2	1
C101.2	3	2	3	3	3	2						2	3	3	2
C101.3	3	2	3	3	3	2						2	3	3	2
C101.4	3	2	3	3	3	2						2	3	3	2
C101.5	3	2	3	3	3	2						1	3	3	2

22CS101	PROBLEM SOLVING USING C++	3/0/2/4
Nature of Course	C(Theory Concept), K (Problem Programming)	
Pre requisites	NIL	

Course Objectives:

1	To learn the fundamental programming concepts and methodologies which are essential to build good C++ programs.
2	To gain knowledge on control structures and functions in C++
3	To provide the basic object oriented programming concepts and apply them in problem solving.
4	To introduce file streams and operations for storing data permanently.
5	To know generic programming paradigm

Course Outcomes :
Upon completion of the course, students shall have ability to

C101.1	Solve problems using operators and control Statements.	[AP]
C101.2	Write C++ programs for processing strings and arrays.	[AP]
C101.3	Apply the concepts of pointers and functions in programs.	[AP]
C101.4	Develop C++ programs using various object-oriented concepts to solve real world problems.	[A]
C101.5	Implement the concepts on file streams and operations.	[AP]

Course Contents:

Module – I: C++ Programming Fundamentals **15 Hours**

C vs C++, Basic of OOPS, the main () function, Header files, Basic Input and Output (I/O) using cinand cout, Variable, Constant.**Operators:** Arithmetic Operators, Assignment Operators, Relational Operators, Logical Operators,Bitwise Operators, Other Operators, Operator Precedence.Control Statements: if, if...else and Nested if...else, switch..case, break and continue, Loops - for loop, while loop, do while loop, goto.**Arrays and Strings**: 1D array, 2D array, Strings, String functions.**Function:** Basics, call by value, call by reference & return by reference, Inline function,overloading Functions, inline Functions, Recursive Functions.**Pointers:** Pointer, Dynamic Memory Allocation.

Module – II: Object Oriented Concepts **15 Hours**

Classes and Objects, public, private, protected. **Constructors and destructors**: Overloaded Constructor, Copy Constructor, Shallow Copying DeepCopying.**Overloading:** this' Pointer, structs vs Classes, Friends of a class, Operator OverloadingInheritance, Overloading vs overriding, Polymorphism, Virtual Functions, Pure Virtual Functionsand Abstract Classes.

Module – III: Files and Generic Programming **15 Hours**

Abstract Classes as Interfaces, Exception, Files, Streams and I/O, STL, Generic Programming, Lambda Expression.

Total Hours	**45**

Lab Component

1. Practice of C Programming using Branching and Iterative constructs.
2. Programs using Functions
3. Programs using arrays and strings.
4. Programs using Structures and Pointers.
5. Programs using classes and objects
6. Programs using constructor and destructor
7. Programs using method overloading, operator overloading and polymorphism concepts
8. Programs using friend class
9. Programs using virtual functions and abstract class

10. Programs using inheritance concepts 11. Programs using Files. 12. Programs using exception handling concept 13. Mini project	
Total Hours	**(45+30)=75**

Text Books:	
1.	E Balagurusamy ,"Object Oriented Programming With C++", 4th Edition, Tata McGraw-Hill Education, 2008.
2.	M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011
Reference Books:	
1.	Herbert Schildt, "The Complete Reference C++", 4th edition ,MH,2015
2.	John Hubbard, "Schaum's Outline of Programming with C++", MH,2016
Web References:	
1	https://www.geeksforgeeks.org/c-plus-plus/
2	http://web.stanford.edu/class/cs106l/
Online Resources:	
1	https://nptel.ac.in/courses/106101208
2	https://www.hackerrank.com/domains/cpp
3	https://codeforces.com/blog/entry/74684
4	https://www.hackerearth.com/practice/notes/tricky-and-fun-programming-in-c/

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C101.1	Apply	Quiz & Assignment	20
C101.2	Apply	Assignment	20
C101.3	Apply	Case study	20
C101.4	Analyze	Group Assignment	20
C101.5	Apply		

Assessment based on Summative and End Semester Examination - Theory		
Bloom's Level	**Summative Assessment (15%) [120 Marks]**	**End Semester Examination (35%)**

	CIA1: (60 Marks)	CIA2: (60 Marks)	[100 Marks]
Remember	10	10	10
Understand	40	40	40
Apply	40	40	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical

Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (15%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (50%)								End Semester Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		Theory Examination (35%) Practical Examination (15%)
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)	
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)			

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C101.1	3	3											3	2	
C101.2	3	3	3	3	3				2	1		3	3	2	1
C101.3	3	3	3	3	3				2	1		3	3	2	1
C101.4	3	3	3	3	3				2	1		3	3	2	1
C101.5	3	3	3	3	3				2	1		2	3	2	1

22EN101	TECHNICAL COMMUNICATION SKILLS	2/0/2/3

Nature of Course	: Theory Skill Based
Pre requisites	Basics of English Language

Course Objectives:

1	To enhance learners' LSRW skills.
2	To develop students' ability to understand the process of communicating and interpreting ideas and human experiences.
3	To facilitate learners to acquire effective technical writing skills.
4	To prepare learners for placement and competitive exams.
5	To facilitate effective language skills for academic purposes and real-life situations.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Remember language skills for technical communication.	[R]
C101.2	Apply communication skills in a corporate environment.	[AP]
C101.3	Understand and communicate effectively in personal and professional situations.	[AP]
C101.4	Understand and analyse a variety of reading strategies to foster comprehension and to construct meaningful and relevant connections to the text.	[U]
C101.5	Apply technical writing skills to write letters, emails and prepare technical documents.	[AP]

Course Contents:

Module I **10 Hours**

Introduction-Listening: - Listening to News in NDTV and Times Now Channels. **Speaking**: Introduction to Effective Communication - Barriers to Effective Communication- Tips to develop Communication Skills - Self Introduction - Overview of Business Communication-Short Talk on Business Topics -Impromptu Speaking (Public Speaking) - Non-Verbal Communication-SATORI-Sharing Personal Information-**Reading**: Reading Comprehension- Values and its Importance. **Writing**: SWOT Analysis -Book Review - Movie Review-Vocabulary Building.

Suggested Activities:

- Listening to Elon Musk speech on TESLA and brainstorm on their thoughts and ideas.
- Introduce themselves and discuss what they knew about the course and why did they choose this course.
- Observe TEDs talk and prepare a TALK on "Digital Tools".
- Speaking on latest technologies.
- A short talk on Valuable Moments in their life.
- Worksheet on Technical Terms, Digital vocabulary, Sci - Fiction and Technology.

Module II **10 Hours**

Listening: Listening to Specific Information. **Speaking**: Speaking on Specific Information. **Reading**: Skimming and Scanning-Reading Short Texts - Comparing Facts and Figures - Short Stories and Scientific Articles. **Writing**: Good and Bad Writing- Note Making - Writing Formal Letters (Inviting, Accepting and Declining Invitations)- Writing Business Letters (Calling for Quotations, Seeking Clarifications, Placing an Order and Complaint Letter)- Transcoding (Bar chart, Flowchart. Pie chart and Table)-Job Application Letter- Resume Writing.

Suggested Activities:

- Listening to Stephen Hawkings speech on APPLE and brainstorm on their thoughts and ideas.
- Listening to Stephen Hawkings speech on APPLE products and speak on the changes from previous product to latest product.
- Writing business letters.
- Worksheets on technical products.

Module III **10 Hours**

Listening: Listening to Narrations and Persuasive speech and identifying narrative and persuasive techniques. **Speaking**: 21st Century Skills- Narrative Skills- Leadership- Conflict Resolution-Persuasive Speaking-How to Tell a Story with Charts and Graphs **Reading:**Product Description and Product Review. **Writing**: Email Writing **–**Advantages and Disadvantages-Circular **–** Agenda and Minutes of the Meeting - Proofreading- Subject Verb Agreement-Tenses-Active Voice- Passive Voice- Impersonal Passive Voice-Report Phrases **–** Report Writing.

Suggested Activities:

- Listening to Sunder Pitchai, Google COE on latest google technology and identify narrative and persuasive speech.
- Speak on Technology using the 21st Century Skills.
- Writing technical reports.
- Worksheets on grammar and technical products.

Hours: (30 Hours)

Lab Components

1	Listening Comprehension 1.News in NDTV and Times Now Channels 2.Listening to Specific Information	[AP]
2	Impromptu Speaking	[AP]
3	Reading Comprehension related to Competitive Exams.	[U]
4	Immersion Activity and Presentation	[AP]
5	Group Discussion	[AP]
6	Group Assignment	[AP]
7	Verbal Ability and Logical Reasoning	[U]
8	Advertising and branding a product	[A]
9	Presenting a news on latest technology	[AP]
10	Create Blog and post content on social media	[A]
	Hours	30
	Total Hours:	(30+30) 60

Text Books:

1	Basic Communication Skills for Technology, by Andrea J Rutherford, Pearson Publishers.2000
2	Remedial English Grammar. F.T. Wood. Macmillan.2007
3	Oxford Guide to Effective Writing & Speaking by John Seely, Oxford University Press.2005

4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.
Reference Books:	
1	Touchstone Student's Book 1 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2005
2	Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.
3	Touchstone Student's Book 2 by Michael McCarthy, Jeanne McCarten, Helen Sandiford, Cambridge University Press.2015
Web References:	
1	http://www.academiccourses.com/Courses/English/Business-English
2	https://www.liveworksheets.com/worksheets/en/English_as_a_Second_Language_(ESL)/Technical_English
Online Resources:	
1	https://www.coursera.org/specializations/business-english
2	https://www.businessenglishresources.com/learn-english-for-business/student-section/practice-exercises-new/

Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C101.1 C101.2	Remember	Quiz	**20**
C101.3	Apply	Technical Presentation	**20**
C101.4	Understand	Reading Comprehension	**20**
C101.5	Apply	Group Assignment	**20**

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (25%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (25%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C101.1										3			1		
C101.2								2		3					
C101.3								2		3	2		1		
C101.4										3					
C101.5										3		3	1		

22CH101	ENGINEERING CHEMISTRY	3 /0 /2 /4
Nature of Course	: E (Theory Skill based)	
Pre requisites	: NIL	

Course Objectives:

1	To understand the principles and applications of electrochemistry and to learn electroanalytical methods.
2	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
3	To understand the basic concepts, synthesis, and applications of nanomaterials.
4	To explore the synthesis and properties of important engineering plastics, energy sources and drug molecules.
5	To understand the concepts of photophysical and photochemical processes in spectroscopy.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Recall the principle and working of reference electrodes and conductivity meters as an analyzer.	[R]
C101.2	Apply the various corrosion control techniques in real time industrial environments.	[AP]
C101.3	Interpret the basic concepts and applications of Nano chemistry.	[U]
C101.4	Use the knowledge of various energy sources in storage devices and polymeric products in engineering field.	[AP]
C101.5	Interpret the principle and working of certain analytical techniques.	[U]

Course Contents

Electrochemistry and Corrosion: Electrochemistry-Introduction-single electrode potential-Electrochemical cells-EMF series. Reference electrodes-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Corrosion-types–mechanism of dry and wet corrosion-galvanic corrosion-differential aeration corrosion. Corrosion protection-electroplating of Chromium-electroless plating of Nickel.

Case Study: Electrochemical oxidation of effluents from sewage water treatment.

15 hours

Nano-Chemistry and Energy sources: Nano Chemistry-Basics-Comparison of molecules, nanomaterials and bulk materials. Preparation of nanomaterials-Electrochemical deposition and electro spinning. Applications of nanomaterials in medicine. Energy Sources-Fuel Cells-H_2-O_2 fuel cell. Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

Case Study: Hydrogen fuel cell in agricultural-opportunities and challenges.

15 hours

Polymer Chemistry and Analytical Techniques

Introduction-monomers and polymers-classification of polymers-Degree of Polymerization Mechanism of addition polymerization (free radical mechanism). Plastics-classification-Thermoplastic-thermosetting plastics. Conducting polymers-Types-Mechanism-applications.Spectroscopy-Beer Lambert's law, principle, instrumentation, and applications of Electronic spectroscopy (UV-visible)-Vibrational and rotational spectroscopy (IR)-Flame emission spectroscopy (FES).

Case Study: To design new drug molecules using molecular docking software.

15 hours

Lab Components: **20 hours**

1	Determination of total, temporary, calcium and magnesium hardness of water sample by EDTA method.	[E]

2	Estimation of alkalinity of water sample.	[E]
3	Estimation of dissolved oxygen in water.	
4	Potentiometry- determination of redox potentials and emf's.	[E]
5	Conductometric titration-mixture of acids vs NaOH..	[E]
6	Determination of strength of strong acid by pH-metry.	[E]
7	Determination of corrosion rate of mild steel in acid medium.	[E]
8	Electroplating of nickel over copper.	[E]
9	Spectrophotometry-Estimation of iron in water.	[E]
10	Determination of single electrode potential of Zinc and Copper by given solution.	[E]
11	Anodizing of Aluminium using Electrolysis process.	[E]
12	Synthesis of Nylon 6 6.	[E]
	Total Hours:	**65**
Understanding the concepts by simple Demonstrations/Experiments:		
13	To detect the chlorine content in tap water using simple chemical method.	
14	To know the presence of dissolved oxygen in given water sample using glucose by redox principle.	
15	To illustrate the rate of corrosion in steel nails using acid medium.	
Text Books:		
1	Dara S.S, Umare S.S, "Engineering Chemistry", First revised Edition by S. Chand & Company Ltd., New Delhi 2015.	
2	Jain P. C. & Monica Jain., "Engineering Chemistry", 16th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2015.	
3	Fundamentals of Molecular Spectroscopy, 4th Edition by C. N. Banwell Publishing McGraw-Hill Book Company (P) Ltd, England, 1994.	
4	Nanochemistry, 2nd Edition by K. Klabunde, G. Sergeev Springer Publisher, 2013.	
Reference Books:		
1	Shikha Agarwal., "Engineering Chemistry and Applications", Cambridge University press, 2016.	
2	Liliya.,Bazylak.I., Gennady.E.,Zaikov.,Haghvi.A.K.,"Polymers and Polymeric Composites" CRC Press,2014.	
3	Lefrou., Christine., Fabry.,Pierre.,Poignet.,Jean-claude.,"Electrochemistry - The Basics, with examples" 2012 ., Springer.	
4	Zaki Ahmad, Digby Macdonald, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science, 2nd Edition 2012.	
5	Introduction to Nano: basics to Nanoscience and Nanotechnology, by Sengupta, Amretashis, Sarkar, Chandan Kumar, Springer Publisher, 2015.	
Web References:		
1	http://www.analyticalinstruments.in/home/index.html	
2	www.springer.com › Home › Chemistry › Electrochemistry	
3	https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry	
4	www.edx.org/	
5	https://www.ntnu.edu/studies/courses	
6	www.corrosionsource.com/	
Online Resources:		
1 2 3 4 5	https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com - Spectroscopic technique, Colorimetry https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/113108051	

Assessment Methods & Levels (based on Blooms' Taxonomy) - Theory			
Formative Assessment based on Capstone Model (10%)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C101.1	Remember	Online Quiz-I	2
C101.2	Apply	Assignment-I	3
C101.3	Understand	Online Quiz-II	2
C101.4	Apply	Assignment-II	3
C101.5	Understand		

Summative Assessment based on Continuous and End Semester Examination - Theory			
Bloom's Level	**Continuous Internal Assessment (15%)**		**End Semester Examination (35%) [35 Marks]**
	CIA 1 [7 Marks]	**CIA 2 [8 Marks]**	
Remember	20	15	20
Understand	30	35	30
Apply	50	50	50
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-

Summative Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%)**		**End Semester Examination (15%) [15 Marks]**
	FA (19 Marks)	**SA (6 Marks)**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyze	-	-	
Evaluate	-	-	
Create	-	-	

Summative Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)							**End Semester Examination (50%)**	
CA 1 (12 Marks)			**CA 2 (13 Marks)**			**Practical Exam (25 Marks)**		
SA 1 (7)	**FA 1**		**SA 2 (8)**	**FA 2**		**FA (19)**	**SA (6)**	**Theory (35)**	**Practical (15)**
	Comp - I (2)	**Comp -II (3)**		**Comp - I (2)**	**Comp - II (3)**			

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**K**	**l**	**1**	**2**	**3**
C101.1	3	2										1	1		1
C101.2	3	2										1	1		1
C101.3	3											1	1		
C101.4	3	2										1			
C101.5	3	2										1	1		1
	3 Strongly agreed			2 Moderately agreed						1 Reasonably agreed					

22MA202	MATHEMATICS II	3/1/0/4

Nature of Course	J (Problem analytical)
Prerequisites	-

Course Objectives:

1	To use logical notation to define and reason mathematically about the fundamental data types and structures used in computer algorithm and systems.
2	To study the concepts needed to test the logic of a program.
3	To learn the working on class of functions which transform a finite set into another finite set which relates to input and output functions in computer science.
4	To use number theory in computer networks and security.
5	To acquire thorough knowledge of fundamental notions of recurrence relations and its application in Cryptography.

Course Outcomes:
Upon completion of the course, students shall have ability to

C202.1	Recall the basic concepts of sets, functions, truth table and number theory.	[R]
C202.2	Understand the formation of Truth table, equivalence relations, division algorithm.	[U]
C202.3	Apply the structure of sets, relations and functions in some of the discrete structures.	[AP]
C202.4	Demonstrate the fundamental concepts of a mathematical function and all of its properties.	[AP]
C202.5	Apply different algorithms in the relevant areas of computer science	[AP]

Course Contents

MODULE 1: Propositional and Predicate Calculus

Propositional Calculus: Basic concepts – Propositions – Connectives – Truth tables – Tautologies and Contradictions – Contrapositive – Logical equivalences and Implications – Normal forms – Principal conjunctive and Disjunctive normal forms– Rules of inference – Validity of arguments – **Predicate Calculus**: Statement function – Variables – Free and bound variables – Quantifiers – Universe of discourse – Theory of inference – The rules of universal specification and generalization – Validity of arguments.

MODULE 2: Set Theory

Sets: Basic sets - Operations on Sets – Law on Sets - Cartesian product of sets – **Relations**: Types of relations and their properties – Relational matrix and graph of a relation – Equivalence relations – Partial ordering - **Functions:** Classification of functions – Composition of functions – Inverse function- Permutation functions- recursive function - hashing function - Counting: Permutations and Combinations - Mathematical induction.

MODULE 3: Number Theory & Recurrence Relation

Number Theory: Division algorithm - Base-b representations - Number patterns - Prime and composite numbers - GCD- Euclidean algorithm - Fundamental theorem of arithmetic – LCM - Wilson's Theorem - Fermat's Theorem -Tau and Sigma Function.
Recurrence Relation: Recurrence relations - Formation of recurrence relation - Solving linear recurrence relations – Generating functions.

Total Hours:	**60 Hrs**

Text Books:

1	Kenneth H. Rosen, - Discrete Mathematics and its Applications, Eight Edition, Tata McGraw – Hill Pub. Co. Ltd., New Delhi, Eight Edition, 2021.

2	Tremblay J.P and Manohar R, - Discrete Mathematical Structures with Applications to Computer Science, Tata McGraw–Hill Pub. Co. Ltd, New Delhi, 30th Reprint, 2011
3	Koshy. T-"Elementary Number Theory with Applications. Elsevier Publications, New Delhi, Second Edition, 2007.
Reference Books:	
1	P. Grimaldi, - Discrete and Combinatorial Mathematics: An Applied Introduction, Fifth Edition, Pearson Education sia, New Delhi, Fifth Edition, 2019.
2	Bernard Kolman, Robert C. Busby, Sharan Cutler Ross, —Discrete Mathematical Structures, sixth edition, Pearson Education Pvt Ltd., New Delhi, 2017
3	Thomas Koshy, —Discrete Mathematics with Applications, Elsevier Publications, 2004.
Web References:	
1	https://nptel.ac.in/courses/111/107/111107058/
2	https://nptel.ac.in/courses/106/106/106106094/
3	https://nptel.ac.in/courses/106/106/106106183/
4	https://nptel.ac.in/courses/111/101/111101137/
Online Resources:	
1	http://discrete.openmathbooks.org/dmoi3.html
2	https://www.csie.ntu.edu.tw/~sylee/courses/dm/resources.htm
3	/youtu.be/qvw1GX93JSY
4	https://www.geeksforgeeks.org/applications-of-hashing/

Summative assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%)						**End Semester Examination (60 %)**
CA 1 (20 Marks)			**CA2 (20 Marks)**			**Theory Examination (60 Marks)**
SA 1 (12 Marks)	**FA 1**		**SA 2 (12 marks)**	**FA 2**		
	Component -I (4 marks)	**Component –II (4 marks)**		**Component -I (4 marks)**	**Component - II (4 marks)**	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C202.1	Remember	Quiz	4
C202.2	Understand	Assignment	4
C202.3	Apply	Case study	4
C202.4	Apply	Tutorial	4
C202.5	Apply		

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%) [60 Marks]**
	CIA1 [12 Marks]	**CIA2 [12 Marks]**	
Remember	20	20	20
Understand	30	30	30

Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C202.1	1	1	1										1		
C202.2	1	2	1										2		
C202.3	3	3	2										2		
C202.4	1	1	2										1		
C202.5	2	1	2										2		

22EE111	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING	2/1/0/3
Nature of Course	G (Theory analytical)	
Course Pre-requisites	Nil	

Course Objectives:

1	To import the students with a basic understanding of Electrical circuits.
2	To learn the working principle of transformers.
3	To understand the Electrical Machines working principles and to have a knowledge on selection of machine for specific types of applications.
4	To equip the students with an ability to understand basics of electronics devices.

Course Outcomes:

Upon completion of the course, students shall have ability to

C111.1	Analyse the concepts in AC circuit and DC circuits.	[A]
C111.2	Examine the working principle of single-phase transformer.	[A]
C111.3	Realize the fundamental concepts of magnetic circuits	[U]
C111.4	Understand the working principle of DC and AC machines.	[AP]
C111.5	Interpret the basic devices in Electronics.	[U]

Course Contents:

Course Contents:

Module I: DC Circuits and AC Circuits **15 Hrs**

DC Circuits - Electrical circuit elements (R, L and C) - Voltage and Current Sources - Kirchoff's current and voltage law - analysis of simple circuits with dc excitation - Mesh and Nodal Analysis. **AC Circuits** - Representation of sinusoidal waveforms, Peak and RMS values, Phasor representation, Real power, Reactive power, Apparent power, Power factor. Analysis of single phase ac circuits consisting of R, L, C, RL and RC. Three phase balanced circuits - Voltage and Current relations in star and delta connections. Case Study: Computer Power Supply Unit.

Module II: Magnetic Circuits and Electrical Machines **15 Hrs**

Magnetic Circuits - Definitions - MMF, Flux, Reluctance, Magnetic Field Intensity, Flux Density, Fringing, Self and Mutual Inductances, Static machines: BH characteristics, Construction and working principle of single-phase and three phase transformers. Rotating machines: Generation of rotating magnetic fields, Construction and working principle of DC machines, Three-phase induction motor and Synchronous motor. Case Study: Computer control system.

Module III: Basics of Electronics and Applications **15 Hrs**

Semiconductor - PN junction diode - Zener diode - Rectifier - Half wave, Full wave and Bridge rectifier - Bipolar Junction Transistor Introduction - Common base, Common emitter and Common collector configuration - Field Effect Transistor Introduction - Construction and characteristics of JFETs - MOSFET - Depletion type MOSFET, Enhancement type MOSFET, Transfer characteristics. Case Study: Role of Electronics in miniaturization of computers.

Total Hours	**45**

Text Books:

1	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 7th edition, 2020.
2	Vincent. Del. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 2nd edition, 2015.
3	E. Hughes, "Electrical and Electronics Technology", Pearson, 10th edition, 2011.
4	Donald .A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition reprint, Tata Mc Graw Hill, 2013.

Reference Books:

1	Charles A.Gross, Thaddeus A.Roppel, "Fundamentals of Electrical Engineering", CRC press, 2012.
2	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, Revised 1st edition 2017.
3	Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, 'Electronic Devices and Circuits', Pearson Education, 6th edition, 2013.
Web References:	
1	http://nptel.ac.in/course.php?disciplineId=108
2	https://ocw.mit.edu/courses/find-bytopic/#cat=engineering&subcat=electricalengineering&spec=electricpower
3	https://nptel.ac.in/video.php?subjectId=117103063
4	https://onionesquereality.wordpress.com/.../more-video- lectures-iit-open
5	https://nptel.iitg.ernet.in/Elec_Comm_Engg/.../Video-ECE.pdf
Online Resources:	
1	http://www.electrical-knowhow.com/
2	https://www.edx.org/course/electricity-magnetism-part-1-ricex-phys102-1x-1
3	https://www.mooc-list.com/course/fundamentals-electrical-engineering-coursera
4	https://nptel.ac.in/course.php

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C111.1	Analyze	Quiz	20
C111.2	Analyze	Tutorial	20
C111.3	Understand	Group Assignment	20
C111.4	Apply		
C111.5	Understand	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	

Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination							
Continuous Assessment (40%) [200 Marks]							**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**				
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**			
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**		

No. of the 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**
C111.1	3	3	3	3					2	2			3		3
C111.2	3	3	3	3					2	2			3		3
C111.3	3	3	3	3					2	2			3		3
C111.4	3	3	3	3					2	2			3		3
C111.5	3	3	3	3					2	2			3		3
1	**Reasonably Agreed**				**2**	**Moderately Agreed**					**3**	**Strongly Agreed**			

22TA101	HERITAGE OF TAMILS	1/0/0/1

Nature of Course:	C (Theory Concept)
Pre requisites:	NIL

Course Objectives:

1	To know various concepts of Tamil Language families.
2	To know about the essentialities of Heritage.
3	To understand the Aram concepts of Tamils and the cultural influence.

Course Outcomes:
Upon completion of the course, students shall have ability to

C101.1	Know about the language families in India, impact of religions and the contribution of Bharathiyar and Bharathidhasan.	[U]
C101.2	Observe the growth of sculpture, making of musical instruments and the role of temples in socio and economic lives.	[U]
C101.3	Understand the significance of folklore and martial arts.	[U]
C101.4	Learn the sangam literature, sangam age and overseas conquest of Cholas.	[U]
C101.5	Understand the contribution of Tamils to Indian Freedom Struggle, role of Siddha medicine and print history of Tamil Books.	[U]

Course Contents:

Language and Literature: Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

Heritage - Rock Art Paintings to Modern Art – Sculpture: Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils. **FolkAndMartialArts:** Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

Thinai ConceptOfTamils - Flora and Fauna of Tamils &Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas. ContributionofTamilstoIndiannationalmovementandindianculture:Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

Total Hours: 15

Text-cum-Reference Books:

1	தமிழகவரலாறு – மக்களும்பண்பாடும்–கே.கே.பிள்ளை(வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2	கணினித்தமிழ் – முனைவர்இல. சுந்தரம் . (விகடன்பிரசுரம்).
3	கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)
4	பொருநை – ஆற்றங்கரைநாகரிகம். (தொல்லியல்துறைவெளியீடு)
5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in

	print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C101.1	Understand	Quiz	20
C101.2	Understand	Seminar	20
C101.3	Understand	Seminar	20
C101.4	Understand	Quiz	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	40	40	40
Understand	60	60	60
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C101.1	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
C101.2	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-
C101.3	-	-	-	-	-	-	-	1	1	-	-	1	-	-	-
C101.4	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
C101.5	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-

22CS201	DATA STRUCTURES AND ALGORITHMS	3/0/2/4
Nature of Course:	F(Theory Programming)	
Pre requisites:	Problem Solving using C++	

Course Objectives:

1.	To introduce data structure concepts and its applications.
2.	To impart the importance of stacks and queues in problem solving.
3.	To provide knowledge on Tree and Graph data structures.
4.	To discuss the role of hashing in information storage and retrieval.

Course Outcomes:
Upon completion of the course, students shall have ability to:

C201.1	Implement the basic data structures like array and LinkedList.	[AP]
C201.2	Solve real world problems efficiently by applying stack and queue data structures.	[AP]
C201.3	Illustrate the applications of tree data structures.	[AP]
C201.4	Discuss the importance of hashing techniques in information storage	[AP]
C201.5	Employ graph algorithms for solving real time computing problems and analyze them.	[A]

Course Contents:

Module I LinkedList & Stack 15 Hours

Linked List: Array vs Linked list - Types of linked list - Singly, Doubly and Circular Linked list - Applications of linked list. Stack: Stack Model, Array and Linked list implementation of Stack – Applications of Stack - Infix, Prefix and Postfix expressions - infix to postfix conversion - Expression Evaluation- Balancing Parenthesis.

Module II Queue and Trees 15 Hours

Queue: Queue Model, Array and Linked list implementation of Queue-Priority Queue - Applications of Queue. Trees: Binary Tree - Binary Search Tree - Insertion, Deletion, Traversal - Inorder, Preorder, Postorder, Level order traversal.

Module III Graphs and Hashing 15 Hours

Graphs: Weighted and Directed graphs - Adjacency matrix and list implementation - Traversal – Breadth First Search & Depth First Search. Hashing: Direct Address Table, Hash function, Collision resolution techniques, Linear Probing, quadratic probing, double hashing.

Total Hours (Theory):	**45 hours**

Lab Component

S. No.	Lab Exercises
1	Implementation of Singly, Doubly and Circular Linked List.
2	Implementation of Stack using Arrays.
3	Implementation of Stack using Linked List.
4	Implementation of Stack Applications.
5	Implementation of Queue using Arrays.
6	Implementation of Queue using Linked List.
7	Implementation of Queue applications.
8	Implementation of Hashing techniques

9	Implementation of Binary Search Tree.	
10	Implementation of Graph Traversal algorithms	
	Total Hours(Lab):	**30 hours**
	Total Hours: (45+30)	**75 Hours**
Text Books:		
1	Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", Silicon paper publications, 2004.	
2	AnanyLevitin, Introduction to the design & analysis of algorithms , 3rd Edition, Pearson Education, 2021.	
3	Michael T. Goodrich, "Data Structures and Algorithms in C++", 2nd Edition, Wiley Publication, 2011.	
Reference Books:		
1	Seymour Lipschutz,"Data Structures by Schaum Series",2nd edition, Tata McGraw Hill, 2013.	
2	NarasimhaKarumanchi,"Data Structures and Algorithms Made Easy: Data Structures and Algorithmic Puzzles",5th Edition, Career Monk,2016.	
3	DebasisSamanta,"Classicdatastructures",PrenticeHallofIndia,2nd edition,2014.	
Web References:		
1	https://www.codingninjas.com/courses/c-plus-plus-data-structures-and-algorithms	
2	https://www.edx.org/course/data-structures-algorithms-using-c	
Online Resources:		
1	https://www.programiz.com/dsa l	
2	https://freevideolectures.com/course/2519/c-programming-and-data-structures	
3	https://www.cprogramming.com/algorithms-and-data-structures.html	

Continuous Assessment									**End Semester Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C201.1	Apply	Quiz	**20**
C201.2	Apply	Assignment	**20**
C201.3	Apply	Case study	**20**
C201.4	Apply	Group Assignment	**20**
C201.5	Analyse		

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	20	10	10
Understand	40	40	40
Apply	40	40	40
Analyse	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	60	40	40
Analyse	-	20	20
Evaluate		-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination									
Continuous Assessment (50%)									**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**			**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**		
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**				

Course Outcome (CO)	**Programme Outcomes(PO)**												**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C201.1	3	3	2									1	3	1	1
C201.2	3	3	3	3	3				2	1		2	3	2	2
C201.3	3	3	3	3	3				2	1		2	3	2	2
C201.4	3	3	3	3	3				2	1		2	3	2	2
C201.5	3	3	3	3	3				2	1		2	3	2	2
C201	**3**	**3**	**3**	**3**	**3**				**2**	**1**		**2**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22IT201	DATABASE MANAGEMENT SYSTEMS	3/0/2/4
Nature of Course:	D (Theory Applications)	
Prerequisites :	Nil	

Course Objectives:

1	To describe information and data models and relational databases.
2	To explain an Entity Relationship Diagram and design a relational database for a specific use case.
3	To implement different relational model constraints.
4	To manage database using SQL commands

Course Outcomes:

Upon completion of the course, students shall have ability to:

C201.1	Understand the fundamental concepts and principles of DBMS.	[U]
C201.2	Understand the Normalization process to design and develop well-structured and normalized database schemas.	[U]
C201.3	Identify the basics of SQL and construct queries using SQL.	[AP]
C201.4	Analyze and design a real database application and develop database application using database management system.	[A]
C201.5	Examine the techniques for query optimization and infer the transactions management, concurrency control mechanism in a database environment.	[A]

Course Contents:

MODULE I INTRODUCTION **15 Hours**

Introduction to DBMS, Characteristics of DBMS, DBMS vs File Systems, need for DBMS, Three Level DBMS Architecture, Data Models – Introduction, Benefits, and Phases, ER Diagrams – Symbols, Components, Relationships, Weak entities, Attributes, Cardinality, Relational Algebra, Domain Relational Calculus, Tuple Relational Calculus, Normalization - 1NF, 2NF, 3NF, BCNF, 4NF

MODULE II CONSTRAINTS AND SQL COMMANDS **15 Hours**

DDL Commands - Create, Drop, Alter, Truncate, Rename, Keys - primary Key, Foreign Key DML Commands - Select, Insert, Update, Delete, Any, All, In, Exists, Non Exists, Union, Intersection, Subqueries - nested, correlated, Joins- Inner, Outer, and Equi, Functions - SUM, COUNT, AVG, MIN, MAX, Clauses - Group By, Having By, Embedded SQL, Dynamic SQL, Transaction Concepts – Transaction model – ACID Properties – Serializability –Transactions as SQL statements.

MODULE IIIQUERIES AND TRANSACTIONS **15 Hours**

Creation and Dropping of Views, Creation and Execution of Stored Procedures Cursors and Triggers - Opening, Fetching and Closing, Creation , Insertion, Deletion and Updating Database Applications: Payroll Processing Systems, Railway Reservation Systems, Bank Management System Introduction, Storage media and file structures, B+ Tree Hashing – static and Dynamic, Introduction to Query Processing – Issues in query optimization – Steps in query processing, Concurrency control and transactions, Lock based protocols Recovery System – Failure classification.

Lab Experiments:

1. Conceptual Database design using E-R DIAGRAM
2. Implementation of SQL commands DDL, DML, DCL and TCL
3. Queries to demonstrate implementation of Integrity Constraints
4. Practice of Inbuilt functions
5. Implementation of Join and Nested Queries AND Set operators
6. Implementation of virtual tables using Views

7. Practice of Procedural extensions (Procedure, Function, Cursors, Triggers) 8. Mini Project (Application Development) i) IT Training Group Database ii) Blood Donation System iii) Salary Management System iv) Traffic Light Information System	
Total Hours:	**45+30**
Text Books:	
1	Abraham Silberschatz, Henry F Korth, S Sudarshan, “Data base System Concepts”, 7th Edition, McGraw hill, 2020.
2	Vijay Krishna Pallaw, “Database Management Systems”, 2nd Edition Asian Books Private Limited, 2010.
3	Mark L. Gillenson, "Fundamentals of Database Systems", 7th Edition, Wiley India Pvt. Limited, 2008.
Reference Books:	
1	Raghu Ramakrishnan, Johannes Gehrke, Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", McGraw-Hill Education, 2017
2	C. Date, "SQL and Relational Theory", O'Reilly Media, Incorporated, 2011.
Web References:	
1	http://www.sqlcourse.com/
2	https://www.w3schools.com/sql/
3	https://www.geeksforgeeks.org/dbms/
Online Resources:	
1	https://www.coursera.org/learn/database-management
2	https://www.udemy.com/database-management-system/
3	https://onlinecourses.swayam2.ac.in/cec22_cs18/preview

Continuous Assessment									**End Semester Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C201.1	Understand	Quiz	20
C201.2		Assignment	20
C201.3, C201.4	Apply	Group Assignment	20
C201.5	Analyse	Case Study	20

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	10	10	20
Understand	40	30	30
Apply	50	40	40
Analyse	-	20	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	20	10	10
Understand	20	20	20
Apply	40	40	40
Analyse	20	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination									
Continuous Assessment (50%)									**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**			**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**		
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**				

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C201.1	3	1			1					1		1	2		1
C201.2	3	3	3	3					2	2		3	3	2	2
C201.3	3	3	2	1					2	1	2	3	3	2	2
C201.4	3	3	2	2	2				2	1	2	2	3	2	2
C201.5	3	2	2		2				1	2	2	3	2	2	2

22AD201	JAVA PROGRAMMING	3/0/2/4

Nature of Course	F (Theory Programming)
Pre requisites	Nil

Course Objectives:

1	To understand the basic concepts of core java.
2	To employ different types of modifiers andControl statements.
3	To implement and interpret Arrays and Strings concepts.
4	To implement streams and java console formatting features.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C201.1	Infer the concepts and features of java.	[U]
C201.2	To examine key aspects of java Standard API library such as util, io, applets, swings, GUI based controls.	[AP]
C201.3	Apply Array and strings in real time environment.	[AP]
C201.4	Analyse and Interpret String Buffer and StringBuilder Classes.	[A]
C201.5	Utilize the functionalities of streams and java console class.	[AP]

Course Contents:

MODULE I Introduction to Java **15 hours**

Introduction to Java: Java Architecture- JVM, JRE & JDK, Keywords, Features of Java, Console input and output statements, variables and Identifiers, Scope of Variables, Data types, Type Conversion, Comments, Command Line Arguments, Access Modifiers **Operators** - Unary Operator- Arithmetic Operator- Shift Operator - Relational Operator - Bitwise Operator - Logical Operator - Ternary Operator andAssignment Operator.**Decision Statements** - if Statements, if-else Branching, switch Statements.

MODULE II Loops, Array & Strings **15 Hours**

Looping Statements: using for loop, using while Loops, Using do Loops. **Jump Statements:** using break and continue, Unlabelled Statements, Labelled Statements. **Arrays:** Declaration, Instantiation and Initialization of Java Array, Types of Array - Single Dimension array, Multi-dimension array **Strings:**String, StringBuilder, and StringBuffer, The String Class, Important Facts About Strings and Memory, Important Methods in the String Class, The StringBuffer and StringBuilder Classes, Important Methods in the StringBuffer and StringBuilder Classes, File Navigation and I/O.

MODULE III Java I/O **15 Hours**

Streams: Types of Streams, The Byte-stream I/O hierarchy, Character Stream Hierarchy, Random Access File class, The java.io.Console Class, Serialization, Dates, Numbers, and Currency, Working with Dates, Numbers, and Currencies, Parsing, Tokenizing, and Formatting, Locating Data via Pattern Matching, Tokenizing.

Total Hours:	**45**

Laboratory Component:

S. No.	List of Experiments
1	Implementation of simple java program using Command Line Arguments
2	Implementation of simple java programs using decision making statements
3	Implementation of simple java programs using Looping statements
4	Implementation of Simple java programs using Jump statements
5	Implementation of 1D Array
6	Implementation of 2D Array
7	Implementation of String functions
8	Implementation of simple java program using Streams
9	Implementation of simple java program using Date and Number classes
10	Implementation of simple java program using Tokenizing
Total Hours:	**15**

Text Books:

1	Herbert Schildt, “Java: The Complete Reference”, 9th edition, Tata McGraw Hill, 2014.
2	Kathy Sierra, “Head First Java: A Brain-Friendly Guide, 2nd Edition, Oreilly, 2009.
3	Herbert Schildt, “Java A Beginner's Guide, Create, Compile and Run Java Programs Today”, 8th edition, Tata McGraw Hill, 2020.
Reference Books:	
1	Paul Deitel, Harvey Deitel, “Java How To Program”, 10th Edition, Prentice Hall Publications, 2014.
2	Y. Daniel Liang, ”Introduction to Java Programming”, 9th Edition, Prentice Hall Publications, 2015.
3.	Ed Roman, RIma Patel, Sriganesh, Gerald Brose, “Mastering Enterprise JavaBeans” 3rd edition, Wikely, 2005.
Web References:	
1	http://www.nptel.ac.in
2	http://www.javaworld.com
3	https://www.learnjavaonline.org/
4	https://www.codecademy.com/learn/learn-java
Online Resources:	
1	https://www.coursera.org/courses?query=java
2	https://www.tutorialspoint.com/java/index.htm
3	https://www.w3schools.com/java/java_intro.asp

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C201.1	Understand	Quiz & Assignment	20
C201.2	Apply	Assignment	20
C201.3	Apply	Case study	20
C201.4	Analyze	Group Assignment	20
C201.5	Apply		

Assessment based on Summative and End Semester Examination - Theory			
Bloom’s Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	10	10	10
Understand	40	40	40
Apply	40	40	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (15%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination										
Continuous Assessment (50%)										End Semester Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		Theory Examination (35%) Practical Examination (15%)		
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)			
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)					

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C201.1	2	2	2						2			2	2		2
C201.2	3	3	3					2	2	2		2	2	2	2
C201.3	2	2	3		2				2			3			3
C201.4	3	2	2		2			2	2	2		3		2	3
C201.5	3	2	2		2			2	2	2		3		2	3

22PH201	PHYSICS	3/0/2/4
Nature of Course	: E (Theory skill based)	
Prerequisites	: Nil	

Course Objectives:

1.	To learn the fundamental concepts of physics and apply this knowledge to both scientific and engineering problems.
2.	To make the students enrich basic knowledge in various fields such as Laser, Optical fibers, Photonics, Superconductors and quantum mechanics of physics and apply the same in computing fields.

Course Outcomes:
Upon completion of the course, students shall have the ability to

C201.1	Understand the basic concepts of lasers and its application in Engineering field.	[U]
C201.2	Recall the various types of optical fibers and its applications.	[R]
C201.3	Describe and conduct experiments in photonic materials and fundamental concepts of superconductors.	[U]
C201.4	Discuss the basic concepts of Quantum Mechanics and quantum ideas at the nanoscale.	[U]
C201.5	Apply the gained knowledge to solve the problems related to their field of study.	[AP]

Course Contents:

Laser and Fiber optics **15 Hours**

Laser:Characteristics of laser **–** Principle of spontaneous emission and stimulated emission **–** Einstein's theory of matter radiation interaction and A and B coefficients (derivation) **–** Population inversion **–** Pumping **–** Nd-YAG and CO_2 laser **– Case Study - Applications**: **Laser printer, Data storage and Bar code scanner.**

Fiber optics: Light propagation through fibers, acceptance angle, numerical aperture **–** Types of fibers: step index, graded index, single mode and multimode **–** V **–** number **– Case Study** - **Optical fibers for computing applications – PC to PC communication and fiber optics in computer networking.**

Photonics and Superconductors **15 Hours**

Photonics: Introduction to photonic materials **–** Photonic crystals **–** Liquid crystal display (LCD) Light sources: Light emitting diode (LED) **–** Photo dependence resistor **–** Photo detectors: PIN, avalanche **–** Photo voltaic effect, Solar cell **– Case Study -Applications of photonic materials in computing – optical computing.**

Superconductors:Properties of Superconductors: effect of magnetic field, Meissner effect, effect of current, thermal properties, isotope effect, Josephson effects and its applications **–** Type**–**I and Type**–**II Superconductors **–** BCS theory **–**High T_C superconductors **–** Application of Superconductors: magnetic levitation, SQUID and cryotron. **Case Study – Superconducting Microprocessor.**

Quantum Mechanics and Quantum computing **15 Hours**

Quantum Mechanics: Planck's quantum theory (derivation) **–** Matter waves, de-Broglie wavelength, Heisenberg's uncertainty principle **–** Schrödinger's wave equation: time independent and time dependent **–** Physical significance of wave function **–** Particle in a one-dimensional potential box **–** Electron microscope: SEM and TEM**–**Postulates of quantum mechanics. ***Quantum computing*****:** Introduction to quantum computing **–** qubits, entanglement, decoherence and quantum supermacy, differences in quantum and classical computation. **Case Study – Real – world applications of Quantum Computing.**

45 Hours

Lab Component **30 Hours**

1	nination of Particle size and measurement of d-spacing in CD using Laser.	[E]
2	Determination of wavelength, angle of divergence and coherence length	[E]

	of laser source.	
3	Determination of numerical aperture and acceptance angle parameter of optical fiber using Laser source.	[E]
4	Determination of Characteristics curves of solar cell.	[E]
5	Determination of Characteristics curve of light dependence resistor (LDR).	[E]
6	Determination and verification of Stefan law.	[E]
7	Determination of Planck's constant using electroluminescence.	[E]
8	Determination of wavelength of mercury spectrum Spectrometer	[E]
9	Determination of bandgap of semiconductor.	[E]
10	Determination of entangled photons using spectrometer.	[E]
	Life Skills Experiments	
11	Determination of pressure required to shut off the fuel pump nozzle.	[E]
12	Determination of capacitance required to shut off the circuit in a circuit breaker.	[E]
13	Determination of earth, neutral and phase line in a circuit.	[E]
	Total Hours:	**75**

Text Books:	
1	David Halliday, Robert Resnick, Jearl Walker "Fundamentals of Physics", 11th edition, Wiley, 2018.
2	FedorMitschke "Fiber Optics physics and Technology", 2nd edition, Springer, 2017.
3	Kasap, Safa, Capper, "Handbook of Electronic and Photonic Materials" 2nd edition, Springer, 2017.
4	Trager, Springer "Handbook of Lasers and Optics" 2nd edition, Springer, 2012.
5	Eleanor Rieffel and Wolfgang Polak, "Quantum computing a gentle introduction", 1st edition, The MIT press, 2012.
6	D. K. Bhattacharya and Poonam Tandon, "Engineering Physics", Oxford University press, 2014
Reference Books:	
1	William T. Silfvast "Laser Fundamentals" Cambridge University Press, 2012
2	P. Chakrabarti, "Optical Fiber Communication", McGraw Hill Education, 2015.
3	Balkan, Naci, Erol, Ayşe, "Semiconductors for Optoelectronics", 1st edition Springer, 2020.
4	David J. Griffiths, "Introduction to Quantum Mechanics", 2nd edition , Cambridge university press, 2017.
5	Chris Bernhardt, "Quantum Computing for Everyone" The MIT press, 2019

Web References:

1	https://www.studocu.com/in/document/mahatma-gandhi-university/engineering-physics/lasers-engineering-physics-lecture-notes-module-i/23900829
2	https://www.nitsri.ac.in/Department/PHYSICS/Unit_IV__Laser.pdf
3	https://www.lifewire.com/fiber-optic-cable-817874
4	https://www.nap.edu/read/5954/chapter/4
5	/www.sciencedirect.com/science/article/pii/S2211379718314268
6	/lecturenotes.in/notes/13602-note-for-optical-fibre-communication-ofc-by-sunil-s-harakannanavar
7	/ocw.mit.edu/courses/materials-science-and-engineering/3-46-photonic-materials-and-devices-spring-2006/lecture-notes/

8	vcchew.ece.illinois.edu/chew/course/QMALL20121005.pdf
9	/www.technologyreview.com/2019/01/29/66141/what-is-quantum-computing/
10	/www.quantum-inspire.com/kbase/what-is-a-qubit/
11	/www.cl.cam.ac.uk/teaching/0910/QuantComp/notes.pdf

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model – Theory			
Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (10%) [80 Marks]
C201.1	Understand	Online Quiz – I	20
C201.2	Remember	Assignment – I	20
C201.3	Understand	Online Quiz – II	20
C201.4	Understand	Assignment – II	20
C201.5	Apply		

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	Summative Assessment (15%) [120 Marks]		End Semester Examination (35%) [100 Marks]
	CIA1: (60 Marks)	CIA2: (60 Marks)	
Remember	20	20	20
Understand	50	50	50
Apply	30	30	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (15%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	30	30	30
Analyse	25	25	25
Evaluate	25	25	25
Create	-	-	-

Assessment based on Continuous and End Semester Examination										
Continuous Assessment (50%)									End Semester Examination (50%)	
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)			Theory Examination (35%) Practical Examination (15%)	
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)			
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)					

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C201.1	3	2	1	1								1			
C201.2	3	2	1	1								1			
C201.3	3	2	1	1								1			
C201.4	3	2	1	1								1			
C201.5	3	2	1	1								1			

22EE114	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY	0/0/2/1
Nature of Course	: M(Practicalapplication)	
Pre-requisites	: Nil	

Course Objectives:

1	Toimplement the basic Electric Circuits.
2	To estimate the current flow and voltage across the circuit elements under different loading conditions.
3	To understand the basic electronic devices.

Course Outcomes:
Upon completion of the course, students shall have ability to

C114.1	Illustrate the Electrical Elements and Sources in an Electric Circuit.	[U]
C114.2	Verify the current flow and voltage across the circuit elements using different analysis method.	[A]
C114.3	Measure three phase power and power factor in a single and three phase AC circuits.	[AP]
C114.4	Illustrate the working principle of residential house wiring, DC and AC machines.	[U]
C114.5	Interpret the basic devices in Electronics.	[AP]

Course Contents:

S.No	Listof Experiments	CO Mapping	RBT
1	Familiarization of Electrical Elements, Sources, Measuring Devices and Verification of ohm's law.	C114.1	[U]
2	Estimation of voltage and current by KVL and KCL in Electric Circuits.	C114.1	[A]
3	Determination of mesh current by Mesh Analysis.	C114.1	[A]
4	Determination of node voltage by Nodal Analysis.	C114.1	[A]
5	Estimation of Voltage and Current in star and delta connections.	C114.1	[A]
6	Measurement of three phase power and Power factor.	C114.2	[AP]
7	Residential house wiring and demonstration of cut-out sections of DC Motor and Induction Motor.	C114.3	[U]
8	Determination of characteristics of MOSFET.	C114.5	[U]
9	Construction of bridge rectifier with and without filters.	C114.5	[AP]
10	Draw the characteristics of Bipolar Junction Transistor.	C114.5	[U]
	Total Hours	**30**	

Text Books:

1	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 7th edition, 2020.
2	Vincent. Del. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 2nd edition, 2015.
3	E. Hughes, "Electrical and Electronics Technology", Pearson, 10th edition, 2011.
4	Donald .A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition reprint, Tata Mc Graw Hill, 2013.

Reference Books:

1	Charles A.Gross, Thaddeus A.Roppel, "Fundamentals of Electrical Engineering", CRC

	press, 2012.
2	D. C. Kulshreshtha, "Basic Electrical Engineering", McGraw Hill, Revised 1st edition 2017.
3	Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, 'Electronic Devices and Circuits', Pearson Education, 6th edition, 2013.
Web References:	
1	http://nptel.ac.in/course.php?disciplineId=108
2	https://ocw.mit.edu/courses/find-bytopic/#cat=engineering&subcat=electricalengineering&spec=electricpower
3	https://nptel.ac.in/video.php?subjectId=117103063

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
75	**25**	**100**	**60**	**40**	**100**

Assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (60%) [100 Marks]**		**End Semester Practical Examination (40%) [100 Marks]**
	FA (75 Marks)	**SA (25 Marks)**	
Remember	0	0	0
Understand	30	30	30
Apply	30	30	30
Analyse	40	40	40
Evaluate	0	0	0
Create	0	0	0

No. of the 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**
C114.1	3	2	1	1			1	2	2	2			3		3
C114.2	3	3	2	2			1	2	2	2			3		3
C114.3	2	1			3								3	2	
C114.4	3	2	1	1			1	2	2	2			3		3
C114.5	2	1			3								3	2	
1	**Reasonably Agreed**				**2**	**Moderately Agreed**					**3**	**Strongly Agreed**			

22GE201	UNIVERSAL HUMAN VALUES	3/0/0/3

Nature of Course	Descriptive
Pre-Requisites	Interpersonal Communication and Value Sciences

Course Objectives:

1	Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being ,family, society and nature/existence.
3	Strengthening of self-reflection.
4	Development of commitment and courage to act.
5	Helping the students to appreciate the essential complementarily between 'VALUES' and' SKILLS' to ensure sustained happiness and prosperity, which are the core aspirations of all human beings.
6	Highlighting plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Understand and take responsibilities in life and handle problems to attain sustainable solutions while keeping human relationships and human nature in mind.	[U]
C201.2	Apply responsibilities towards their commitments (human values, human relationship and human society).	[AP]
C201.3	Apply what they have learnt to their own self indifferent day-to-day settings in real life, at least a beginning would be made in this direction.	[AP]
C201.4	Analyze ethical and unethical practices, and formulate strategies to actualize a harmonious environment wherever they work.	[AN]
C201.5	Understand the harmony in nature and existence, and work out mutually on fulfilling participation in nature.	[U]

CourseContents:

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being-Harmony in Myself!

15 Hours

Self-evaluation of the students- Pre-test of UHV- Purpose and motivation for the course. Self-Exploration–Its content and process- A look at basic Human Aspirations. Understanding Happiness and Prosperity correctly-Understanding the needs of Self('I') and 'Body'-Understanding the Body as an instrument of 'I'(being the doer, seer and enjoyer)-Understanding the characteristics and activities of 'I' and harmony in 'I' - Understanding the harmony of 'I' with the Body- Social activities – Waste Management - Water Conservation-Soil Pollution - Physical Health and related activities - Lectures by eminent persons- Literary activities.

Module 2: Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship, Understanding Harmony in the Nature and Existence- Whole existence as Coexistence

15 Hours

Understanding values in human relationship - Understanding the harmony in the society (society being an extension of family): - Visualizing a universal harmonious order in society-Understanding the harmony in Nature.-Understanding Existence as Coexistence of mutually

Interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence-Buddy program- Relationships-Homesickness- Managing peer pressure-Projects-Socially responsible engineers-Visit to local areas (orphanages, special children)-Physicalactivities(games).

Module 3: Implications of the above Holistic Understanding of Harmony on Professional Ethics

15 Hours

Natural acceptance of human values- Definitiveness of Ethical Human Conduct- Basis for Humanistic Education-Humanistic Constitution and Humanistic Universal Order-Competence in professional ethics-Case studies of typical holistic technologies, management models and eco-friendly production systems - Strategy for transition from the present state to Universal Human Order-Sum up: Self-evaluation of the students-Post test of UHV.

	TotalHours:	**45**
TextBooks:		
1	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010	
2	Rajni Setia, Priyanka Sharma, "Human Values", Genius Publication", Jaipur, 2019.	
ReferenceBooks:		
1	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.	
2	The Story of My Experiments with Truth –by Mohandas Karamchand Gandhi	
3	IndiaWins Freedom-MaulanaAbdulKalamAzad.	
WebReferences:		
1	https://examupdates.in/professional-ethics-and-human-values/	
2	http://hvpe1.blogspot.com/2016/06/notes-human-values-and-professional.html	
3	https://www.yourmorals.org/schwartz.2006.basic%20human%20values.pdf	
OnlineResources:		
1	https://nptel.ac.in/courses/109/104/109104068/	
2	https://medium.com/the-mission/the-12-important-life-skills-i-wish-id-learned-in-school-f4593b49445b	
3	https://www.thebalancecareers.com/life-skills-list-and-examples-4147222	

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**

C201.1	Understand & Apply	Online Quiz	20
C201.2	Understand & Apply	Group Assignment	20
C201.3	Understand	Presentation	20
C201.4	Apply		
C201.5	Apply	Seminar	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	10	10	10
Understand	10	20	20
Apply	40	40	40
Analyse	40	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	**Programme Outcomes(PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C201.1						3						1	1		1
C201.2						3			3			1		1	
C201.3						3		3				1	1		1
C201.4						3	3	3			2	1			
C201.5						3	3					1	1		

22MA302	RANDOM VARIABLES & STATISTICS	3/1/0/4

Nature of Course	J (Problem analytical)
Pre requisites	Concepts of basic differentiation and Integration

Course Objectives:

1	To study the basic probability concepts
2	To understand and have a well – founded knowledge of standard distributions which can be used to describe real life phenomena
3	To acquire skills in handling situations involving more than one random variable
4	To learn the concept of testing hypothesis using statistical analysis
5	To apply the Analysis of variance classifications in one way and two way

Course Outcomes:
Upon completion of the course, students shall have ability to

C302.1	Recall the concepts of basic probability	[R]
C302.2	Understand how to handle situations involving random variable	[U]
C302.3	Applying different standard distribution methods in real life problems.	[AP]
C302.4	Derive the logic and attain the knowledge of hypothesis testing.	[AP]
C302.5	Apply the analytical comparisons using ANOVA.	[AP]

Course Contents:

Module 1: Probability and Standard distributions **20 hrs**

Probability: Probability concepts – Addition and Multiplication law of probability – Conditional probability – Total probability theorem –Bayes theorem. **Standard distributions**: Discrete distributions – Binomial, Poisson, Geometric – Continuous distributions – Uniform, Exponential, Normal distributions.

Module 2: Random Variables **20 hrs**

One dimensional random Variables: Discrete random variables – Probability mass function – Continuous random variables – Probability density function – Moment generating Function. **Two dimensional random variables**: Joint distributions – Marginal and conditional distributions – Covariance – Correlation – Regression – Central limit theorem (statement only).

Module 3: Statistics **20 hrs**

Mean, median, mode and standard deviation for raw, discrete and continuous data – Testing of Hypothesis: Large sample – Z test – Test of significance – Proportions – Small sample test – t test and F test for single mean – difference of means and variance – Chi -square test for goodness of fit and independence of attributes. **Analysis of variance** :One way and two way classifications.

Total Hours:	**60 Hrs**

Web References:

1	http://nptel.ac.in/courses/111104079/
2	http://nptel.ac.in/video.php/subjectId=117105085
3	http://nptel.ac.in/syllabus/111105041/
4	http://freevideolectures.com/Course/3028/Econometric-Modelling/22#
5	http://nptel.ac.in/courses/111104079/

Online Resources:

1	www.edx.org/Probability
2	https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/
3	https://onlinecourses.nptel.ac.in/noc15_ec07/

Summative assessment based on Continuous and End Semester Examination

Continuous Assessment (40%)						End Semester Examination (60 %)
CA 1 (20 Marks)			CA 2 (20 Marks)			
SA 1 (12 Marks)	FA 1		SA 2 (12 marks)	FA 2		Theory Examination (60 Marks)
	Component -I (4 marks)	Component –II (4 marks)		Component -I (4 marks)	Component -II (4 marks)	

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C302.1	Remember	Quiz	**4**
C302.2	Understand	Group Assignment	**4**
C302.3	Apply	Case Study	**4**
C302.4 & C302.5	Apply	Group Activities / Tutorial	**4**

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Internal Assessment (24%)**		**End Semester Examination (60%)[60 Marks]**
	CIA 1 [12 Marks]	**CIA 2 [12 Marks]**	
Remember	20	15	20
Understand	30	35	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C302.1	2	1	1	1									1		
C302.2	1	2	2	1									2		
C302.3	2	2	2	3									2		
C302.4	1	1	2	2									2		
C302.5	2	3	2	3									3		

22TA201	TAMILS AND TECHNOLOGY	1/0/0/1

Nature of Course:	C (Theory Concept)
Pre requisites:	NIL

Course Objectives:

1	To know about weaving, ceramic, design and construction technologies in sangam age.
2	To know the significance of technologies such as manufacturing, agriculture and irrigation.
3	To understand the development of Scientific Tamils and Tamil Computing.

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Describe about the weaving industry in sangam age and ceramic technology.	[U]
C201.2	Observe the design of houses, sculptures and construction of temples.	[U]
C201.3	Relate the various manufacturing materials and stone types in Silappathikaram.	[U]
C201.4	Understand the significance of agriculture and irrigation technology in ancient period.	[U]
C201.5	Explain the growth of scientific Tamil, Tamil computing and digitization of Tamil books.	[U]

Course Contents:

Weaving and Ceramic Technology: Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries. **Design and Construction Technology:** Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - ThirumalaiNayakarMahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

Manufacturing Technology: Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel - Copper and gold - Coins as source of history - Minting of Coins – Beads making-industries Stone beads - Glass beads - Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram. **Agriculture and Irrigation Technology:** Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

Scientific Tamil & Tamil Computing: Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Total Hours:	**15**

Text-cum-Reference Books:

1	தமிழகவரலாறு – மக்களும்பண்பாடும்–கே.கே.பிள்ளை(வெளியீடு: தமிழ்நாடுபாடநூல்மற்றும்கல்வியியல்பணிகள்கழகம்).
2	கணினித்தமிழ் – முனைவர்இல. சுந்தரம் . (விகடன்பிரசுரம்).
3	கீழடி – வைகைநதிக்கரையில்சங்ககாலநகரநாகரிகம் (தொல்லியல்துறைவெளியீடு)

4	பொருநை – ஆற்றங்கரைநாகரிகம். (தொல்லியல்துறைவெளியீடு)
5	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9	Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author).
11	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
12	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C201.1	Understand	Seminar	20
C201.2	Understand	Quiz	20
C201.3, C201.4	Understand	Quiz	20
C201.5	Understand	Seminar	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	40	40	40
Understand	60	60	60
Apply	-	-	-
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (40%) [200 Marks]								End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks				CA 2 : 100 Marks				
SA 1 (60 Marks)	FA 1 (40 Marks)			SA 2 (60 Marks)	FA 2 (40 Marks)			
	Component - I (20 Marks)	Component - II (20 Marks)			Component - I (20 Marks)	Component - II (20 Marks)		

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C201.1	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1
C201.2	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1
C201.3	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1
C201.4	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1
C201.5	-	-	-	-	-	-	-	-	-	1	-	1	-	-	1

22AD301	DESIGN AND ANALYSIS OF ALGORITHMS	1 / 0/ 4 / 3
Nature of Course:	I (Problem Concepts)	
Pre requisites:	Data Structures and Algorithms	

Course Objectives:

1	To understand the techniques for analyzing the computer algorithms.
2	To learn the paradigms for designing the algorithms.
3	To analyze the efficiency of various algorithm design techniques / paradigms for the same problem.
4	To understand the graphical algorithms for solving problems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C301.1	Illustrate the searching and sorting algorithms.	[U]
C301.2	Interpret the design principles of greedy and pattern searching algorithms with examples.	[AP]
C301.3	Explore problem-solving methodology used in Backtracking.	[A]
C301.4	Analyse the time and space complexities of dynamic programming strategy in solving complex problems.	[A]
C301.5	Employ range query and graph algorithms in real world problems.	[AP]

Course Contents:

Sorting, Searching and String Algorithms: **[15 Hours]**

Time Complexity Analysis – Mathematical Analysis of Recursive and Non Recursive algorithms - Searching & Sorting, Divide and Conquer – Bubble sort, Insertion sort, Selection sort, Binary search, quick sort, merge sort – Heaps & Hashing –Binary heap, heapsort - Greedy Algorithms–Activity selection problem, Fractional knapsack - String algorithms - Naive algorithm, Rabin Karp algorithm, KMP algorithm, Z algorithm, Manacher's algorithm – Huffman coding.

Greedy and Dynamic Programming: **[15 Hours]**

Backtracking - Rat in a maze, Permutation and Combination, N Queen problem and Problems on Backtracking, Knight's Tour Problem, Subset Sum, M-Coloring Problem, Hamiltonian Cycle Problem, Sudoku Solver, Sieve of Sundaram, Prime Numbers after P with Sum. Dynamic Programming – Greedy vs Dynamic programming, Top-down and bottom-up approach, Longest Common Subsequence, Longest increasing subsequence, Edit distance, 0-1 Knapsack, Coin change problem, Minimum Cost Path, Subset Sum Problem, Maximum Size Square Sub Matrix with all 1s, Longest Palindromic Subsequence.

Tree and Graph Algorithms: **[15 Hours]**

Range query Algorithms - Range Minimum Query (Brute Force Approach). Segment Tree, Range Minimum Query on the Constructed Segment Tree, Range Minimum Query Using Sparse Table. Graph Algorithms –Single source shortest path algorithm, Floyd warshall's Algorithm - Minimum Spanning Tree.

Total Hours:	**45**

Lab Component	
1	Implementation of Linear, Binary Search and Tries.
2	Implementation of Sorting Algorithms - Bubble, Insertion, Selection, Merge Sort, Quick sort, Heap

	Sort.
3	Implementation of Greedy Algorithms.
4	Implementation of Pattern Searching Algorithms.
5	Implementation of Backtracking Algorithms.
6	Implementation of Dynamic Programming.
7	Implementation of Range Query Algorithms.
8	Implementation of Minimum Spanning Tree.
9	Implementation of Shortest path Algorithms.
10	Implementation of Maximum Flow Minimum cut Algorithm.
	Total Hours : 30
Text Books:	
1.	AnanyLevitin, "Introduction to Design and Analysis of Algorithms", Pearson Publications, 3rd Edition, 2012.
2.	Thomas H.Cormen, Charles E.Leiserson, R.L.Rivest, "Introduction to Algorithms", Prentice Hall of India Publications, 3rd Edition, 2009.
Reference Books:	
1	Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, "Computer Algorithms/ C++", 2nd Edition, Universities Press, 2019.
2	Sara Baase and Allen Van Gelder, "Computer Algorithms: Introduction to Design and Analysis", Pearson Publications, 3rd Edition, 2008.
Web References:	
1	https://www.cs.usfca.edu/~galles/visualization/Algorithms.html
2	https://www.coursera.org/learn/introduction-to-algorithms
3	https://timroughgarden.org/videos.html
Online Resources:	
1	https://onlinecourses.nptel.ac.in/noc19_cs47/preview
2	https://www.csa.iisc.ac.in/~barman/daa18/E0225.html
3	https://freevideolectures.com/course/2281/design-and-analysis-of-algorithms

Continuous Assessment									**End Semester Practical Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C301.1	Understand	Quiz & Assignment	20
C301.2	Apply	Assignment	20

C301.3 & C301.4	Analyze	Case study	20
C301.5	Apply	Assignment	20

Assessment based on Summative Assessment - Theory

Bloom's Level	Summative Assessment (15%) [120 Marks]	
	CIA1: (60 Marks)	CIA2: (60 Marks)
Remember	10	10
Understand	40	40
Apply	40	40
Analyse	10	10
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical

Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Practical Examination (50%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Practical Examination

Continuous Assessment (50%)								End Semester Practical Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)	
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)			

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

Cos	Pos												PSOs		
	a	b	C	d	e	f	g	h	i	j	k	l	1	2	3
C301.1	3	3	3	1	3	2	1	2			2	1	3	2	2
C301.2	3	3	3	1	3	2	1	2				1	3	2	2
C301.3	3	3	3	1	3	2	1	2			1	1	3	2	2
C301.4	3	3	3	1	3	2	1	2				2	3	2	2
C301.5	3	3	3	1	3	2	1	2				2	3	2	2

22IT302	WEB TECHNOLOGY	1/0/4/3
Nature of Course	F (Theory Programming)	
Prerequisites	Java Programming	
Course Objectives:		
1.	To discuss the essence of front-end development skills.	
2.	To understand and use JavaScript in client-side web applications.	
3.	To impart the knowledge of React components used in web application development.	
4.	To deploy and test the React App used in Web Applications.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C302.1	Demonstrate the client-side JavaScript application development with React library.	[U]
C302.2	Construct the single page applications in React.	[AP]
C302.3	Apply the react features including components and forms.	[AP]
C302.4	Analyze the functionality of front-end UI applications using React.	[A]
C302.5	Examine the responsive react applications with CSS	[A]

Course Contents:

Introduction **15 Hours**

Fundamentals of React – Requirements, JavaScript Essentials, Event loop, Node.js Fundamentals, Traditional Programming Limitations, React JSX, Overview of frameworks, libraries for client side Web applications, React DOM, Component Instantiation, Environment Setup for React Application, NPM commands, VS Code extensions for ES6, Handler Function- React(formatting and check styles), Hello world app in React, React Essential Features and Syntax, React App Project Directory Structure, Overview of Webpack, Babel, React Component Basic, Create React Component, Understanding JSX, Limitations of JSX, Working with Components and Reusing Components.

React Components and Styles **15 Hours**

React Components - Props and State, Understanding and using Props and State, Handling Events with methods, Manipulating the State, Two way data-binding, Functional (Stateless) VS Class (Stateful) Components, Parent – Child Communication, Dynamically rendering contents, Showing Lists, List and keys, Styling Components, CSS Styling, Scoping Styles using Inline Styles, Limitations of inline styles, Inline Styles with Radium, Google Material UI, Installing Material UI, Material UI AppBar, Material UI's Toolbar, Custom React NavBar. CSS - Material UI Buttons, Using Material UI - Rendering a Button, Material UI Card, Material UI Checkbox, Material UI Grid Component, Material UI IconButton, Material UI Paper Component, Style Material UI Components with my own CSS, UI Templates for Business, Typography Usage, Debugging React Apps, Understanding React Error Messages, Handling Logical Errors, Debugging React apps using google developer tools and React DevTool. Understanding Error Boundaries, React Component life cycle, Updating life cycle hooks, Pure Components, React's DOM Updating Strategy, Returning adjacent elements, Fragments, React Component in Details, Higher Order Components, Passing unknown Props, Validating Props, Using References, React Context API, Updated LifeCycle hooks (16.3)

Deploying and Testing Web Applications **15 Hours**

React Projects, Demo apps, HTTP Requests/Ajax Calls, HTTP Requests in React, Introduction of Axios package, HTTP GET Request, fetching & transforming data, HTTP POST, DELETE, UPDATE, Handing Errors, Adding/Removing Interceptors, Creating/Using Axios instances, Redux, React Thunk, Difference between Thunk & other, React hooks, Application Using React & Redux , React Routing, Routing and SPAs, Setting Up the Router Package, react-router vs react-router-dom, Preparing the Project For Routing, Switching Between Pages. Routing-Related Props, The "withRouter" HOC & Route Props, Passing & extracting route/query parameters, Using Switch to Load a Single Route, Navigating Programmatically. React Forms and Form Validation, Creating a Custom Dynamic Input Component, Setting Up a JS Config for the Form, Dynamically Create Inputs based on JS Config, Adding a Dropdown

Component. Handling User Input, Handling Form Submission, Adding Custom Form Validation, Fixing a Common Validation, Adding Validation Feedback, Showing Error Messages, Handling Overall Form Validity, Deploying React App to the Web, Testing React apps with Jasmine & implementing JEST.	
Total Hours	**45**

Lab Component:	
1.	Create a Stateless Functional Component
2.	Create a Stateful Class Component
3.	Implementation of Conditional Rendering using Class Component
4.	Implementation of Communication (Parent-child) between Components
5.	Create material UI Card using React
6.	Design a Custom Navigation bar using React
7.	Implementation of React component to handle HTTP requests
8.	Implementation of a Dropdown component using React
9.	Implementation of Routing in React
10.	Implementation of FORM validation in React
Total Hours:	**30**

Text Books:	
1.	Robin Wieruch, "The Road to React", 2022 Kindle Edition.
2.	Alex Banks, Eve Porcello. "Learning React: Modern Patterns for Developing React Apps", O'Reilly Media,2020.
Reference Books:	
1.	Adam Bouch, "React and React Native", Packt Publishing, 3rd Edition, 2020.
2.	Kirupa Chinnathambi, "Learning React: A Hands-On Guide to Building Web Applications Using React and Redux", Pearson Education, 2nd Edition, 2018
3.	Adam Boduch, Roy Derks "React and React Native: A Complete Hands-on Guide to Modern Web and Mobile Development with React.js", Packt Publishing, 2020.
Web References:	
1.	https://www.coursera.org/learn/front-end-react
2.	https://www.geeksforgeeks.org/full-stack-development-with-react-node-js-live/
3.	https://www.edx.org/learn/front-end-web-development
4.	https://www.w3schools.com/REACT/DEFAULT.ASP
Online Resources:	
1.	https://reactjs.org/
2.	https://www.youtube.com/watch?v=3HMtarQAt3A
3.	https://frontendmasters.com/guides/front-end-handbook/2018/what-is-a-FD.html
4.	https://www.youtube.com/watch?v=HT82p_re-EY

Continuous Assessment									**End Semester Practical Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C302.1	Understand	Quiz	20
C302.2	Apply	Quiz	20
C302.3	Apply	Mini Project	20
C302.4	Analyze		
C302.5	Analyze	Mini Project	20

Assessment based on Summative Assessment - Theory		
Bloom's Level	**Summative Assessment (15%) [120 Marks]**	
	CIA1: (60 Marks)	**CIA2: (60 Marks)**
Remember	-	-
Understand	30	30
Apply	40	30
Analyse	30	40
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (50%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	-	-	-
Understand	10	-	10
Apply	50	60	50
Analyse	40	40	40
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Practical Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C302.1	3	3	3	2	2				2	2	2	2	3	3	2
C302.2	3	3	3	2	2				2	2	2	2	3	2	3
C302.3	3	3	3	3	2				3	2	2	2	3	2	2
C302.4	3	3	3	2	3				2	2	2	2	3	3	3
C302.5	3	3	3	2	3				2	2	2	2	3	2	2

22CS301	ADVANCED JAVA PROGRAMMING	1/0/4/3
Nature of Course	F (Theory Programming)	
Pre requisites	Java Programming	

Course Objectives:

1	To provide insight knowledge of OOP concepts and usage of this, static, super and final keywords.
2	To discuss about different type of Collection Frameworks.
3	To demonstrate threads, JDBC & exception handling with real world examples.
4	To illustrate designing of GUI applications using swing component.

Course Outcomes :
Upon completion of the course, students shall have ability to

C301.1	Illustrate the OOPs concepts like Constructors, Inheritance, Polymorphism and the usage of this, static, super and final keywords.	[AP]
C301.2	Apply the concepts of Exception Handling in real world applications and usage of collection frameworks.	[AP]
C301.3	Develop Multithreaded applications.	[AP]
C301.4	Develop GUI Applications using swing component and to explain the concept of Servlets.	[AP]
C301.5	Develop java application to interact with database by using relevant JDBC Driver.	[AP]

Course Contents:

Module I Introduction to OOPS 15 Hours

Class and Object, Encapsulation and Abstraction, Inheritance, Polymorphism, Message Passing, Keywords : this, super, static, final, extends and implements. Method Signature and Prototype, Mutator Methods and Accessor Methods, Var-Arg Method, hashCode() and toString() methods. Immutable Objects Vs Mutable Objects, User defined Immutable Class, Constructors : Introduction, Default Constructor, User Defined Constructors, Constructor Overloading, Instance Variable, Instance Methods, Instance Block and Instance Flow Of Execution. Regular Expressions (RegEx).

Inheritance Introduction, Types of Inheritance, Up Casting, Down Casting, IS-A Relationship & HAS-A Relationship, Composition Vs Aggregation, **Polymorphism:** Method Overloading, & Method Overriding.

Module II Abstraction, Exception Handling & Collections 15 Hours

Abstraction: Abstract Methods and Abstract classes. Interfaces, abstract classes and Interfaces, Concrete Methods Vs Abstract Methods, Differences between classes, abstract classes and Interfaces, Marker Interfaces

Exception - try catch block, Finally Block, Exception Hierarchy, Multiple Exceptions In a Catch Block, Parameterized Try Block, Overriding Methods And Exception. Creating Your Own Exception, The Assert Keyword, The Generics Framework, **Collections:** Set, List, Map & Tree, The Iterator Interface. Working with Hashtable Collection **Threads:** Introduction to Threads, Creating And Starting Threads, Basic Thread Control Methods. Multithreading, Working with Multiple, threads, Thread Life Cycle, Thread Priorities, Synchronizing Methods.

Module III Swings, Servlets & JDBC 15 Hours

Swings: Introduction, JLabel, JButton, JTextField ,JTextArea, JPasswordField, JCheckbox, JComboBox, JRadioButton, JScrollBar, JMenuItem and JMenu.

JDBC: Drivers, CURD operations, Database connectivity

Servlets : Overview of Servlets , Servlet Life Cycle, Servlet Request and Response , web.xml and its need, Servlet Configuration, Session Tracking

Total Hours	**45 Hours**

List of Experiments

1. Implementation of default and parameterized constructors.
2. Implementation of method overloading and overriding.
3. Implementation of Inheritance.
4. Implementation of Abstract and Interface concepts.
5. Programs using collection Interface.
6. Implementation of multithreading Concepts.
7. Program to handle multiple exception using try, catch and finally block.
8. Implementation of swing components.
9. Implement Simple application using servlets.
10. Implement CURD operation using JDBC.

Total Hours	**30 Hours**

Text Books:	
1.	Herbert Schildt,"Java:TheCompleteReference",12th edition, Mc craw Hill, 2021.
2.	Robert Liguori, Patricia Liguori, "Java 8 Pocket Guide", O'Reilly Media, 2014.
3.	ShagunBakliwal, Hands-on Application Development using Spring Boot, bpb publisher, 2021.
Reference Books:	
1.	Paul Deitel, Harvey Deitel, "Java How To Program",10th Edition, Prentice Hall Publications,2014.
2.	Cay S.Horstmann and GaryCornell, "Core Java, Vol.2: Advanced Features", 9th Edition, Prentice Hall,2013.
Web References:	
1	https://www.javatpoint.com/java-tutorial
2	https://www.geeksforgeeks.org/java/
3	http://www.javatpoint.com/java-tutorial
Online Resources:	
1	http://www.coursera.org/specializations/object-oriented-programming
2	http://www.udemy.com/topic/java-certification/
3	http://www.edx.org/learn/jav

Continuous Assessment									**End Semester Practical Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model – Theory			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C301.1 & C301.3	Apply	Quiz	20
C301.2	Apply	Assignment	20
C301.4 & C301.5	Apply	Case Study	40
Assessment based on Summative Assessment – Theory			

Bloom's Level	Summative Assessment (15%) [120 Marks]	
	CIA1: (60 Marks)	CIA2: (60 Marks)
Remember	20	20
Understand	40	40
Apply	40	40
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical

Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (50%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (50%)								End Semester Practical Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)	
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)			

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C301.1	3	3	3	1					2	2		2	3	2	3
C301.2	3	3	3	3	2				3	2		2	3	2	2
C301.3	3	3	3	2	3				2	2		2	3	3	3
C301.4	3	3	3	2	3				2	2		2	3	3	3
C301.5	3	3	3	2	3				2	2		2	3	3	3
C301	**3**	**3**	**3**	**3**	**3**				**3**	**2**		**2**	**3**	**3**	**3**

22AD302	PYTHON ESSENTIALS	2/0/2/3
Nature of Course	F (Theory and Programming)	
Prerequisite	Nil	

Course Objectives:

1	To understand and execute Python script using types and expressions.
2	To understand the difference between expressions and statements.
3	To utilize high level data types such as lists and dictionaries.
4	To import and utilize a module and to perform read & write operations on files.
5	To use the latest python libraries for data science in real time paradigms.

Course Outcomes:

Upon completion of the course, students shall have ability to

C302.1	Recognize the general principles and good algorithmic problem solving.	[U]
C302.2	Interpret the fundamental Python syntax and semantics and use of Python control flow statements.	[U]
C302.3	Understand variables, data types, control flow structures (such as loops and conditionals), functions, and file handling.	[U]
C303.4	Design and implement modular and reusable code.	[AP]
C304.5	Examining compound data using Python lists, tuples and dictionaries.	[AP]
C305.6	Correlating how to leverage popular libraries such as NumPy, Pandas, and Matplotlib for data manipulation, analysis, and visualization.	[A]

Course Contents:

Algorithmic Problem Solving, Data, Expressions and Statements: (15 Hrs)

Algorithms, Building Blocks of Algorithms (Statements, State, Control Flow, Functions), Notation (Pseudo Code, Flow Chart, Programming Language), Algorithmic Problem Solving, Simple Strategies For Developing Algorithms (Iteration, Recursion). Illustrative Problems: Find Minimum In A List, Insert A Card In A List Of Sorted Cards, Guess An Integer Number In A Range, Towers of Hanoi. - Python Interpreter and Interactive Mode; Values And Types: Int, Float, Boolean, String, And List; Variables, Expressions, Statements, Tuple Assignment, Precedence of Operators, Comments; Modules And Functions, Function Definition And Use, Flow of Execution, Parameters And Arguments; Illustrative Programs: Exchange The Values of Two Variables, Circulate The Values of N Variables, Distance Between Two Points. Case study- Boston housing price prediction.

Control Flow, Functions, Strings: (15 Hrs)

Conditionals: Boolean Values And Operators, Conditional (If), Alternative (If-Else), Chained Conditional (If-Elif-Else); Iteration: State, While, For, Break, Continue, Pass; Fruitful Functions:

Return Values, Parameters, Local And Global Scope, Function Composition, Recursion; Strings: String Slices, Immutability, String Functions And Methods, String Module;.Lists As Arrays. Illustrative Programs: Square Root, GCD. Lists: List Operations, List Slices, List Methods, List Loop, Mutability, Aliasing, Cloning Lists, List Parameters; Case Study: Text Analysis.

Python Tuple, Dictionary and Libraries for Data Science: (15 Hrs)

Tuples: Tuple Assignment, Tuple As Return Value; Dictionaries: Operations And Methods, Exception handling, Files-reading and writing - Basics for Data Science: Loading the Data from CSV file, Cleaning the Data, Visualization, Numpy and Numpy Operations, Pandas and pandas operations, Matplotlib: types of plots. **Case study:** Analyse the academic performance of students and plot a graph.

Total Hours:	**45**

Lab Exercise

1. Running instructions in Interactive interpreter a Python Script and Programs for Familiarizing with the syntax and basic concepts.
2. Create a Python program to find the XOR of two given strings interpreted as binary numbers.
3. The first pile has n stones. If n is even, then all piles have an even number of stones. If n is odd, all piles have an odd number of stones. Each pile must more stones than the previous pile but as few as possible. Write a Python program to find the number of stones in each pile.
4. Python program to generate and print the first n rows of Pascal's Triangle using function and recursive function.
5. Create a file where all letters of the English alphabet are listed by specified number of letters on each line.
6. Generate a random color hex, a random alphabetical string, random value between two integers (inclusive) and a random multiple of 7 between 0 and 70. Use random.randint().
7. There are two elements in this game – snake and food. The player has to move the snake such that it touches(eats) the food and grows in size. The snake dies if it touches its own body or the boundaries of the window. On an obvious note, the player needs to win and hence avoid dying. Build and Implement GUI using turtle.
8. Implement a Pandas program to get the day of month, day of year, week number and day of week from a given series of date strings
9. Given a 2D Numpy array representing the grades of students in different subjects. Calculate the average grade for each student and overall class average.
10. Given a numpy array representing the sales data for different products, find the total sales, average sales and maximum sales value.

Text Books:	
1	Vijay Kumar Sharma, Vimal Kumar, Swati Sharma, Shashwat Pathak, "Python Programming A Practical Approach", CRC Press, 2021.
2	Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python" – Revised and updated for Python 3.2, Network Theory Ltd., 2018.
3	Jake Vanderplas, "Python Data Science Handbook: Essential Tools for Working with Data, Second Edition, O'Reilly, 2022.
Reference Books:	
1	Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.
2	Timothy A. Budd, "Exploring Python", Mc Graw Hill Education (India) Private Ltd., 2015.
3	John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2017.
4	Peter Morgan, "Data Analysis from scratch with python: Beginner guide using python, pandas, Numpy, SCIKIT-learn, IPython, TensorFlow and Matplotlib", AI Sciences, 2018.
Web References:	
1	http://nptel.ac.in/courses/106106145/
2	https://www.codecademy.com/learn/learn-python
3	https://www.coursera.org/learn/python-data-analysis#syllabus
Online Resources:	
1	https://www.programiz.com/python-programming
2	https://www.fullstackpython.com/best-python-resources
3	https://www.youtube.com/watch?v=edvg4eHi_Mw

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Assessment Methods & Levels (based on Blooms' Taxonomy)
Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C302.1	Understand	Quiz	20
C302.2	Understand	Tutorial	20
C302.3	Understand	Group Assignment	20
C302.4, C302.5	Apply		
C302.6	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	Summative Assessment (25%) [120 Marks]		End Semester Examination (25%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (25%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								End Semester Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		Theory Examination (25%) Practical Examination (25%)
SA 1 (60 M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)	
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)			

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)															
Cos	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C302.1	3	3	2	2	3	3	1		1	1	2	2	2	3	3
C302.2	3	3	3	3	2	2	1				2	3	3	3	2
C303.3	3	3	2	2	3	3	1		1	1	2	2	3	2	2
C304.4	3	3	3	3	2	2	1				2	3	2	2	3
C305.5	3	3	2	2	3	3	1				2	2	3	3	
C306.6	3	3	2	2	3	3	1				2	2	3	3	3

22MA401	OPTIMIZATION AND PROJECT MANAGEMENT	3/1/0/4

Nature of Course	J (Problem analytical)
Pre requisites	Probability distributions and random variables

Course Objectives:

1	Students will develop problem modeling and solving skills and learn how to make intelligent decisions from the point of view of optimization.
2	Understand the meaning, purpose, and tools of Operations Research.
3	Critically analyze a problem, identify, formulate and solve problems in any engineering field using operations research principles, considering current and future trends.
4	Formulate Queuing models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these Queuing problems.
5	The students will define the basics of simulation modeling and replicating the practical situations in organizations

Course Outcomes:
Upon completion of the course, students shall have ability to

C401.1	Recall the basic concepts of optimization, Queueing and simulation.	[R]
C401.2	Understand the concepts of linear programming problems.	[U]
C401.3	Apply operations research techniques for LPP in industrial optimization problems.	[AP]
C401.4	Apply the concepts of discrete time Markov chains to model computer systems.	[AP]
C401.5	Apply the concepts of simulation in different real life probabilistic situations using Monte Carlo simulation technique.	[AP]

Course Contents:

Module 1: **DEVELOPMENT OF OPERATIONS RESEARCH AND LINEAR PROGRAMMING (20)**
Linear programming problem: Graphical method – Simplex method – Big M Method – Transportation problem: North west corner method – Least cost method – Vogel's approximation method – Optimal solution – MODI method – Balanced and unbalanced Transportation problem – Assignment problem – Hungarian method.

Module 2: QUEUEING MODELS (20)
Introduction to Queuing Models – Characteristics — Birth and death processes – Markovian queues – Single and multiple server queueing models – Little's formula – Non Markovian Queueing Model M/G/1

Module 3: **SIMULATION (20)**
Simulation: Introduction – Types of simulation models – Discrete Event Simulation – Monte - Carlo Simulation – Advantages and Disadvantages – Application of Simulation to queuing and inventory – Case study.

Total hours:	**60**

Text Books:

1	KantiSwarup, P.K.Gupta, Manmohan, "Operations research", Sultan Chand and Sons,2nd Edition 2015
2	Taha H.A, "Operation Research", Pearson Education,10th Edition, 2017
3	Gross, D., Shortle, J.F, Thompson, J.M and Harris. C.M.,Fundamentals of Queueing Theory", Wiley Student 4th Edition, 2014.

Reference Books:

1	D.S. Hira and P.K. Gupta, Operations Research, (Revised Edition), Published by S. Chand & Company Ltd, 2014
2	S. Kalavathy, Operation Research, Vikas Publishing House Pvt Limited, 2013
3	S. D Sharma, Operation Research, Kedarnath Ram Nath Publishers,2020

Web References:	
1	https://archive.nptel.ac.in/courses/112/106/112106134/
2	https://onlinecourses.nptel.ac.in/noc22_ma48/preview
3	https://nptel.ac.in/courses/110106062
4	https://www.aicte-india.org/flipbook/p&ap/Vol.%20II%20UG/UG_2.html#p=8
5	https://www.britannica.com/topic/operations-research
Online Resources:	
1	https://www.edx.org/course/operations-research-an-active-approach
2	https://in.coursera.org/learn/operations-research-modeling
3	https://in.coursera.org/projects/simulation-call-centre-operations

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C401.1	Remember	Quiz	20
C401.2	Understand	Case Study	20
C401.3	Apply	Tutorial	20
C401.4 – C401.5	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]				End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks		CA 2: 100 Marks		
SA 1	FA 1 (40 Marks)	SA 2	FA 2 (40 Marks)	

(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)											Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C401.1	1	1	1										1		
C401.2	2	2	2										1		
C401.3	3	3	3										2		
C401.4	3	3	3										2		
C401.5	3	3	3										2		

22IT402	SOFTWARE TESTING	1/0/4/3
Nature of Course	F (Theory Programming)	
Pre requisites	Nil	
Course Objectives:		
1.	To provide students with an understanding of Core Testing concept.	
2.	To learn the functional and non-functional testing.	
3.	To understand the different types of User Acceptance testing and end-to-end testing.	
4.	To get familiarize with the best practices of Testing.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C402.1	Plan and apply the appropriate level of testing within the context of a software development application to the satisfaction of its beneficiaries.	[AP]
C402.2	Analyze specific and measurable test cases to ensure coverage and traceability to requirements	[A]
C402.3	Understand the problem of reporting techniques, metrics, and testing status reports and communicate testing results to colleagues, managers, and end users.	[U]
C402.4	Apply testing models, processes and practices appropriate for the software development lifecycle model of a project	[AP]
C402.5	Apply principles and practices of test-driven development to improve testing quality and reduce delivery times	[AP]
C402.6	Inspect the various testing processes towards the continuous delivery of a software product.	[A]

Course Contents:

Introduction to Automation Testing with Selenium: **15 Hours**

What is Software Testing, Why Software Testing, Benefits of Software Testing, Software Test Levels, Unit Testing, Integration Testing, System Testing, Acceptance Testing, Software Test Types, Functional testing, Non-functional testing, Change Related Testing.

Test Scenario Design - Functional and non-functional test scenarios, identify and write business critical scenarios.

Test Case Design - pre-requisites, test steps and expected results for test cases, Positive and negative testcases for each scenario, Test case prioritization, Test case optimization technique. RTM, DSR.

Classes and Objects, Inheritance, and Polymorphism, Exception Handling, Collections, and, Collections(List), JDBC Connectivity, Creating CURD OPERATION JDBC Connectivity

Working with Selenium: **15 Hours**

Selenium webdriver - Maven Configuration, WebDriver Commands, Navigation Command, Selenium locators - Selenium Locators Basics (id, name),Xpath and css locators, Selenium WebElement - Handling of Form Elements, Synchronization Methods, Selenium Exceptions, Keyboard and mouse handling, Alert handling, Iframe Handling in Selenium, Java Script Execution, Handling WebTable and calendar.

Introduction to TestNG - TestNg Introduction, Advantage of testNg , testNG Annotations, Test data preparation, Generation of TestNG Reports, Implicit wait and Explicit wait.

Testing Framework **15 Hours**

Testing Frameworks - Data driven testing using Apache POI, POM. Extent Reports - HTML Report Generation using Extent Reports, Attaching Screenshot in HTML Report.

Log4j - configuring log4j Property files, Log4j - parameters for Properties file, Log levels and logging using log4j, Hybrid framework implementation., Creating the POM with a Hybrid framework folder structure, Implementing the Hybrid framework in POM.

Total Hours	**45**

Lab Component:	
1.	Develop a program to automate the login process for a specified webpage using Selenium.
2.	Write an automation script using Selenium to handle form elements on a given website.
3.	Create an automation script with Selenium to interact with specific web elements on a designated webpage.
4.	Implement automation scripts using TestNG, prioritizing different test cases for efficient testing on a given website.
5.	Develop automation scripts with TestNG, incorporating seven levels of logging for detailed analysis while testing a specified website.
6.	Execute application tests using designed test cases and generate an HTML report for a comprehensive overview.
7.	Design and implement a hybrid framework for a ticket booking system, along with associated test cases.
8.	Develop a hybrid framework and associated test cases for a hotel room booking system.
9.	Design and develop a hybrid framework and relevant test cases for a hospital appointment application.
10.	Implement a hybrid framework and associated test cases for an e-commerce application.
11.	Develop a hybrid framework and design test cases for comprehensive testing of an insurance website.

Text Books:	
1.	Rex Allen Jones II, “Absolute Beginner, Part 1 Selenium Webdriver for Functional Automation Testing”, 1st Edition, Createspace Independent Pub, 2016
2.	S Basu, “Selenium with Python Simplified for Beginners”, 1st Edition, 2020
3.	Paul Watson, “Selenium webdriver with Node.js: Beginner's Guide”, 1st Edition, CreateSpace Independent Publishing Platform, 2016.
Reference Books:	
1.	Satya Avasarala, “Selenium Web Driver Practical Guide”, 1stEdition, Packt Publishing Limited, 2014
2.	Sujay Raghavendra, "Python Testing with Selenium: Learn to Implement Different Testing Techniques Using the Selenium WebDriver", Apress, 2020.
3.	Pinakin Ashok Chaubal, “Selenium Framework Design in Keyword-Driven Testing: Automate Your Test Using Selenium”, BPB Publications, 2020.
Web References:	
1.	https://www.coursera.org/projects/building-test-automation-framework-using-selenium-and-testng
2.	https://www.edx.org/professional-certificate/delftx-automated-software-testing
3.	https://onlinecourses.nptel.ac.in/noc22_cs12/preview
4.	https://www.nextgenerationautomation.com/post/selenium-coding-exercises
5.	https://www.studytonight.com/maven/build-and-test-maven-project
Online Resources:	
1.	https://www.tutorialspoint.com/selenium-for-software-testing-getting-started/index.asp
2.	https://www.softwaretestingmaterial.com/selenium-tutorial/
3.	https://www.leapwork.com/discover/selenium-automation

Continuous Assessment									End Semester Practical Examination	Total
Theory				Practical			Total (A+ B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	Bloom's Level	Assessment Component	FA (10%) [80 Marks]
C402.3	Understand	Assignment	20
C402.5	Apply	Quiz	20
C402.1, C402.4	Apply	Case Study	20
C402.2, C402.6	Analyse	Assignment	20

Assessment based on Summative Assessment - Theory		
Bloom's Level	Summative Assessment (15%) [120 Marks]	
	CIA1: (60 Marks)	CIA2: (60 Marks)
Remember	10	-
Understand	20	20
Apply	60	50
Analyse	10	30
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Examination (50%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	-	10
Understand	20	20	20
Apply	60	50	60
Analyse	10	30	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (50%)						End Semester Practical Examination (50%)
CA 1 (100 Marks)		CA 2 (100 Marks)		Practical Exam (100 Marks)		
SA 1	FA 1	SA 2	FA 2	FA	SA	

(60M)	Component-I (20 Marks)	Component-II (20 Marks)	(60M)	Component-I (20 Marks)	Component-II (20 Marks)	(75M)	(25M)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C402.1	2	2	2	2	2						2	2	2	2	2
C402.2	2	2		1	2						2	2	2	2	2
C402.3	2		1	1	3						2	2	2	2	2
C402.4	2	2	1	2	1						3	3	2	3	2
C402.5	1	2	2	1	2						2	3	3	2	2
C402.6	1	3	2	1	2						2	2	2	3	2

22AD401	CLOUD COMPUTING	1/0/4/3
Nature of Course	F (Theory Programming)	
Pre requisites	Data Base Management Systems	

Course Objectives:

1	To understand the evolution of AWS from the existing technologies.
2	To have knowledge on AWS security and various scaling methods.
3	To team the necessary skills for design, develop and deploy services in creatingwith the help of docker.
4	To implement automated system update and DevOps lifecycle
5	To understand virtualization and provide the perfect security for the entire infrastructure.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C401.1	Demonstrate the basic global infrastructure of the AWS Cloud.	[AP]
C401.2	Identify an appropriate solution using AWS Cloud services for various use cases.	[U]
C401.3	Interpret how the components of Docker containers support compute container implementations.	[AP]
C401.4	Examine common Infrastructure Servers, Availability and Scalability.	[A]
C401.5	Learn why automation, culture, and metrics are essential to a successful DevOps project.	[U]
C401.6	Analyze various cloud models and apply them to solve problems.	[A]

Course Contents:

MODULE I MANAGING CLOUD USING AWS **15 Hours**

Introduction,Future of AWS, Services - AWS EC2, AWS S3 - Cloud storage, Types, Benefits, AWS IAM - AWS Security,Working of IAM, Components AWS CloudFront Working, Benefits. Introduction, Snapshots vs AMI, Different scaling plans. Introduction, Benefits, Algorithms used for load balancing. **Case study:** E-commerce Website Infrastructure on AWS.

MODULE II CONTAINERIZATION USING DOCKERS **15 Hours**

Docker, Containers, Usage of containers, Terminology, Docker Run Static sites, Docker Images, Docker File, Docker on AWS, Docker Network, Docker Compose, Development Workflow, AWS EC Services. **Case study:** Microservices Architecture for a Social Media Application using Docker and AWS.

MODULE III DEVOPS **15 Hours**

Introduction, Test Driven Development, Continuous Integration, Code coverage, Best Practices, Virtual Machines vs Containers, Rolling Deployments, Continuous Deployment, Auto Scaling. **Case Study:** Open Stack, Cloud based ML Solutions in Healthcare. **Case study:** Cloud-Based Machine Learning Solutions in Healthcare.

Total Hours:	**45**

List of Experiments:

1	Study of Hosted Hypervisor and Bare Metal Hypervisor.
2	Install a Virtualbox / VMware Workstation with different flavours of linux or windows S
3	Implementation of Virtual Machine(S) and create a Virtual Datacenter.
4	Configuration of Virtual Internetworking Components.

5	Configuration of Virtual Internetworking Components.
6	Install a docker engine and docker client on windows.
7	Creation and removal of container, container images.
8	Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim
9	Find a procedure to transfer the files from one virtual machine to another virtual machine Using VMWare
10	Install Google App Engine. Create a hello world app and other simple web applications using python / java
	Total Hours : 30
Text Books:	
1	Mark Wilkins, "Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud", 2019.
2	Sean P. Kane, Karl Matthias,"Docker: Up & Running: Shipping Reliable Containers in Production", O'Reilly Media Inc, 2015.
3	Jennifer Davis and Ryn Daniels, "Effective DevOps: Building a Culture of Collaboration, Affinity, and Tooling at Scale", 2016, O'Reilly Media Inc.
Reference Books:	
1	Ardian, "Using Docker: Developing and Deploying Software with Containers", O'Reilly Media Inc, 2015.
Web References:	
1	https://cloudacademy.com/course/introduction-to-devops/intro-3/
2	https://awscloud.in/

Continuous Assessment									**End Semester Practical Examination**	**Total**
Theory				**Practical**			**Total (A+ B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C401.1	Apply	Quiz & Assignment	20
C401.2 & C401.5	Understand	Assignment	20
C401.3	Apply	Case study	20
C401.4 & C401.6	Analyze	Assignment	20

Assessment based on Summative Assessment - Theory		
Bloom's Level	**Summative Assessment (15%) [120 Marks]**	
	CIA1: (60 Marks)	**CIA2: (60 Marks)**
Remember	10	10
Understand	40	40
Apply	40	40

Analyse	10	10
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical

Bloom's Level	Continuous Assessment (25%) [100 Marks]		End Semester Practical Examination (50%) [100 Marks]
	FA: (75 Marks)	SA: (25 Marks)	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Practical Examination

Continuous Assessment (50%)								End Semester Practical Examination (50%)
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		
SA 1 (60M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)	
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)			

Mapping of Course Outcomes (CO) with Programme Outcomes(PO) and Programme Specific Outcomes(PSO)

Cos	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C401.1	3	3	3					3	3	3		3			3
C401.2	3	3	3					3	2	3		3			3
C401.3	3	3	3					3	3	3		3			3
C401.4	3	3	3					3	3	3		3			3
C401.5	3	3	3					2	3	3		3			3
C401.6	2	3	3					2	3	2		3			2

22CS402	WEB FRAMEWORKS	1/0/4/3
Nature of Course:	D (Theory Application)	
Pre requisites:	Java Programming	

Course Objectives:

1	To impart the knowledge of REST API and HTTP methods used in Spring Boot Framework.
2	To discuss LIKE queries using JPA and handle CRUD operations with JPQL.
3	To explore the various relational mapping with JPA.
4	To deploy Spring AOP - Annotation Based applications.

Course Outcomes:
Upon completion of the course, students shall have ability to:

C402.1	Create simple applications with REST API and handle HTTP methods.	[AP]
C402.2	Apply database connectivity with JPA using queries	[AP]
C402.3	Build application using Spring Boot and handle CRUD operations with JPQL.	[AP]
C402.4	Demonstrate various relational mapping with JPA.	[AP]
C402.5	Develop a real-time application using UI & Spring AOP	[AP]

Course Contents:

Module I : APIs and JSON **15 Hours**

REST API, HTTP Methods in Rest, Overview of JSON, Controller and Service Layer, GET API with JSON & Spring Boot, @Value annotation, Runnable JAR Of Spring Boot App, @JsonIgnore Usage, @JsonProperty Usage, MySQL Database.

Module II : Spring JPA **15 Hours**

Spring Boot-MySQL Database Connection with JPA, @Repository Annotation, GET API with JPA, HTTP POST API, PUT API, DELETE API with @RequestParam, Path variable - @PathVariable, AND,OR,IN Query using JPA, Pagination & Sorting using JPA. @Transient Annotation, Queries using JPA, Starts and Ends with query using JPA, JPQL with @Query Annotation, Select, Update, Delete with JPQL.

Module III: JPA Mapping with Spring Boot **15 Hours**

OneToOne Relationship Mapping with JPA, Join Query, Lazy Loading in JPA, BiDirectionalOneToOne Relationship with JPA, OneToMany Relationship with JPA, Insert Record with OneToOne and OneToMany Relationship and JPA. SwaggerUI with Spring Boot, OpenUI with Spring Boot, Logging with Spring Boot, Changing Log Level,Logging Request and Response JSON, Logging properties with Spring Boot. AOP Terms, @BeforeAdvice with Method Parameter,@After Advice,@AfterReturning Advice, @Around Advice.

Total Hours: 45

Laboratory Experiments:

1. Display the information about the current weather in a certain location using RESTful API use a weather forecast provider such as openweathermap.org.
2. Create your own app that embeds the information about flights, hotels and rental cars using Skyscanner API.
3. Create a simple Spring Application and inject the literal values by setter injection. So, create a simple class Employee having three attributes Id, Name, and Designation. Create setter methods for these attributes and a simple method to print the details of the student.
4. Create a simple payroll service that manages the employees of a company. Store employee objects in a database, and access them (via something called JPA).
5. Create a simple payroll service that manages the employees of a company. Perform the following LIKE queries using query methods with the keywords Containing, Contains, IsContaining, StartsWith and EndsWith.
6. Create a simple payroll service that manages the employees of a company. Perform the following LIKE queries using query methods with the keywords

NotContains, NotContaining and NotLike. 7. Create a Spring Boot application with Student entity and Student JPA repository. Use Spring Rest Controller API to perform CRUD operations on Student data. 8. Build a simple Rest API application called Donors. This application manages blood donors information and allows its users to Add a new donor, update existing donor information, view existing donors and delete a donor information from the application.
Total Hours: 45
Text Books:
1.KirupaChinnathambi, "A Hands-On Guide to Building Web Applications Using React and Redux", Addison-Wesley Professional, 2018.
2.Raja CSP Raman, LudovicDewailly, "Building RESTful Web Services with Spring 5", Packt Publishing, 2018.
3.Leonard Richardson, Sam Ruby "RESTful Web Services" O'Reilly Media, 2008.
Reference Books:
1.Ranga Karanam, "Master Java Web Services and REST API with Spring Boot", Packt Publishing, 2018.
2.Balaji Varanasi, Sudha Belida, "Spring REST", Apress, 2015.
Web References:
1.https://www.freecodecamp.org/news/how-to-build-a-rest-api-with-spring-boot-using-mysql-and-jpa-f931e348734b/
2.https://github.com/scbushan05/book-api-spring-boot
3.https://www.geeksforgeeks.org/spring-value-annotation-with-example/
4.https://www.baeldung.com/spring-jpa-like-queries
5.https://medium.com/thecodefountain/design-a-rest-api-with-spring-boot-and-mysql-a5572d94ccc7
Online Resources:
1.https://www.udemy.com/course/rest-api-with-java-spring-boot-spring-data-jpa-jparepository-swagger/
2.https://spring.io/guides/tutorials/rest/
3.https://www.javaguides.net/2018/10/spring-boot-2-restful-api-documentation-with-swagger2-tutorial.html

Continuous Assessment									End Semester Practical Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (10%) [80 Marks]**
C402.1, C402.2 & C402.3	Apply	Mini Project	**40**
C402.4	Understand	Quiz	**20**

C402.5	Apply	Case Study	**20**

Assessment based on Summative Assessment - Theory		
Bloom's Level	**Summative Assessment (15%) [120 Marks]**	
	CIA1: (60 Marks)	**CIA2: (60 Marks)**
Remember	20	20
Understand	40	40
Apply	40	40
Analyse	-	-
Evaluate	-	-
Create	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (50%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Practical Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C402.1	2	2	2									1	2		1
C402.2	3	3	3	2	2				2	1		3	3	1	2
C402.3	3	3	3	3	3				2	1		3	3	2	2
C402.4	3	3	3	3	3				2	1		3	3	2	2
C402.5	3	3	3						1	1		3	3		1
C402	**3**	**3**	**3**	**3**	**3**				**2**	**1**		**3**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22AD402	DATA WAREHOUSING AND DATA MINING	2/0/2/3

Nature of Course:	D (Theory application)
Pre requisites:	Database Management System

Course Objectives:

1	To learn the architecture of Data warehouse architecture and its Implementation
2	To be familiar with theData Mining system.
3	To explore various Mining techniques.
4	To understand various classification and clustering techniques.
5	To analyze the cluster-based methods.

Course Outcomes:
Upon completion of the course, students shall have ability to

C402.1	Understand the basics and evolutionary path of Data Warehouse and Data Mining techniques.	[U]
C402.2	Examine data warehouse architecture, data integration, data cleansing and data transformation techniques.	[AP]
C402.3	Apply classification and Clusteringalgorithm to extract knowledge from large datasets.	[AP]
C402.4	Comprehend the important role that Data Warehouse and Data Mining play in various fields.	[U]
C402.5	Integrate the gained practical experience in using data tools and technologies for implementation.	[AP]

Course Contents:

Introduction to Data Warehousing and Data Mining **15 Hours**

Data Warehousing Components- Data Warehouse Architecture, OLAP vs OLTP, OLAP operations - Data Warehouse v/s Data Mining, Data Mining Process, Data Mining Functionalities, overview of wekatool and its feature -Installation and setup of weka- Data Pre-processing Descriptive Data Summarization, Application of data pre-processing in health care - Data Cleaning, Integration and Transformation, Reduction.Case study - Financial and Market Analysis.

Data Mining Concepts: **15 Hours**

Classification, Issues in Classification, Statistical-Based Algorithms, Distance-Based Algorithms, Prediction techniques, Linear and Non-Linear Regression. Association Rule Mining: Efficient and Scalable Frequent Item set Mining Methods Mining Various Kinds of Association Rule - Association Mining to Correlation Analysis - Applications: Intrusion detection, Case study - A web data mining.

Clustering and its real time application: **15 Hours**

Categorization of Major Clustering Methods: Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Outlier Detection. Applications of clustering – Pattern recognition, Clustering Algorithm in Identifying Cancerous Data- Case Study: Finding similar users on Twitter, Analyzing the Stack Overflow data set.

Total Hours:45

Lab component(WEKA Tool)

1. Investigate Application interfaces of the WEKA tool.
2. Create a Weather table with a training data set which includes attributes like outlook, temperature, humidity, windy, play. Apply Pre-Processing techniques to the training data set of the Weather Table.
3. Interpret the house price prediction using a regression model in WEKA Tool.
4. With the help of a dataset that contains information about growth of a plant over time. The goal is to build a non-linear regression model to predict the plant's growth based on the time elapsed.
5. Demonstration of association rule mining using Apriori algorithm on supermarket data.
6. Create a dataset in ARFF (Attribute-Relation File Format) for any given dataset and perform Market-Basket Analysis.
7. Experiment on hierarchical Data Clustering algorithms.
8. Find all the neighbour points within eps and identify the core points or visited with more than MinPtsneighbours using DBSCAN algorithm.
9. Implement grid-based clustering using weka tool.
10. Create multi-dimensional data as inputs and cluster them according to the model parameters and determine outlier usingdensity-based outlier detection method.

Text Books:	
1	Mohammed J. Zaki, Wagner Meira, Jr,"Data Mining and Machine Learning Fundamental Concepts and Algorithms", cambrdge university press,2020.
2	ParteekBhatia ,"Data Mining and Data Warehousing Principles and Practical Techniques", Cambridge University Press, 2019.
Reference Books:	
1	Jiawel Han,MichelineKamber and Jian Pei," Data Mining Concepts and Techniques", third Edition, Elsevier,2018.
Web References:	
1	https://examupdates.in/data-mining-lecture-notes/
2	http://www.miet.edu/course/wp-content/uploads/2019/05/dwdm-completed-notes.compressed.pdf
3	https://livebook.manning.com/book/mahout-in-action/chapter-12/82
Online Resources:	
1	https://www.classcentral.com/subject/data-mining
2	https://onlinecourses.nptel.ac.in/noc20_cs12/preview
3	https://www.coursera.org/specializations/data-mining

Continuous Assessment									**End Semester Examination**	**Total**
Theory				**Practical**			**Total (A+B)**	**Total Continuous Assessment**		
Formative Assessment	**Summative Assessment**	**Total**	**Total (A)**	**Formative Assessment**	**Summative Assessment**	**Total (B)**				
80	**120**	**200**	**100**	**75**	**25**	**100**	**200**	**50**	**50**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C402.1	Understand	Quiz	20
C402.2	Apply	Tutorial	20
C402.3	Apply	Assignment	20
C402.4	Understand		20
C402.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
	Summative Assessment (24%) [120 Marks]		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (25%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-

Create	-	-	-

Assessment based on Continuous and End Semester Examination									
Continuous Assessment (50%)								End Semester Examination (50%)	
CA 1 (100 Marks)			CA 2 (100 Marks)			Practical Exam (100 Marks)		Theory Examination (25%) Practical Examination (25%)	
SA 1 (60 M)	FA 1		SA 2 (60M)	FA 2		FA (75M)	SA (25M)		
	Component-I (20 Marks)	Component-II (20 Marks)		Component-I (20 Marks)	Component-II (20 Marks)				

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C402.1	1	2	1	2	2							2	2	2	1
C402.2	3	3	2	3	2							3	2	3	2
C402.3	3	3	2	3	2							2	3	3	3
C402.4	3	3	2	3	2							3	3	2	3
C402.5	3	3	2	3	2							3	3	2	3

22CS403	OPERATING SYSTEMS	3/0/2/4
Nature of Course:	F (Theory Programming)	
Pre requisites:	Nil	

Course Objectives:

1	To identify the structure and functions of Operating System.
2	To describe the OS mechanisms to handle processes and threads.
3	To experiment CPU scheduling policies, synchronization techniques and deadlock handling in real time problems.
4	To articulate Memory management schemes.
5	To discuss Device Management, I/O and File systems concepts.

Course Outcomes

Upon completion of the course, students shall have ability to

C403.1	Review the basic concepts and functions of operating systems.	[U]
C403.2	Interpret the processes and threads in operating systems for real world problems.	[U]
C403.3	Examine CPU scheduling algorithms, process synchronization mechanisms and deadlock handling methods.	[AP]
C403.4	Practice memory management techniques including virtual memory and page replacement algorithms.	[AP]
C403.5	Illustrate the concepts related to mass storage, I/O and file system.	[AP]

Course Contents:

MODULE I Introduction **15 Hours**

Defining Operating Systems - User view - System view - Computer-System organization - Computer System Architecture - Operating System Operations - Resource Management - Virtualization - Computing Environments - OS Services - System Calls - Overview of Operating System Specific applications - OS Structures - System Boot. Process: Concept - Scheduling – Operations. Thread: Overview - Multicore Programming - Multithreading Models.

MODULE II Process & Memory Management **15 Hours**

CPU Scheduling - Process Synchronization: Synchronization Tools - Classic Problems of Synchronization – Deadlocks: System Model- Deadlock in Multithreaded Applications - Deadlock Characterization - Methods for Handling Deadlocks - Prevention - Avoidance -Detection – Recovery. Main memory: Background - Contiguous Memory Allocation – Paging - Structure of the Page Table – Swapping. Virtual memory - Background - Demand Paging - Copy-on-Write - Page Replacement - Allocation of Frames - Thrashing - Memory Compression.

MODULE III File Management, I/O and storage **15 Hours**

File-System Interface: File concept - Access methods - Directory Structure - Protection. File System Implementation: File System Structure- Directory implementation- Allocation Methods- Free Space Management. File system Internals: File Systems - File System mounting - Partitions and Mounting - File Sharing. I/O Systems: Overview - I/O Hardware. Mass Storage Structure: Overview - HDD Scheduling - NVM Scheduling - Storage Device Management - Storage Attachment. Case Study: NAND flash storage system, IPC in windows.

Total Hours:	**45 Hours**

Laboratory Component:

S. No	List of Experiments
1.	Study of Basic Linux Commands, proc file system of linux, disk I/O, buffer caches, disk monitoring tool
2.	Implementation of Shell Programming
3.	Implementation of Unix System Calls
4.	Implementation of Non Pre emptive and Pre emptive CPU Scheduling Algorithms
5.	Implementation of Dining Philosopher's Problem to demonstrate Process Synchronization
6.	Implementation of Banker's Algorithm for Deadlock Avoidance
7.	Implementation of Memory Allocation and Management Techniques
8.	Implementation of Page Replacement Techniques
9.	Implementation of File organization Techniques and study on modern file systems like ZFS, btrfs, ext4 etc.
10.	Implementation of Disk Scheduling Algorithms. Compare CPU and Disk Scheduling algorithms in terms of the number of voluntary and involuntary context switches.
	Total Hours: 30 Hours
Text Books:	
1.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne, "Operating System Concepts" 10th Edition, John Wiley, 2018
2.	D.M Dhamdhere, "Operating Systems"- A Concept based Approach, 3rdEdition, McGraw Hill,2017
Reference Books:	
1.	Andrew S. Tanenbaum, Modern Operating Systems 5thEdition, Pearson Education, 2016.
2.	William Stallings, "Operating Systems – Internals and Design Principles", 8thEdition, Pearson Publications, 2014.
Web References:	
1.	https://www.studocu.com/sg/course/nanyang-technological-university/operating-systems/1390534
2.	https://www.cs.uic.edu/~jbell/CourseNotes/OperatingSystems/
3.	https://www.gatevidyalay.com/operating-system/
Online Resources:	
1.	https://www.coursera.org/learn/os-power-user
2.	https://nptel.ac.in/courses/106108101

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (10%) [80 Marks]**
C403.1	Understand	Quiz	20
C403.2	Understand	Assignment	20
C403.3 & C403.4	Apply	Tutorial	20
C403.5	Apply	Case Study	20

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	20	20	20
Understand	40	30	40
Apply	40	50	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	20	20	20
Understand	40	20	30
Apply	40	60	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C403.1	2	2	2						2	1		2	2	2	2
C403.2	3	3	3	2	2				2	1		3	3	2	2
C403.3	3	3	3	3	3				2	1		3	3	2	2
C403.4	3	3	3	3	3				2	1		3	3	2	2
C403.5	3	3	3						2	1		3	2	2	2
C403	**3**	**3**	**3**	**3**	**3**				**2**	**1**		**3**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22AD501	SIGNALS, SYSTEMS AND NETWORKS	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	NIL	

Course Objectives:	
1	Understand the basic properties of signals and systems.
2	Understanding signals and systems in terms of both time and frequency domains.
3	Utilize the Laplace transform method to solve continuous, linear, time-invariant systems and to obtain transfer functions.
4	Developing Expertise in time domain and frequency domain approaches to the analysis of Discrete time signals and system in Z-transform domain
5	To learn and familiarise the functions of OSI layers and its protocols in data communication networks

Course Outcomes: **Upon completion of the course, students shall have ability to**		
C501.1	Acquire the knowledge of signal, system and its classifications	[R]
C501.2	Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier Transform and Laplace Transform	[AN]
C501.3	Analyze system properties based on impulse response and Frequency Response	[AN]
C501.4	Apply Z-transform for the analysis of discrete-time signals and systems	[AP
C501.5	Understand the basic layers and its functions in computer networks	[U]
C501.6	Analyze the protocols for various functions in the network and examine the common layers and its protocols	[AN]

Course Contents:

CLASSIFICATION OF SIGNALS AND SYSTEMS: **15 hours**

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids - Classification of signals - Continuous time (CT) and Discrete Time (DT) signals, Periodic & aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems - CT systems and DT systems - Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable - Applications of Biomedical signal.

ANALYSIS OF CONTINOUS TIME SIGNALS AND DISCRETE TIME SIGNALS 15 hours

Laplace Transforms and properties - System representation using differential equations - System Analysis using Laplace transform and Fourier transform - Impulse response and step response - System representation using difference equations - System Analysis using Z - transform - Impulse response and step response - Case study: Biological Signal Analysis

DATACOMMUNICATION NETWORKING AND TRANSMISSION 15 hours

Introduction: Data Communications - Networks - Protocols and standards - The OSI model - TCP/IP Protocol Suite - Physical layer: Ethernet and Wi-fi - Data link layer: Error detection and correction (Parity & CRC) - Network layer: Logical Addressing - IPv4, IPv6 Addresses and Packet Formats - Transport layer: Transport layer services, User datagram protocol, Transmission control protocol - Application layer: WWW, HTTP, FTP, Electronic Mail and Domain Name System (DNS) - Case study: Investigating the impact of AI-driven applications on network protocols and its services.

	Total Hours:	**45**

Text Books:

1	Allan V. Oppenheim etal, "Signals and Systems", Prentice Hall of India, 2/E, 2015
2	Ramakrishna Rao P, "Signals and Systems", McGraw Hill Education, New Delhi, 2/E, 2013.
3	Behrouz A. Foruzan, "Data communication and Networking", 5th Edition Tata McGraw-Hill, 2013.

Reference Books:

1	J. Roberts, "Fundamentals of Signals and Systems", Tata McGraw Hill, 2007.

2	Simon Haykin and Barry Van Veen “Signals and Systems”, 2nd edition, Wiley 2005.
3	AS Tanenbaum, DJ Wetherall, “Computer Networks”, 6th Edition, Prentice-Hall, 2021.
Web References:	
1	http://www.nptelvideos.in/2012/12/signals-and-system.html
2	http://library.aceondo.net/ebooks/Computer_Science/Data_Communication_and_Networking_by_Behrouz.A.Forouzan_4th.edition.pdf
Online Resources:	
1	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-2
2	https://cosmolearning.org/courses/data-communication-542/video-lectures/

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C501.2	Analyze	Quiz	20
C501.1	Remember	Tutorial	20
C501.3	Analyze	Assignment	20
C501.4	Apply		
C501.5, C501.6	Analyse	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C501.1	2	2	3	3	1		1				1	2	2	1	2
C501.2	3	3	3	3	1		1				1	2	2	1	2
C501.3	3	3	3	3	1		1				1	2	2	1	2
C501.4	3	3	3	3	1		1				1	2	2	1	3
C501.5	3	3	3	3	1		1				1	3	2	1	2

22AD502	MACHINE LEARNING	3/0/0/3
Nature of Course	: G (Theory Analytical)	
Pre requisites	: Data Warehousing and Mining	

Course Objectives:

1.	To introduce applications of machine learning and case studies.
2.	To provide an insight to different supervised learning techniques, merits and demerits.
3.	To enable the students to understand Graphical models and their applicability to real world problems.
4.	To explore discovering clusters in the given data.
5.	To study and evaluate dimensionality reduction for the given data.

Course Outcomes:
Upon completion of the course, students shall have ability to

C502.1	Understanding the fundamental issues and challenges of machine learning.	[U]
C502.2	Explore the acquired knowledge on concept learning and hypothesis selection.	[AP]
C502.3	Understand the concepts behind different types of learning, algorithms and their appropriateness.	[U]
C502.4	Analyse the differentiation between feature selection and feature extraction techniques in dimensionality reduction.	[A]
C502.5	Apply appropriate machine learning technique for a given real world problem.	[AP]

Course Contents:

Module I Introduction to Machine Learning **15 Hours**

Introduction – Data Preprocessing - Designing a learning system, Issues - Examples of Machine Learning Applications, Overview: Supervised Learning, Learning Associations, Classification, Regression, Unsupervised learning and Reinforcement Learning - Concept learning and general to specific ordering: A concept learning task, concept learning as search, FIND-S: Finding a maximally specific hypothesis, version spaces and the candidate elimination algorithm, Remarks, Inductive Bias. **Case Study:** Building a Machine Learning System for Customer Churn Prediction.

Module II Supervised Learning **15 Hours**

Generative vs discriminative learning, Decision Tree learning, Neural Networks, Support vector machines, Instance based learning, Ensemble learning – Bagging and Boosting - Linear regression, Logistic regression, Other types of Regression. Face recognition and Hand-writing Recognition. **Case Study:** Spam Filtering, Predicting Loan Default using Supervised Learning.

Module III Unsupervised Learning and Reinforcement Learning **15 Hours**

Unsupervised learning Algorithms: Gaussian mixture models, Discovering clusters, Discovering latent factors, Dimensionality reduction – Principal Component Analysis. **Case Study**: You tube video Recommendation - Utilizing unsupervised learning techniques to perform customer segmentation for a retail company. Genetic programming, Reinforcement learning: the learning task, Q learning, non-deterministic rewards and actions. **Case Study:** Applying Reinforcement Learning for Autonomous Drone Navigation.

Total Hours:	**45 Hours**

Text Books:

1.	Harsh Bhasin, “Machine Learning for Beginners”, BPB Publications, January 2020.
2.	Ethem Alpaydin, “Introduction to Machine Learning 3e (Adaptive Computation and Machine

	Learning Series)", Third Edition, MIT Press, 2014.
3.	Kevin P. Murphy, "Machine Learning A probabilistic Perspective", MIT press, 2018.
4.	Tom M. Mitchell, " Machine Learning", 3rd Edition, Tata McGrawHill, 2015.
5.	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", 3rd edition, Paperback, October 2022.
Reference Books:	
1.	Manuel Garcia-Piqueras, "Heuristic search of optimal machine teaching",Springer, 2023.
2.	Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2017.
3.	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
Web References:	
1.	https://onlinecourses.nptel.ac.in/noc16_cs18/
2.	http://freevideolectures.com/Course/2257/Machine-Learning
3.	https://towardsdatascience.com/machine-learning/

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C502.1	Understand	Quiz	20
C502.2	Apply	Tutorial	20
C502.3	Understand	Assignment	20
C502.4	Analyze		
C502.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination				
Continuous Assessment (40%) [200 Marks]				**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks		**CA 2 : 100 Marks**		
SA 1	**FA 1 (40 Marks)**	**SA 2**	**FA 2 (40 Marks)**	

(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	

	Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)														
COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C502.1	2	3	3	3	2	2						2	2	3	2
C502.2	2	3	3	3	2	2						2	2	3	2
C502.3	3	3	2	3	2	2						2	3	2	3
C502.4	2	3	2	3	2	2						2	3	2	2
C502.5	2	3	3	2	3	2						2	3	3	3
	3	Strongly agreed		2	Moderately agreed			1	Weakly agreed						

22AD503	DATA SCIENCE USING R	2/0/2/3

Nature of Course	F (Theory Programming)
Prerequisites	Python Essentials

Course Objectives:

1	Apply quantitative modelling and data analysis techniques to the solution of real-world business problems.
2	To exercise the fundamentals of statistical analysis in the R environment.
3	To analyse data for the purpose of exploration using Descriptive and Inferential Statistics.
4	To use descriptive, predictive and prescriptive analytics to drive growth.
5	To extract valuable information for use in strategic decision making, product development, trend analysis, and forecasting.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C503.1	Understand the core concepts like data types, variables, control flow structures, functions and data structures.	[U]
C503.2	Apply R programming essentials to manipulate, clean and analyse data.	[AP]
C503.3	Implement and explore proficiency in using packages like dplyr and tidyr for data wrangling tasks such as filtering, transforming and summarizing data.	[AP]
C503.4	Examine skills in data visualization using R's powerful graphics capabilities.	[A]
C503.5	Analyse and explore regression analysis, hypothesis testing and other statistical modelling techniques.	[A]

Course Contents:

MODULE I: INTRODUCTION TO R **15 Hours**

Overview of R Language - Data Types - Variable - Operators - Decision Making - Loop control - Array - String - Function - Vector - Lists - Matrices - Factors - Data Frames –Merging Data Frames - Packages - Data and File Management - Charts & Graphs. Case study: Analyze the dataset and derive insights to make data-driven decisions.

MODULE II: DATA ANALYSIS AND VISUALIZATION **15 Hours**

Introduction to data science - Data visualization - A grammar for graphics - Data Pre-processing - Data wrangling on one table - Data wrangling on multiple tables - Tidy data – Iteration – Outlier Detection - Dimensionality reduction - Time series analysis - Model evaluation and validation - Ensemble methods. Case study: Perform data analysis and visualization to uncover patterns, trends, and insights related to customer satisfaction and feedback.

MODULE III: STATISTICS AND MODELING **15 Hours**

Statistical foundations - Predictive modelling –Logistic Regression – Random Forest – Naïve Bayes – Hierarchical Clustering - Support Vector Machines - Decision Trees - Gradient Boosting - Time Series Forecasting - Anomaly Detection - Model Selection and Hyperparameter Tuning - Survival Analysis. Case study: Fit a series of supervised learning models to predict arrival delays for flights from New York to SFO using the nycflights13 package.

Total Hours:	**45 Hours**

Lab Component

1. Getting Used to R: Describing Data – Calculate and summary statistics such as mean, median, and standard deviation based on student grade.
2. Creating and displaying Data - Create a dataset to store information about employees, including their names, ages, and salaries
3. Creating and manipulating a List and an Array - Manipulate the list to add or remove elements for a set of student list with their corresponding grades.
4. Creating a Data Frame and Matrix-like Operations on a Data Frame.
5. String Manipulations - Suppose you have a dataset containing customer names and email addresses. How would you use R to perform string manipulations, such as extracting the domain name from email addresses or converting names to uppercase.
6. Data transpose operations in R - Imagine you have a dataset with observations in rows and variables in columns. How would you use R to transpose the data, converting the rows into columns and vice versa.
7. Probability Distributions - Working on a project that requires modelling a random variable with a specific probability distribution, such as the normal distribution.
8. Basic Statistics in R – Consider a dataset containing the heights of individuals, calculate basic statistics such as mean, median, standard deviation, and correlation coefficients
9. Visualizing Data - Tables, charts and plots - create a line chart showing the monthly sales trends for each product category over the past year and a stacked bar chart comparing the sales distribution among different regions for the top-selling product category.
10. Creating models for prediction - Develop a predictive model using the dataset to identify customers who are at a high risk.

Total Hours: 30 Hours

Text Books:

1	Vinod MotiramRathod, Harish SadashivMotekar, ReshmaRamakantKanse, “Data Science Using R”, Book Rivers, August 2023.
2	Benjamin S. Baumer, Daniel T. Kaplan, and Nicholas J. Horton, “Modern Data Science with R”, 2nd edition, CRC Press, July 28, 2021.
3	Hadley Wickham & Garrett Grolemund "R for Data Science - Import, Tidy, Transform, Visualize, and Model Data", O'Reilly , 1st edition, December 2016.

Reference Books:

1	Tilman M. Davies, "The Book of R", No Starch Press, 1st edition, July 16 2016.
2	Joel Grus, "Data Science from Scratch", O'Reilly, 1st edition, April 2015.
3	Norman Matloff, "The Art of R Programming", No Starch Press, 1st edition, 2011.
4	Garrett Grolemund, "Hands on programming with R", O'Reilly , 1st edition, July 22 2014.

Web References:

1	https://nptel.ac.in/courses/106/106/106106179/
2	https://www.atnyla.com/syllabus/r-programming-language/7

Online References:

1	https://www.knowledgehut.com/blog/data-science/r-for-data-science
2	https://www.coursera.org/specializations/data-science-foundations-r
3	https://www.mastersindatascience.org/learning/data-scientist-skills/r/

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C503.1	Understand	Quiz	20
C503.2	Apply	Tutorial	20
C503.3	Apply	Assignment	20
C503.4	Analyze		
C503.5	Understand	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (25%) [120 Marks]**		**End Semester Examination (25%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (25%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theory Examination (25%) Practical Examination (25%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

	Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)														
COs	**POs**												**PSOs**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
C503.1	2	3	3	3	2							1	2	3	
C503.2	2	3	3	3	2							1	2	3	
C503.3	3	3	2	3	2							1	3	2	3
C503.4	2	3	2	3	2							1	3	2	
C503.5	2	3	3	2	3							1	3	2	3
	3 Strongly agreed			2 Moderately agreed					1 Weakly agreed						

22AD504	MACHINE LEARNING LABORATORY	0/0/3/1.5
Nature of Course	: L (Programming)	
Pre requisites	: Python Essentials	

Course Objectives:

1.	To understand the basic concepts and techniques of Machine Learning through python programming.
2.	To enable the students to understand Graphical models and their applicability to real world problems.
3.	To develop skills of using recent machine learning packages for solving practical problems.
4.	To explore discovering clusters in the given data.
5.	To study and evaluate dimensionality reduction for the given data.

Course Outcomes:

Upon completion of the course, students shall have ability to

C504.1	Explore the hands-on experience in implementing and applying various machine learning algorithms.	[AP]
C504.2	Explorethe knowledge on how topreprocess and transform raw data to make it suitable for machine learning tasks.	[AP]
C504.3	Design and implement classifiers and clustering algorithms for machine learning applications.	[AP]
C504.4	Choose and implementappropriate algorithms based on the problem at hand and apply them effectively.	[A]
C504.5	Apply machine learning in various domains, such as healthcare, finance, marketing, and computer vision, etc.	[AP]

Course Contents:

1. Implementation of Gaussian Mixture Models - A marketing company wants to identify different customer segments based on their purchasing behaviour. They have collected data on customer transactions.
2. Implementation of Data Pre – Processing - A research team is working with a large dataset that contains missing values and outliers. Before proceeding with their analysis, they need to preprocess the data, handle the missing values and outliers effectively.
3. Implementation of Decision Tree Classifier - A credit card company wants to build a model that predicts whether a customer is likely to default on their payment. They have historical data on customer attributes and payment behaviour.
4. Implementation of Neural Networks Algorithm - An image recognition startup aims to develop a deep learning model that can accurately classify images into different categories.
5. Implementation of Support Vector Machines - A healthcare organization wants to predict the likelihood of a patient developing a particular disease based on their medical history. They have collected a large dataset with patient attributes and disease outcomes.
6. Implementation of K- nearest Neighbor Classifier - An e-commerce company wants to recommend products to customers based on their browsing history and previouspurchases.
7. Implementation of Regression Algorithm - A real estate agency wants to predict housing

prices based on factors such as location, size, and amenities. They have collected data on recently sold properties.

8. Implementation of Clustering Algorithm - A retail chain wants to group their customers into distinct segments based on their purchasing patterns. They have collected data on customer transactions.
9. Implementation of Dimensionality Reduction Algorithm - A data analysis team wants to reduce the dimensionality of a high-dimensional dataset to improve computational efficiency and remove noise.
10. Mini Project

Total Hours: 45

Text Books:

1.	AurélienGéron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems", 3rd edition, Paperback, October 2022.
2.	Oliver Theobald, "Machine Learning for Absolute Beginners", 3rd edition, Scatterplot Press, 2021
3	Tom M. Mitchell, "Machine Learning", 3rd Edition, Tata McGrawHill, 2015.
4	EthemAlpaydin, "Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)", 3rd Edition, MIT Press, 2014.

Reference Books:

1.	Kevin P. Murphy, "Machine Learning A Probabilistic Perspective", MIT press, 2012.
2.	Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2014.
3.	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Web References:

1.	https://onlinecourses.nptel.ac.in/noc16_cs18/
2.	http://freevideolectures.com/Course/2257/Machine-Learning
3.	https://www.youtube.com/watch?v=8I6RPr17xac

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	-	-	-
Understand	-	-	-
Apply	60	60	60
Analyse	30	30	30

Evaluate	10	10	10
Create	-	-	-

	Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)														
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C504.1	2	3	3	3	2	2						2	2	3	2
C504.2	2	3	3	3	2	2						2	2	3	2
C504.3	3	3	2	3	2	2						3	3	2	3
C504.4	2	3	2	3	2	2						3	3	2	2
C504.5	2	3	3	2	3	2						3	3	2	3

3	Strongly agreed	2	Moderately agreed	1	Weakly agreed

22AD505	MINI PROJECT	0/0/2/1
Nature of Course	M (Practical Application)	
Pre-Requisites	Programming Languages	
Course Objectives:		
1	To identify a problem area and showcasing a strong understanding of the selected domain.	
2	To explore the latest advancements within their selected field of study.	
3	To understand and adhere to ethical standards and professional practices in software development.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C505.1	Identify a problem and carry out a thorough study on the chosen problem	[A]
C505.2	Analyze ongoing developments in the chosen domain and demonstrate technical knowledge pertaining to the same.	[A]
C505.3	Apply suitable tools, techniques, Algorithms, frameworks to solve the practical problems.	[AP]
C505.4	Develop a solution for the chosen problem and validate the results.	[C]

Course Guidelines:

Introduction: Identify domain, Framing Problem Statement, Dataset Collection, Analyze the Techniques, Organize the work flow. **Experiments:** Develop software life cycle model, Implement, and provide solution for the chosen problem statement, Validate the result, and provide the documentation for findings.

1. The entire semester shall be utilized by the students to do their Mini project work by receiving the directions from the project guide.
2. Every student shall have a project guide who is the member of the faculty of the institution for the in-house project or an industry mentor from the industry as project guide for an industry/internship project.
3. Identification of project guide has to be completed by the end of previous semester of the project work to be carried out.
4. The duration may be used for library reading, laboratory work, literature survey, computer analysis or field work as assigned by the guide and also to present periodical seminars about the progress made in the project.
5. Number of students in the project team should be maximum of 4.
6. Students can select project topics from the thrust areas.
7. Projects can be Research Based, Application Based, or Multidisciplinary.
8. Students can choose projects in line with the Departmental Mission, Vision and Program Outcomes.
9. Students can identify the project area / title, obtain the consent of faculty to guide them.
10. Students can make use of college subscribed E-resources like IEEE, ScienceDirect and Elsevier to choose base papers and thereby do literature surveys.
11. After project guide allocation, the student team must meet the respective project guide and update about the status of project periodically.
12. While working on the project, every student team must keep a project diary and record all relevant information. The diary must be verified and signed by the project guide which will be the periodic progress report and submitted during the project review to the project coordinator.
13. Students should not be involved in unethical behaviour, such as plagiarism, copyright violations, etc while working on projects and when submitting project reports.
14. The progress of the project will be evaluated on a continuous basis by conducting periodic internal reviews. The review committee may be constituted by the Head of the Department.
15. A final external project viva-voce examination will be conducted to evaluate the student project work based on oral presentation and the project report by an Internal and External Examiner.
16. Every student team will be required to prepare and submit two (2) copies plus (no. of students) copies of the Project report of typical length 30 – 60 pages (excluding Appendices).
17. The final report shall be in typewritten form as specified in the guidelines issued by the COE.

18. As outcome of the project, students are motivated to publish papers in Scopus Indexed Journals or present the project work in International Conferences.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Project Evaluation	August	30	100
Project Evaluation	September	30	
Project Evaluation	October	40	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

Cos	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C505.1	3	3	2	2	1			3	3	3		3	2	3	3
C505.2	3	3	3	3	3			3	2	3	2	3	2	3	3
C505.3	3	3	3	3		3	3	3	3	3	3	3	2	3	3
C505.4	3	3	3	3				3	3	3	3	3	2	3	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS701	INTERNET OF EVERYTHING	3/0/0/3
Nature of Course:	D (Theory Applications)	
Prerequisites:	Internet of Things	

Course Objectives:

1.	To recite the fundamentals of internet of everything.
2.	To identify the characteristics and environments of internet of everything.
3.	To enumerate the benefits and challenges of internet of everything.
4.	To enumerate service innovation for internet of everything.
5.	To correlate internet of everything with related technologies.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C701.1	Differentiate IoT and IoE and explore the IoE architecture	[U]
C701.2	Build an application using IoT by selecting suitable devices and technologies to solve the real-time problem.	[AP]
C701.3	Interpret privacy and security in internet of everything.	[AP]
C701.4	Develop a system for real-time applications using IoE.	[AP]
C701.5	Infer the internet of everything in augmented reality.	[A]

Course Contents:

MODULE I - Introduction to IoT and IoE **15 Hours**

Definitions of IoT- IoT Architecture - Conceptual Design of IoT -IoT Middleware - Middleware Layer functions - IoT Application Scenarios - Design with IoT - Internet of Things (IoT) to Internet of Everything (IoE) - IoE Architecture - Characteristics and Environments - Context-Aware Life-Cycle - Context-Aware Systems - Architecture Overview - Systems Features - Context-Awareness in IoE **– Application Case Study-** Smart Agriculture with IoT Based Pest Controlling System**.**

MODULE II - Challenges of IoE **15 Hours**

Technologies and Challenges - IoE Connection Types - Benefits and Challenges of IoE - Drivers of IoE - Technology Drivers - Barriers to IoE Adoption - Service Innovation for IoE - Navigating IoE Size and Scope with Services - Transforming Data into Information and Actions Using Services - Services to Wrangle and Direct All the IoE Data - IoE Privacy and Security - Situational and Contextual Security- **Application Case Study –** Applications and issues with Wearable Device based IOE.

MODULE III - Design with IOE and Use cases **15 Hours**

Manufacturing application with simple predictive maintenance analytics - IoE Solutions for the Retail Industry - Queue Management and IoE- Augmented reality in retail - Designing Energy Harvesting - Device Hardware Perspective - Fog Computing: A Taxonomy, Survey and Future Directions. **Application Case Study –** Fog Computing based healthcare systems design**.**

Total Hours: 45 Hours

Text Books:

1.	Aarti Jain, Rubén González Crespo and Manju Khari, “Smart Innovation of Web of Things” , CRC Press, 2020.
2.	HazimDahir, Bil Dry and Carlos Pignataro, “People, Processes, Services, and Things-Using Services Innovation to Enable the Internet of Everything”,Business Expert Press, 2015.

Reference Books:

1.	Manoj Kavedia, Dr. Mahesh Sanghavi, Rajiv Bhandari, Dipesh Agrawal, “Internet of Everything”, Tech-Neo Publications, 2022.

2.	Beniamino Di Martino, Kuan-Ching Li, Laurence T. Yang, Antonio Esposito", "Internet of Everything: Algorithms, Methodologies, Technologies and Perspectives, Springer, 2019.
3.	Jordi MongayBatalla, George Mastorakis, "Beyond the Internet of Things -Everything Interconnected", Springer Nature, 2017.
4.	Gunneswara Rao VSSS Kalaga, "Design of Internet of Things", CRC Press, 2022.
Web References:	
1.	https://www.techtarget.com/iotagenda/definition/Internet-of-Everything-IoE
2.	https://www.bbvaopenmind.com/en/technology/digital-world/the-internet-of-everything-ioe/
3.	https://ioe.org/
4.	https://www.sam-solutions.com/blog/what-is-internet-of-everything-ioe/
5.	https://www.techopedia.com/definition/30121/internet-of-everything-ioe
Online Resources:	
1.	https://www.coursera.org/specializations/uiuc-iot
2.	https://www.cisco.com/c/en/us/training-events/training-certifications/exams/current-list/700-821-iotse.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C701.1	Understand	Quiz	20
C701.2	Apply	Tutorial	20
C701.3	Analyze	Presentation	20
C701.4	Analyze		
C701.5	Apply	Assignment	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30

Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C701.1	3	2										1	1	1	1
C701.2	3	2										2	1	1	1
C701.3	3	3	3	2								2	3	3	2
C701.4	3	3	3	2								2	3	3	2
C701.5	3	3	3	2								2	3	3	2

22AD601	DEEP LEARNING AND ITS APPLICATIONS	3/0/2/4

Nature of Course	D (Theory Application)
Pre requisites	Introduction to Artificial Intelligence, Machine Learning

Course Objectives:

1	To understand the basics of deep neural networks.
2	To understand CNN of architectures of deep neural networks.
3	To understand the different architectures and learning methods of deep Neural Networks.
5	To learn about applications of deep learning in variety of real-world problems.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C601.1	Understand the basic concepts of deep learning and principles underlying deep learning.	[U]
C601.2	Analyse existing algorithms as well as design novel algorithms pertaining to complex pattern recognition.	[AP]
C601.3	Explore concept based networks for search deep structural and search models.	[AP]
C601.4	Design and implement architectures including feed forward networks, convolutional neural networks and recurrent neural networks.	[A]
C601.5	Apply various deep learning techniques to design efficient algorithms for real-world Applications.	[AP]

Course Contents:

MODULE I INTRODUCTION, MEMORY AND STATE BASED NETWORKS **15 Hours**

The Perceptron, Feed-forward networks and multi-layer perceptron, Memory based networks - Boltzmann Machines, Hopfield Networks. State based networks - Recurrent Neural Networks, Long Short-Term Memory Networks **–** Fraud Detection - Pattern Recognition of eye's iris- **Case study:** Rumor Detection via Recurrent Neural Networks.

MODULE II DEEP LEARNING ARCHITECTURE AND LEARNING **15 Hours**

Convolutional Neural Networks, Bidirectional networks, Concept based networks used for transfer learning, Structural Networks for structured prediction, Attention based networks, Auto encoders for dimension reduction and embedding, Generative Adversarial Networks, Deep Gaussian Processes, Deep Bayesian nets, Deep Search Models, Deep Reinforcement Learning, Deep Neural Recommenders. Medical Image Analysis **– Case Study:** SIIM-ACR Pneumothorax Segmentation.

MODULE III APPLICATIONS OF DEEP LEARNING **15 Hours**

Detection in chest X-ray images - Object detection and classification - RGB and depth image fusion - NLP tasks - Dimensionality estimation - Time series forecasting - Building electric power grid for controllable energy resources - Guiding charities in maximizing donations and robotic control in industrial environments, multi-media analytics, Proof checking. **Case Study:** Sentiment Analysis in MOOC.

Total Hours:	**45**

Lab Experiments:(Tools – Tensorflow, PyTorch, Keras)

1. Compare the performance of different activation functions (e.g., sigmoid, ReLU) for the hidden layers and evaluate their impact on accuracy. Investigate the influence of varying the number of hidden layers or neurons on the recognition accuracy.
2. Implement a Multilayer Perceptron (MLP) neural network to solve the XOR problem, which is a classic non-linearly separable problem.
3. Build an Artificial Neural Network (ANN) to recognize characters and digits from images.
4. Utilize autoencoders, a type of neural network to analyse X-ray images for anomaly detection or image reconstruction tasks.

5. Build a deep learning architecture such as a recurrent neural network (RNN) or a convolutional neural network (CNN) for speech recognition.
6. Utilize Convolutional Neural Networks (CNNs) to detect and classify objects in traffic scenes.
7. Build a video-based activity recognition system using deep learning models and evaluate its accuracy on different activity classes.
8. Acquire a dataset containing share market transactions with features related to fraud indicators and analyze and detect online fraud in share market data.
9. Employ a deep Restricted Boltzmann Machine (RBM) to perform image augmentation, a technique that generates new images by applying transformations to existing images.
10. Utilize Long Short-Term Memory (LSTM), a type of recurrent neural network (RNN), for sentiment analysis.

Total hours	**30**

Text Books:

1	Ian Goodfellow, YoshuaBengio, Aaron Courville, "Deep Learning", Second Edition, MIT Press, 2016.
2	Stone, James., "Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning", Second Edition, Sebtel Press, United States, 2019.
3	Vance, William, "Data Science: A Comprehensive Beginners Guide to Learn the Realms of Data Science", Joining the dots tv Limited, 2020.

Reference Books:

1	Wani, M.A., Raj, B., Luo, F., Dou, D. (Eds.), "Deep Learning Applications", Volume 3, Springer Publications 2022.
2	Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Punlishing, 2018.

Web References:

1	https://www.oracle.com/artificial-intelligence/machine-learning/what-is-deep-learning/
2	https://towardsdatascience.com/deep-learning/
3	https://link.springer.com/article/10.1007/s42979-021-00815-1

Online Resources:

1	https://in.mathworks.com/discovery/deep-learning.html
2	https://www.coursera.org/courses?query=deep%20learning

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Formative Assessment based on Capstone Model - Theory			
Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz,	FA (10%) [80 Marks]

		Assignment, Case Study, Seminar, Group Assignment)	
C601.1	Apply	Quiz & Assignment	20
C601.2	Apply	Assignment	20
C601.3	Understand	Case study	20
C601.4	Apply	Assignment	20
C601.5	Apply		

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: (60 Marks)	**CIA2: (60 Marks)**	
Remember	10	10	10
Understand	40	40	40
Apply	40	40	40
Analyse	10	10	10
Evaluate	-	-	-
Create	-	-	-
Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C601.1	3	3	3	3	3	2			2	2		2	3	2	2
C601.2	3	3	3	3	3	2	2		2	2		2	3	2	2
C601.3	3	3	3	3	2	2	2		2	2		2	3	2	2
C601.4	3	3	3	3	3	2	2		2	2		2	3	3	3
C601.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

22AD602	NATURAL LANGUAGE PROCESSING	3/0/2/4

Nature of Course	D (Theory Application)
Pre-Requisite	Machine Learning

Course Objectives:

1	To learn the fundamentals of natural language processing.
2	To understand the human morphology process.
3	Recognize speech and parts with grammar.
4	To familiarize with concepts of parsing.
5	To apply statistical techniques and create machine translation models.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C602.1	Understand the basics of natural language techniques such as text normalization and pattern recognition. (Module 1)	[U]
C602.2	Realize semantics and pragmatics of English language for text processing. (Module 1)	[U]
C602.3	Examine the understanding of tokenization, part-of-speech tagging, syntactic parsing, named entity recognition and sentiment analysis. (Module 2)	[A]
C602.4	Apply the hidden Markov and Maximum Entropy model for word analysis. (Module 2)	[AP]
C602.5	Explore techniques for language generation, including text generation, machine translation, and dialogue systems.	[U]
C602.6	Apply machine translation principles on developing the speech recognition system.	[AP]

Course Contents:

MODULE I: INTRODUCTION **15 Hours**

Origin of NLP - knowledge in speech and language processing - Regular Expression - Basic Patterns - Disjunction, grouping, precedence - Finite State Automata - Words and Transducers: English Morphology - Finite state Transducers - Words and Sentence Tokenization - Detecting and Correcting Spelling Errors - Minimum Edit distance - Human Morphological Processing. **Case study:** Human Morphological Processing.

MODULE II: WORD LEVEL ANALYSIS **15 Hours**

Unsmoothed N-grams, Evaluating N-grams, Smoothing, Interpolation and Backoff – Word Classes, Part-of-Speech Tagging, Rule-based, Stochastic and Transformation-based tagging, Issues in PoS tagging – Hidden Markov and Maximum Entropy models - Context-Free Grammars, Grammar rules for English, Treebanks, Normal Forms for grammar – Dependency Grammar – Syntactic Parsing, Ambiguity, Dynamic Programming parsing – Shallow parsing. **Application:** Shallow Parsing

MODULE III: MACHINE TRANSLATION **15 Hours**

Speech recognition architecture - Dialogue and Machine Translation - Constituency grammar – Statistical translation – Word alignment – Phrase based translation – Dependency Parsing - Dialogue Acts – Automatic, Plan inferential, Cue based Interpretation of Dialogue Acts. **Application: Text Summarization in NLP**.

Total Hours:	**45**

Lab Components:

1. Implementation of Word Analysis - Analyzing Customer Feedback
2. Creation of Word Generation - Generate new words based on existing word roots.
3. Select a word root and fill the add-delete table using morphology.
4. Implementation of N-Grams - Capture the relationships between consecutive words in a sentence or text.
5. Implementation of N-Grams Smoothing - Gather a large corpus of product reviews for different electronic devices. Clean the text by removing any irrelevant information and perform necessary

text normalization steps such as converting to lowercase, removing punctuation, and handling special characters.

6. Calculate emission and transition matrix using Hidden Markov Model - Split the preprocessed reviews into individual words or tokens. You can use a tokenizer to segment the text into meaningful units.
7. Find POS tags of words in a sentence using Viterbi decoding - Generate n-grams (sequences of adjacent words)
8. Study the context and size of the training corpus in learning Parts of Speech - Count the frequency of each n-gram in the corpus of product reviews.
9. Implement chunking with regular expression - Extracting Product Information from Customer Reviews
10. Implement BERT for text classification - calculate the overall sentiment of a product review.

Total Hours:	**30**

Text Books:

1	**Dwight Gunning, "Natural Language Processing Fundamentals", Packt Publishing, 2019.**
2	Daniel Jurafsky, James H. Martin, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech", Pearson Publication, 2018.
3	James Allen, "Natural language Understanding", Pearson Education, Second Edition, 2020.

Reference Books:

1	Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", Third Edition, OReilly Media, 2019.
2	Nitin Indurkhya and Fred J. Damerau, "Handbook of Natural Language Processing", Second Edition, Chapman and Hall/CRC Press, 2010.

Web References:

1	https://www.coursera.org/specializations/natural-language-processing
2	https://www.simplilearn.com/natural-language-processing-training-course

Continuous Assessment									End Semester Examination	Total
Theory				Practical			Total (A+B)	Total Continuous Assessment		
Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)				
80	120	200	100	75	25	100	200	50	50	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C602.1	Understand	Quiz	20
C602.2, C602.6	Apply	Tutorial	20

C602.3	Apply	Assignment	20
C602.4	Analyze		
C602.5	Understand	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination - Practical			
Bloom's Level	**Continuous Assessment (25%) [100 Marks]**		**End Semester Examination (15%) [100 Marks]**
	FA: (75 Marks)	**SA: (25 Marks)**	
Remember	10	10	10
Understand	30	30	30
Apply	40	40	40
Analyse	20	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination								
Continuous Assessment (50%)								**End Semester Examination (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theory Examination (35%) Practical Examination (15%)**
SA 1 (60M)	**FA 1**		**SA 2 (60M)**	**FA 2**		**FA (75M)**	**SA (25M)**	
	Component-I (20 Marks)	**Component-II (20 Marks)**		**Component-I (20 Marks)**	**Component-II (20 Marks)**			

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C602.1		1	3	3	3							1	3	3	3
C602.2	1	2	3	3	3	1						1	3	3	3
C602.3	2	2	3	3	2							1	3	3	3
C602.4	2	1	3	3	3							1	3	3	3
C602.5	2	1	2	3	2	1						1	3	3	3
C602.6	3	3	3	3	2				2	2		1	3	3	3

22CS702	INTERNET OF EVERYTHING LABORATORY	0/0/3/1.5
Nature of Course	L (Problem Experimental)	

Course Objectives:

1.	To build a small low cost embedded system using Arduino.
2.	To build a small low cost embedded system using Raspberry PI.
3.	To build a small low cost IoE system using Arduino and Raspberry PI.
4.	To apply the concept of Internet of Everything in the real world scenario.
5.	To apply machine learning algorithms in internet of everything.

Course Outcomes:

Upon completion of the course, students shall have ability to

C702.1	Attain the fundamental knowledge on IoT platform.	U
C702.2	Interface sensors and actuators with Raspberry Pi and Arduino and test its functionalities.	AP
C702.3	Create cloud connectivity with IoT devices.	AP
C702.4	Implement aIoT based realtime system.	AP
C702.5	Analysis and report the sensitive application using IoE.	A

List of Experiments:

(Use Arduino / Raspberry Pi / Any other relevant hardware)

1. 10 acres of Agriculture land running with insufficient man power and the irrigation to the crop is the most hectic process for them. Design a system which reduce the man power requirement to automate the monitoring and controlling process of irrigation from remote location. Use required sensors and actuators and select suitable embedded processor (Eg. Arduino or Raspberry Pi) to build the system.
2. A hospital's Intensive Care Unit (ICU) connected with different monitoring units and set of supporting nurses are there in shift basis to monitor the patient's conditions in 24X7. Some time, due to manual error and low accuracy in detection, wrong treatment may be given to patent, which leads series of issues. Hospital Management planned to automate the ICUs and doctors expected to monitor the same from remote location using Cloud. Data required to store and used for further analysis. Develop a model to satisfy this requirement.
3. A food storage unit in agriculture system usually store different food items in certain temperature. Temperature above the threshold value may damage the items. Develop a monitoring system with sensor devices which collect the temperature from different locations in the storage unit and a gateway will forward the same to cloud. The cloud application monitors temperatures, and takes actions if the temperature gets too low or high.
4. A manufacturing industry with 200 employees working with three shift mode. The Management expected to implement a remote monitoring system which improves their security. Build a model to consider i) employee entry-exit, ii) Machines running status, iii) Fire alarm system and store collected information in cloud for analysis with suitable IoT components.
5. Build an attendance automation system with RF ID card for your department. The ID card is embedded with RF ID (Sensor) and all the classes are equipped with RF readers. Collect the details from each class by considering each reader with specific serial number and match with class. Develop an application which collects these details and store the same cloud for further analysis. Extend this model for Lab area and Library for calculation of their utilization.
6. A retail shop running nearby planning for automation, which includes supply chain management (Sensors, which are attached to storage containers or to products themselves) and Layout Optimization (Sensors in the store collect data like voice, image

	or video to better understand customer habits and preferences). Build a smart retail shop with mentioned sensors and use required actuators and processors. Store the collected details in cloud for remote monitoring and further analysis.
Total Hours:	**45**

Text Books:	
1	Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", First Edition, Packt Publishing, 2020.
2	MarcoSchwartz,"InternetofThingswithArduinoCookbook",PacktPublishing,2019.
3	Adrian McEwen, "Designing the Internet of Things", Wiley Publishers, 2021.
Reference Books:	
1	Vandana Roy, Piyush Kumar, Anoop Kumar Chaturvedi, PritiMaheswary, "Internet of Everything for Biomedical Applications", CRC Press, 2021.
2	Gaston C. Hillar "Internet of Things with Python", Packt Publishing, 2016.
Web References:	
1	www.ptc.com › Internet of Things (IoT)
2	http://wwwusers.di.uniroma1.it/~spenza/files/labIoT2015/Lab-IoT-1.pdf
3	https://onlinecourses.nptel.ac.in/noc22_cs53/preview
Online Resources:	
1	http://www.iotlab.eu/
2	http://www.libelium.com/resources/top_50_iot_sensor_applications_ranking/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
75	**25**	**100**	**60**	**40**	**100**

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember		
Understand	20	20
Apply	70	70
Analyze	10	10
Evaluate		
Create		

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C702.1	3	2										1	1	1	1
C702.2	3	2	1	1	1	1				2	2	2	1	1	1
C702.3	3	3	3	3	2	2	2			2	2	2	3	3	2
C702.4	3	3	3	3	2	2	3			2	2	2	3	3	2
C702.5	3	3	3	3	2	2	3			2	2	2	3	3	2
C702	3	3	3	3	2	2	3			2	2	2	3	3	2

22AD701	DATA ANALYTICS	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-requisite	Cloud Computing

Course Objectives:

1	Understand the Big Data Platform and its use cases
2	Learn to build and maintain reliable, scalable, distributed systems with Apache Hadoop
3	Provide an overview of Apache Hadoop
4	To apply Hadoop ecosystem components
5	Develop a big data solution using Hive.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C701.1	Understand the challenges of big data and insights from large and complex datasets.	[U]
C701.2	Recognize the popular big data technologies and platforms used in industry.	[U]
C701.3	Analyse the Big Data framework like Hadoop to efficiently store and process big data.	[A]
C701.4	Design algorithms to solve data Intensive problems using Map Reduce Paradigm.	[AP]
C701.5	Implement and explore the challenges and considerations involved in handling and analysing big data using Hive, HiveQL and Hbase.	[AP]

Course Contents:

INTRODUCTION TO BIG DATA

Evolution of Big data - Best Practices for Big data Analytics - Big data characteristics - Four Vs, Drivers for Big data, Big data analytics, Big data applications-Classification of Analytics - Top Analytics Tools - Apache Spark, Case Study - MongoDB.

HADOOP AND MAP REDUCE PROGRAMMING MODEL

Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop - Hadoop Architecture, Hadoop Storage: HDFS Understanding inputs and outputs of MapReduce - MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression- Application of MapReduce-Case Study : Big-data Management using Map Reduce on Cloud.

HIVE AND HIVEQL, HBASE

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting and Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper. Big-data Management using Map Reduce on Cloud.

Total Hours:	**45**

Text Books:

1	Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publications, First Edition, 2015.
2	Jay Liebowitz,” Data Analytics and AI”,CRC Press; 1st edition, 2020.
3	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007. 2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O“reilly Media, 2011.

Reference Books:

1	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)
2	Tom White, “Hadoop The Definitive Guide”, O’Reilly Publications, Fourth Edition, 2015.

Web References:

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/learn/google-data-analytics-capstone

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C701.1	Understand	Quiz	20
C702.2	Understand	Tutorial	20
C703.3	Analyze	Assignment	20
C704.4	Apply		
C705.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C701.1	3	3	3	2	3	2						2	2	2	2
C701.2	3	3	3	2	3	2						2	2	2	2
C701.3	3	3	3	3	3	2						2	2	2	2
C701.4	3	3	3	2	3	2						2	2	3	3
C701.5	3	3	3	3	3	3						3	3	2	2

22AD702	DATA VISUALIZATION USING TABLEAU	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre requisites	Data Science using R	

Course Objectives:

1.	To perceive in-depth knowledge on how to represent data with visual analytics as suits the target audience, task and data.
2.	To equip the students with knowledge of visual encoding design choices for arranging and representing data in an interactive and spatial form.
3.	To gain an insight into Data Visualization techniques and tools.
4.	To explore business insights and achieve business goals in the right direction
5.	To provide insight and training on designing visualization dashboard that would support decision making on large scale data

Course Outcomes

Upon completion of the course, students shall have ability to

C702.1	Understand the importance of visualizing data effectively to convey insights and patterns.	[U]
C702.2	Apply the various visual analytics techniques available for arranging the different types of data.	[A]
C702.3	Identify and apply appropriate data visualization techniques, given particular requirements imposed by the data.	[AP]
C702.4	Employ best practices in data visualization to develop charts, maps, tables and other visual representations of data to identify the need for reducing and aggregating item-sets.	[R]
C702.5	Apply the different exploratory data analysis techniques on the datasets using Tableau.	[AP]
C702.6	Experiment on how to import and prepare data, create a variety of visualizations, design interactive dashboards and reports effectively.	[AP]

Course Contents:

MODULE I INTRODUCTION **15 Hours**

Purpose of visualization, Data Abstraction: Data Types, Dataset types, Attribute types, Semantics, Preparing your Data, Survey Data, Compute descriptive Statistics, Explore the data visually, Design Standards: Chart Format, Color, Text and Labels Readability, Scales, data Integrity, chart Junk, data density, data richness, Attribution and Design Standard Checklist. Task Abstraction: Actions, Targets, Analyzing& Deriving **–** Example, Four levels for Validation, Marks and Channels, Analysis **–** Four levels of Validation. **Case Study** -Enhancing Data Analysis through Visualization.

MODULE II Data Manipulation with Pandas **15 Hours**

Introduction, Data Indexing and selection, operating on data, handling missing data, Hierarchical Indexing, combining dataset, Aggregation and Grouping, Pivot tables, String operation Visualization with Matplotlib: Line plots, Scatter Plots, Visualizing Errors, Density and Contour plots, Histogram, Customizing Plot legends, Color bars, Test and Annotation, Three dimensional Plotting, Geographic data with base map, visualization with sea born.**Visualization Techniques**: Arrange tables, Arrange Network and Trees, Map Color and other Channels, Manipulate Views, Facet, Reduce Items and Attributes: Filter, Aggregate, Time-Series Data visualization, Text data Visualization, and Multivariate data visualization. **Case Study**- Analyzing Sales Data Using Pandas and Matplotlib.

MODULE III DATA VISUALIZATION USING TABLEAU **15 Hours**

Exploratory Data Analysis using Tableau Visualizations, Creating basic visualizations- Bar Chart, Geographic map, Crosstab Report, Scatter plot, Line Chart, Connecting to Data, Live Connection, Extract Data, Combine data sources, Join tables, Blend data sources, cross-database join, filtering and sorting data, creating groups and hierarchies - Publishing to Tableau Server - Mapping **– Case Study:** Design Principles and Interactivity.

Total Hours	**45 hours**

Text Books:	
1.	Jaejin Hwang,Youngjinyoon,"Data analytics and Visualization using Tableau "Kindle Edition ,CRC,July 2021..
2.	Praveen Kumar,"Data Visualization with TABLEAU: Learn Data Visualization, Charts, Dashboard and Storytelling with Tableau",GurucoolPublisher,August 2020.
Reference Books:	
1.	Tania Lincoln, Dmitry Anoshin,"Tableau 2019.x Cookbook: Over 115 recipes to build end-to-end analytical solutions using Tableau" ,1st Edition. Packt Publisher, January 2019
2.	Cole NussbaumerKnaflic, "Storytelling With Data: A Data Visualization Guide For Business Professionals" 1st Edition. Wiley Publishers November 2015
Web References:	
1.	https://datavizproject.com/
2.	https://app.rawgraphs.io/
3.	https://www.datawrapper.de/
4.	https://www.tableau.com/
5.	https://marketing platform.google.com/about/data-studio/
6.	https://cedar.princeton.edu/sites/g/files/toruqf1076/files/media/introduction_to_tableau_training_0.pdf
Online Resources:	
1.	https://learning.oreilly.com/library/view/visualization-analysis-and/9781466508910/
2.	https://www.udacity.com/course/data-visualization-nanodegree--nd197
3.	https://www.udemy.com/course/mastering-the-art-of-data-visualization-2020/
4.	https://www.datacamp.com/courses/data-visualization-for-everyone

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C702.1	Understand	Quiz	20
C702.2	Analyze	Tutorial	20
C702.3	Apply	Assignment	20
C702.4	Remember		
C702.5 & C702.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	

Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C702.1	2	3	1		1								1	2	2
C702.2	1	2	2		2								2	1	1
C702.3	3	3	3	3	3								3	3	1
C702.4	1	1	2		1								1	1	1
C702.5	2	1	2	2	1								2	1	2
C702.6		2	2		2								1	1	1

22AD703	DATA ANALYTICS LABORATORY	0/0/2/1

Nature of Course	J (Problem analytical)
Prerequisites	Data Mining

Course Objectives:

1	To Understand the various hadoop operating modes.
2	To explore file management tasks in Hadoop.
3	To implement Map Reduce programs for processing big data.
4	To solve Big Data problems using pig,hbase,hive commands.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C703.1	Gain hands-on experience with tools such as Hadoop, Hive, PIG and HBase.	[U]
C703.2	Demonstrate the knowledge of big data analytics and implement different file management tasks in Hadoop.	[AP]
C703.3	Implement Map Reduce Paradigm and develop data applications using a variety of systems.	[AP]
C703.4	Analyse and perform different operations on data using Pig Latin scripts.	[A]
C703.5	Illustrate and apply different operations on relations and databases using Hive.	[AP]

Course Contents:

1. Perform setting up and Installing Hadoop in its three operating modes: Standalone, Pseudo distributed, fully distributed.
2. Implement the following file management tasks in Hadoop: Adding files and directories, retrieving files, Deleting files.
3. Create a local directory called "data" on your machine, which contains multiple text files.Upload all the files from the "data" directory to HDFS under the path "/user/example/input". Additionally, create a new directory in HDFS called "output" under the path /user/example/output". Interpret the task using HDFS shell command.
4. Run a basic word count Map Reduce program to understand Map Reduce Paradigm.
5. Analyze time-temperature statistics and generate reports with max/min temperature in weather data using Map Reduce program.
6. Implement matrix multiplication with Hadoop Map Reduce
7. Installation of Pig and Load the input data, tokenize each line into words, group the words, calculate the count for each word, and store the word count result in the specified output directory using pig.
8. Implement the Pig Latin Scripts to find a max temp for each and every year.
9. Install and Run Hive then use Hive to create, alter, and drop databases, tables, views, functions, and indexes.
10. Create a table, update, read and delete data using HBase Commands.

Total Hours:	**45**

Text Books:

1	Seema Acharya, Subhashini Chellappan, “Big Data and Analytics”, Wiley Publications, First Edition,2015
2	Jay Liebowitz,” Data Analytics and AI”,CRC Press; 1st edition, 2020
3	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007. 2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O“reilly Media, 2011

Reference Books:

1	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)

Web References:

1	https://nptel.ac.in/courses/106104189

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	-	-	-
Understand	-	-	-
Apply	60	60	60
Analyze	30	30	30
Evaluate	10	10	10
Create	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C703.1	3	3	1	1	2								3	2	3
C703.2	2	2	1	1	2								3	2	3
C703.3	3	2	3	3	2								3	3	3
C703.4	2	3	3	3	3								3	3	3
C703.5	1	2	3	2	1								3	3	3

22AD704	DATA VISUALIZATION LABORATORY	0/0/2/1

Nature of Course	D (Practical Application)
Pre requisites	Data Science using R

Course Objectives:

1	To Explore data visualization of spreadsheet models in order to provide new insight.
2	To equip the students with knowledge of visual encoding design choices for arranging and representing data in an interactive and spatial form.
3	To gain an insight into Data Visualization techniques and tools.
4	To design visualization dashboard and action.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C704.1	Understand the Spreadsheet model and semi - structured data.	[U]
C704.2	Design oracle database using python	[AP]
C704.3	Understand Tableau and aggregation methods	[U]
C704.4	Demonstrate various Data Visualization Interactive plots using python	[AP]
C704.5	Discover time series using python	[AP]
C704.6	Create Dashboards,actions and storytelling in Tableau	[AP]

Course Contents: (Tool – Tableau)

1. Visualization of Spreadsheet Models.-Visualization Solution Transforms The Complex Spreadsheet Model Into An Intuitive And Interactive Visual Representation.

2. Establish a seamless connection between Python and an Oracle database. By doing so, you aim to retrieve, manipulate, and analyze data from the Oracle database using Python's powerful data processing and analysis capabilities ,Oracle Database Connectivity using Python.

3. Create a visualization solution that enables the effective exploration and analysis of semi-structured data. By visualizing the data, you aim to identify key themes, sentiments, and patterns, allowing for better understanding and decision-making based on the insights gained.

4. Explore The Different Aggregation Methods Available Within The Tool

5. Design a basic dashboard using Tableau, focusing on utilizing visual encodings and creating an effective layout. By leveraging visual encodings and organizing the dashboard elements thoughtfully, you aim to present key marketing metrics in a visually appealing and informative manner.

6. Create interactive plots using Python libraries such as Matplotlib and Plotly. By incorporating interactivity into the plots, you aim to provide a dynamic and immersive data visualization experience that empowers users to interact with the data and uncover hidden patterns and trends.

7. Create hierarchical and topographical data visualizations using Tableau. By utilizing Tableau's features, you aim to visualize hierarchical relationships within data sets and represent topographical data to gain insights into transportation networks and optimize routes.

8. Create calendar heatmaps and flow data visualizations using Python libraries such as Matplotlib, Seaborn, and Plotly.

9. Time series data visualizations using python libraries such as matplotlib, seaborn.

10. To Create Interactive Dashboards, Implement Actions For User Interaction, And Use Storytelling Techniques In Tableau.

Total Hours:	**45 Hours**

Text Books:	
1	Sosulski K, “Data Visualization made simple: Insights into Becoming Visual”,New York: Routledge.2018
2	Robert Collins, “Data Visualization: Introduction to Data Visualization with Python, R and Tableau”, September 2018.
3	Jake VanderPlas, “Python Data Science Handbook”, November 2017.
Reference Books:	
1	Few Stephen, “Show me the numbers: Designing Tables and Graphs to Enlighten” 2nd Edition. Analytics Press Publishers, June 2018.
2	Mathew Ward, Georges Grinstein and Daniel Keim, “Interactive Data Visualization Foundations, Techniques, Applications”, 2015.
Web References:	
1	https://datavizproject.com/
2	https://app.rawgraphs.io/
3	https://www.datawrapper.de/
4	https://www.tableau.com/
Online Resources:	
1	https://www.udacity.com/course/data-visualization-nanodegree--nd197
2	https://www.udemy.com/course/mastering-the-art-of-data-visualization-2020/

Assessment based on Continuous and End Semester Examination			
Bloom’s Level	**Continuous Assessment (60%) [100 Marks]**		**End Semester Practical Examination (40%) [100 Marks]**
	FA (75 Marks)	**SA (25 Marks)**	
Remember	-	-	-
Understand	-	-	-
Apply	60	60	60
Analyse	30	30	30
Evaluate	10	10	10
Create	-	-	-

Continuous Assessment				End Semester Examination	Total
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
75	**25**	**100**	**60**	**40**	**100**

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C704.1	2	3	1		1								1	2	2
C704.2	1	2	2		2								2	1	1
C704.3	3	3	3	3	3								3	3	1
C704.4	1	1	2		1								1	1	1
C704.5	2	1	2	2	1								2	1	2
C704.6		2	2		2								1	1	1

22AD801	PROJECT	0/0/24/12
Nature of Course	M (Practical Application)	
Pre-Requisites	Programming Languages	
Course Objectives:		
1	To demonstrate technical, interdisciplinary and interpersonal abilities.	
2	To enhance problem-solving and critical thinking abilities through the identification and resolution of technical challenges.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C801.1	Identify the real-life problem from societal need point of view.	[AP]
C801.2	Choose and compare alternative approaches to select most feasible one.	[C]
C801.3	Analyze and synthesize the identified problem from technological perspective.	[A]
C801.4	Design the reliable and scalable solution to meet challenges.	[C]
C801.5	Examine and validate the solution based on the criteria specified.	[A]

Course Guidelines:

1. The entire semester shall be utilized by the students to do their project work by receiving the directions from the project guide.
2. Every student shall have a project guide who is the member of the faculty of the institution for the in-house project or an industry mentor from the industry as project guide for an industry/internship project.
3. Identification of project guide has to be completed by the end of previous semester of the project work to be carried out.
4. The duration may be used for library reading, laboratory work, literature survey, computer analysis or field work as assigned by the guide and also to present periodical seminars about the progress made in the project.
5. Number of students in the project team should be maximum of 4.
6. Students can select project topics from the thrust areas.
7. Projects can be Research Based, Application Based, or Multidisciplinary.
8. Students can choose projects in line with the Departmental Mission, Vision and Program Outcomes.
9. Students can identify the project area / title, obtain the consent of faculty to guide them.
10. Students can make use of college subscribed E-resources like IEEE, ScienceDirect and Elsevier to choose base papers and thereby do literature surveys.
11. After project guide allocation, the student team must meet the respective project guide and update about the status of project periodically.
12. While working on the project, every student team must keep a project diary and record all relevant information. The diary must be verified and signed by the project guide which will be the periodic progress report and submitted during the project review to the project coordinator.
13. Students should not be involved in unethical behaviour, such as plagiarism, copyright violations, etc while working on projects and when submitting project reports.
14. The progress of the project will be evaluated on a continuous basis by conducting periodic internal reviews. The review committee may be constituted by the Head of the Department.
15. A final external project viva-voce examination will be conducted to evaluate the student project work based on oral presentation and the project report by an Internal and External Examiner.
16. Every student team will be required to prepare and submit two (2) copies plus (no. of students) copies of the Project report of typical length 30 – 60 pages (excluding Appendices).
17. The final report shall be in typewritten form as specified in the guidelines issued by the COE.

18. As outcome of the project, students are motivated to publish papers in Scopus Indexed Journals or present the project work in International Conferences.

Summative assessment based on Continuous and End Semester Examination

Activity	Month	Continuous Assessment [60 marks]	End Semester Examination [40 marks]
Project Evaluation	February	30	100
Project Evaluation	March	30	
Project Evaluation	April	40	

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C801.1	3	3	2	2	1	2		3	3	3		3	2	3	3
C801.2	3	3	3	3	3	3		3	2	3	2	3	2	3	3
C801.3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
C801.4	3	3	3	3	2			3	3	3	3	3	2	3	3
C801.5	3	3	3	3	2	3	3	3	2	3	3	3	2	3	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CD901	DATA VIRTUALIZATION	3/0/0/3
Nature of Course:	G (Theory Analytical)	
Pre requisites:	-	

Course Objectives:

1.	To learn about different Visualization Techniques
2.	To study the Interaction techniques in information visualization fields
3.	To understand various abstraction mechanisms
4.	To create interactive visual interfaces

Course Outcomes:

Upon completion of the course, students shall have ability to

C901.1	Describe about different Virtualization techniques	[U]
C901.2	Understand the Interaction techniques in information virtualization fields	[U]
C901.3	Understand Various abstraction mechanisms	[U]
C901.4	Understand security concerns specific to virtualized environments	[U]
C901.5	Compute interactive virtual interfaces	[AP]

Course Contents:

MODULE I Data Virtualization Tools and Platforms **15 Hours**

Overview of Data Virtualization-Definition and Concepts-Comparison with ETL, Data Warehousing, and Data Lakes- Benefits and Challenges Data Virtualization Architecture Components of Data Virtualization-Logical vs. Physical Data Integration-Data Sources: Structured, Semi-Structured, and Unstructured Data- Overview of Leading Data-Virtualization Platforms-Denodo, IBM Cloud Pak, TIBCO, and others-Key Features and Capabilities.

MODULE II Designing and Implementing Data Virtualization Solutions **15 Hours**

Hands-on with Denodo Platform-Installation and Setup-Creating Data Views and Data Services-Connecting to Various Data Sources-Data Modeling in Virtualization-Logical Data Models-Data Views and Relationships-Best Practices for Data Modeling Query -- Optimization and Performance Tuning-Query Federation-Caching Strategies-Performance Monitoring and Optimization Techniques Security and Governance in Data Virtualization-Data Access Controls

MODULE III Abstraction in Time And Interactive Systems **15 Hours**

Data Masking and Encryption-Compliance and Regulatory Considerations Real-Time Data Virtualization-Streaming Data Integration-Use Cases: IoT, Financial Services, Healthcare-Integration with Big Data and Cloud Platforms-Integrating with Hadoop, Spark, and Cloud – Data-Warehouses-Hybrid and Multi-Cloud Data Virtualization- Machine Learning and AI with Data Virtualization-Enabling Data Science with Virtualized Data Case Studies: Predictive Analytics and Real-Time Insights.

Total Hours:	**45**

Text Books:

1.	Van der Lans, Rick F, “Data Virtualization for Business Intelligence Systems: Revolutionizing Data Integration for Data Warehouses”, 1st Edition, 2012.
2.	Davis, Judith R. & Eve, Robert, “Data Virtualization: Going Beyond Traditional Data Integration to Achieve Business Agility”, 1st Edition, 2011.
3.	John Wiley & Sons, “Data Virtualization for Dummies”,1st edition, 2015.

Reference Books:	
1.	Moxon, Paul, “Logical Data Warehouse: Design, Architecture, and Technology”, 1st Edition, 2015.
2.	van der Lans, Rick F,” Data Virtualization: Selected Writings 2009–2019”, 1st Edition, 2019.
3.	McKnight, William, “Information Management: Strategies for Gaining a Competitive Advantage with Data”, 1st Edition, 2013.
Web References:	
1.	http://turing.cs.washington.edu/papers/nips08.pdf
2.	http://www.barnesandnoble.com/w/computational-visualization-thomasstrothotte/1111486638
Online Resources:	
1.	https://www.geeksforgeeks.org/data-virtualization/
2.	https://www.javatpoint.com/cloud-computing-data-virtualization

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C901.1 & C901.2	Understand	Quiz	20
C901.3 & C901.4	Understand	Assignment	20
C901.5	Apply	Case Study	40

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	2											1			1
C901.2	2	2	2	1	1							1	2	2	1
C901.3	2	2	2	1	1							1	2	2	1
C901.4	2	2	2	1	1							1	3	2	1
C901.5	2	2	2	1	1							1	3	2	1

22IT901	CLOUD SERVICES AND INTEGRATION	3/0/0/3
Nature of Course	F (Theory Programming)	
Prerequisites:	Operating Systems	

Course Objectives:

1	To understand the evolution of AWS from the existing technologies.
2	To practice PuttyGen Environment Setup and Configuration.
3	To team the necessary skills for design, develop and deploy services in core cloud services.
4	To learn basic and advanced linux commands.
5	To provide the perfect security for the entire infrastructure.

Course Outcomes:
Upon completion of the course, students shall have ability to:

C901.1	Illustrate cloud benefits using Amazon Web Services.	[U]
C901.2	Deploy applications using PuttyGen Environment set up.	[AP]
C901.3	Identify an appropriate solution using AWS Cloud services for various use cases.	[AP]
C901.4	Explain the concept of Virtual Network Configuration, IAM, load balancing and scaling.	[AP]
C901.5	Practice basic and advanced Linux commands and Interpret the network security concepts in NAT, VPC and Routing policies.	[AP]

Course Contents:

Module I: Introduction to Cloud and Application deployment **15 Hours**

Use case definition and application design-Introduction to cloud –Benefits of Cloud- Environmental Setup - Amazon Web services Overview – creating an AWS free account – AWS free tier features – AWS Management Console – Accessing AWS Management console -Regions and Availability Zones -AWS support-Application deployment-WinSCP – Putty-PuttyGen-ppk – pem -Application Environment Setup – nginx/httpd -web server configuration.

Module II: Core cloud service **15 Hours**

Elastic Compute Cloud (EC2) Service - EC2 Instance life cycle hooks - Amazon Elastic Block Store (Amazon EBS) : Features - data services -optimized instances - Amazon Cloud Watch metrics for Amazon EBS - Event Bridge for Amazon EBS. Supply Chain Management (SCM) **-** Functions of Supply Chain Management - Elements - Model Types - Instance of SCM. Introduction to Simple Storage Service – Static web site hosting.

Module III: Linux basics and Network Security **15 Hours**

Virtual Network Configuration/Setup - Identity and Access Management - load balancing - scaling - Linux basics and advanced commands -grep commands-NAT Instance – NAT Gateway- Virtual private Cloud (VPC) - VPC Peering and VPC End Points - VPC Flow Logs-Security Groups-Cloud Front-Registering a domain-Weighted Routing Policy-Latent Routing policy -Application integration and setup SSM parameter.

Total Hours:	**45**

Text Books:

1	Mark Wilkins,"Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud", 1st Kindle Edition,2019.

2	Andrew Mallett Mokhtar Ebrahim ,"Mastering Linux Shell Scripting - Second Edition: A practical guide to Linux command-line, Bash scripting, and Shell programming", 2nd Edition Paperback ,2018.
Reference Books:	
1	John Culkin, Mike Zazon ,"AWS Cookbook: Recipes for Success on AWS ",1st Edition 2022.
2	Daniel J. Barrett,"Linux Pocket Guide", O'Reilly Media, 3rd edition.2016.
Web References:	
1	https://www.cloudflare.com/learning/cloud/what-is-a-virtual-private-cloud/
2	https://docs.aws.amazon.com/whitepapers/latest/aws-overview/introduction.html
3	https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/AmazonEBS.html

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C901.1	Apply	Quiz	20
C901.2	Understand	Tutorial	20
C901.3	Apply	Presentation	20
C901.4	Analyze		
C901.5	Apply	Case Study	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	40	40	40
Analyze	10	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	2	1	3	3	3	2						3	2	3	3
C901.2	1	2	3	3	3	2		2			2	3	2	3	3
C901.3	2	2	3	3	2	2		2			2	3	2	3	3
C901.4	2	1	3	3		2						3	2	3	3
C901.5	2	1	2	3	2	2		2				3	2	3	3
C901	**2**	**2**	**3**	**3**	**3**	**2**		**2**			**2**	**3**	**2**	**3**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CY901	SECURITY AND PRIVACY IN CLOUD	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	To give an outline on the components of cloud
2.	To understand the types of security in cloud
3.	To understand the various privacy issues in cloud

Course Outcomes

Upon completion of the course, students shall have ability to

C901.1	Understand the basic components of cloud & Security in the cloud .	[R]
C901.2	Illustrate the Infrastructure Security and Data Security in cloud	[R]
C901.3	Understand the concepts of Identity and Access Management	[U]
C901.4	Identify the storage and security management in the cloud.	[AN]
C901.5	Illustrate the privacy issues in could environment	[AP]

Course Contents:

MODULE 1 **15 Hours**

Introduction to cloud and Infrastructure security : What Is Cloud Computing: Cloud Computing Defined, The SPI Framework for Cloud Computing, Relevant Technologies in Cloud Computing, The Traditional Software Model,The Cloud Services Delivery Model, Cloud Deployment Models, Key Drivers to Adopting the Cloud, The Impact of Cloud Computing on Users, Governance in the Cloud, Barriers to Cloud Computing Adoption in the Enterprise. Infrastructure Security: Infrastructure Security: The Network Level, Infrastructure Security: The Host Level, Infrastructure Security: The Application Level

MODULE 2 **15 Hours**

Data Security and Access Management : Aspects of Data Security, Data Security Mitigation, Provider Data and Its Security Trust Boundaries and IAM, Why IAM?,IAM Challenges, IAM Definitions, IAM Architecture and Practice, Getting Ready for the Cloud, Relevant IAM Standards and Protocols for Cloud Services, IAM Practices in the Cloud, Cloud Authorization Management, Cloud Service Provider IAM Practice

MODULE 3 **15 Hours**

Security Management and Privacy Issues in the Cloud Security Management Standards, Security Management in the Cloud Availability Management, SaaS Availability Management PaaS Availability Management, IaaS Availability Management, Access Control, Security Vulnerability, Patch, and Configuration Management. What Is Privacy, What Is the Data Life Cycle, What Are the Key Privacy Concerns in the Cloud, Who Is Responsible for Protecting Privacy, Changes to Privacy Risk Management and Compliance in Relation to Cloud Computing.,Laws and Regulations

Total Hours	**45**

Text Books:

1.	Tim Mather, Subra Kumara swamy,Shahed Latif,"Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'ReillyMedia; 1edition [ISBN:0596802765], 2009

Reference Books:

1.	RonaldL.Krutz, Russell Dean Vines, "CloudSecurity" [ISBN:0470589876],2010.
2.	John Rittinghouse, James Ransome, "Cloud Computing" CRC Press; 1 edition [ISBN:1439806802], 2009.

Web References:

1.	https://cloud.google.com/learn/what-is-cloud-data-security
2.	https://www.flexential.com/resources/blog/cloud-data-privacy
3.	https://techbeacon.com/security/cloud-security-data-privacy-essentials-why-they-matter

Online Resources:	
1.	https://www.coursera.org/courses?query=cloud%20security
2.	https://iisecurity.in/courses/cloud-computing-security-course

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component	FA (16%) [80 Marks]
C901.1	Remember	Assignment	20
C901.2	Analyze	Case Study	20
C901.3	Analyze	Group Assignment	20
C901.5	Apply	Quiz	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	-	-	-
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	20	20	20

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component-I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C901.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C901.3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C901.4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C901.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

22AD902	STORAGE TECHNOLOGIES	3/0/0/3

Nature of Course	D (Theory Application)
Prerequisites	Data base systems, Computer Architecture

Course Objectives:

1.	To discuss the basic principles of data storage and retrieval.
2.	To analyze storage architecture; understand logical and physical components of storage Infrastructure.
3.	To describe storage networking technologies such as FC-SAN, NAS, IP-SAN and data archival solution –CAS.
4.	To understand and articulate business continuity solutions including, backup and recovery technologies.

Course Outcomes:
Upon completion of the course, students shall have ability to:

C902.1	Illustrate Information Storage architecture and Information Management	U
C902.2	Understand the Components of an Intelligent Storage System and Third Platform Technologies.	U
C902.3	Analyze the architecture and working of Fibre Channel and compare Fibre Channel with other storage protocols	AN
C902.4	Implement NAS hardware for specific needs and demonstrate the file sharing protocols.	AP
C902.5	Implement and manage backup and recovery processes effectively.	AP

Course Contents:

STORAGE SYSTEM **15 Hours**

Introduction to Information Storage and Management: Information Storage - Evolution of Storage Technology and Architecture - Data Center Infrastructure - Key Challenges in Managing Information - Information Lifecycle. Storage System Environment: Components of a Storage System Environment - Disk Drive Components - Disk Drive Performance. RAID: Implementation of RAID - RAID Array Components - RAID Levels - RAID Comparison - RAID Impact on Disk Performance. Intelligent Storage System: Components of an Intelligent Storage System - Intelligent Storage Array. Third Platform Technologies: Cloud computing and its essential characteristics - Cloud services and cloud deployment models - Big data analytics, Social networking and mobile computing.

STORAGE NETWORKING TECHNOLOGIES **15 Hours**

Direct-Attached Storage and Introduction to SCSI: Types of DAS - DAS Benefits and Limitations - Disk Drive Interfaces - Introduction to Parallel SCSI - SCSI Command Model. Fibre Channel: Overview - The SAN and Its Evolution - FC Connectivity - Fibre Channel Ports - Fibre Channel Architecture - Zoning, Fibre Channel Login Types. Network-Attached Storage: General-Purpose Servers vs. NAS Devices - Benefits of NAS - NAS File I/O - Components of NAS - NAS Implementations - NAS File-Sharing Protocols - NAS I/O Operations. IP SAN: iSCSI - FCIP. Content-Addressed Storage: Fixed Content and Archives - Types of Archives - Features and Benefits of CAS - CAS Architecture - Object Storage and Retrieval in CAS.

STORAGE VIRTUALIZATION **15 Hours**

Storage Virtualization: Forms of Virtualization - SNIA Storage Virtualization Taxonomy - Storage Virtualization Configurations - Storage Virtualization Challenges - Types of Storage Virtualization. Introduction to Business Continuity: Information Availability - BC Terminology - BC Planning Lifecycle - Failure Analysis - Business Impact Analysis - BC Technology Solutions. Backup and Recovery: Backup Purpose - Backup Considerations - Backup Granularity - Recovery Considerations - Backup Methods - Backup Process - Backup and Restore Operations - Backup Topologies - Backup Technologies. Local Replication: Source and Target - Uses of Local Replicas - Data Consistency - Local Replication Technologies - Restore and Restart Considerations - Management Interface.

Total Hours:	**45**

Text Books:

1.	EMC Corporation, “Information Storage and Management”, Wiley India, 3rd Edition, 2020.
2.	Morgan Kaufmann, "Storage Systems", 2nd edition, October 2021.
3.	McGraw Hill, "Storage Networks: The Complete Reference" 2nd edition, Dec 2020.

Reference Books:

1.	IBM, “Introduction to Storage Area Networks and System Networking”, 5th edition, November 2017.
2.	Robert Spalding, “Storage Networks: The Complete Reference”, Tata McGraw Hill, Osborne, 6th reprint 2019.

Web References:

1.	https://aws.amazon.com/training/learn-about/storage/
2.	https://www.ibm.com/storage/virtualization

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C902.1	Understand	Quiz	20
C902.2	Understand	Tutorial	20
C902.3	Analyze	Group Assignment	20
C902.4	Apply		
C902.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C902.1	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C902.2	3	3	3	3	2	2	2	3			2	3	3	3	2
C902.3	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C902.4	3	3	3	3	2	2	2	3			2	3	2	2	3
C902.5	3	3	2	2	3	3	3	3			2	2	3	3	2

22CS901	SOFTWARE DEFINED NETWORKS	3/0/0/3
Nature of Course	D (Theory Application)	
Pre requisites	Computer Networks	

Course Objectives:

1.	To outline the fundamentals of software defined networks.
2.	To identify the separation of the data center and controller of SDN.
3.	To examine the SDN Programming.
4.	To demonstrate the various applications using SDN Framework.
5.	To gain knowledge about the languages and tools used for SDN.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C901.1	Analyze the evolution of software defined networks.	[AP]
C901.2	Illustrate the various components of SDN data center networks.	[U]
C901.3	Design and develop various applications using SDN programming.	[AP]
C901.4	Construct the knowledge about various controllers of SDN.	[AP]
C901.5	Analyze real time networks using Virtual Programming Tools and SDN Frameworks.	[A]

Course Contents:

MODULE I Introduction **15 Hours**

History of Software Defined Networking (SDN) - Modern Data Center - Traditional Switch Architecture- Why SDN - Evolution of SDN - How SDN Works - Centralized and Distributed Control and Date Planes- Open Flow Specification - Drawbacks of Open SDN - SDN via APIs - SDN via Hypervisor- Based Overlays - SDN via Opening up the Device - SDN Controllers - General Concepts.

MODULE II Data Center and Programming **15 Hours**

Multitenant and Virtualized Multitenant Data Center - SDN Solutions for the Data Center Network - VLANs - EVPN - VxLAN - NVGRE - **Programming SDNs:** Northbound Application Programming Interface - Current Languages and Tools - Composition of SDNs.

MODULE III Applications **15 Hours**

Implementation and Applications-Juniper SDN Framework - IETF SDN Framework - Open Daylight Controller - Floodlight Controller - Bandwidth Calendaring - Data Center Orchestration. **Case Study:** Performance of an OpenFlow Controller using Mininet.

Total Hours: 45 Hours

Text Books:

1.	Paul Goransson and Chuck Black, Software Defined Networks: A Comprehensive Approach, 2nd Edition, Morgan Kaufmann, 2016.
2.	William Stallings, Foundations of Modern Networking‖, Pearson Ltd., 2016.
3.	Thomas D. Nadeau, Ken Gray, SDN: Software Defined Networks, O'Reilly Media, 2013.

Reference Books:

1.	SiamakAzodolmolky, Software Defined Networking with Open Flow, Packet Publishing, 2013.
2.	VivekTiwari, “SDN and OpenFlow for Beginners”, Amazon Digital Services, Inc., ASIN: 2013.
3.	Fei Hu, Editor, Network Innovation through Open Flow and SDN: Principles and Design, CRC Press, 2014.

Web References:

1.	https://cse.iitkgp.ac.in/~smisra/theme_pages/sdn/index.html
2.	http://www.openflow.org, 2015.
3.	https://www.cs.fsu.edu/~xyuan/cis5930/

Online Resources:

1.	https://www.coursera.org/learn/sdn
2.	https://www.edx.org/course/introduction-to-software-defined-networking

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C901.1	Apply	Quiz	20
C901.2			
C901.3	Apply	Assignment	20
C901.4	Create	Case Study	40
C901.5			

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component – II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C901.1	3	3	3	2	1							1	3	2	1
C901.2	3	3	3	2	1							1	3	2	1
C901.3	3	3	3	2	1							1	3	2	1
C901.4	3	3	3	2	1							1	3	2	1
C901.5	3	3	3	2	1							1	3	2	1
C901	**3**	**3**	**3**	**2**	**1**							**1**	**3**	**2**	**1**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CB901	STREAM PROCESSING	3/0/0/3
Nature of Course	D (Theory Application)	
Pre requisites	NIL	

Course Objectives:

1.	To introduce data processing terminology, definition & concepts
2.	To define different types of Data Processing
3.	To apply the concepts of Real-time Data processing
4.	To select appropriate structures for designing and running real-time data services in a business environment
5.	To illustrate the benefits and drive the adoption of real-time data services to solve real world problems

Course Outcomes

Upon completion of the course, students shall have ability to

C901.1	Introduce fundamental data processing terminology and concepts.	[U]
C901.2	Define and differentiate between types of data processing.	[U]
C901.3	Apply the principles and significance of real-time data processing.	[AP]
C901.4	Teach how to design and implement real-time data services in business.	[AP]
C901.5	Illustrate the benefits of real-time data services for solving business problems.	[A]

Course Contents:

Module 1 **(15 Hours)**

Introduction to Data Processing, Stages of Data processing, Data Analytics, Batch Processing, Stream processing, Data Migration, Transactional Data processing, Data Mining, Data Management Strategy, Storage, Processing, Integration, Analytics, Benefits of Data as a Service, Challenges. Introduction to Big data, Big data infrastructure, Real-time Analytics, Near real-time solution, Lambda architecture, Kappa Architecture, Stream Processing,Understanding Data Streams, Message Broker, Stream Processor, Batch & Real-time ETL tools, Streaming Data Storage.

Module 2 **(15 Hours)**

Relational Model, Document Model, Key-Value Pairs, NoSQL, Object-Relational Mismatch, Many to-One and Many-to-Many Relationships, Network data models, Schema Flexibility, Structured Query Language, Data Locality for Queries, Declarative Queries, Graph Data models, Cypher Query Language, Graph Queries in SQL, The Semantic Web, CODASYL, SPARQL. Apache Kafka, Kafka as Event Streaming platform, Events, Producers, Consumers, Topics, Partitions, Brokers, Kafka APIs, Admin API, Producer API, Consumer API, Kafka Streams API, Kafka Connect API.

Module 3 **(15 Hours)**

Structured Streaming, Basic Concepts, Handling Event-time and Late Data, Fault-tolerant Semantics, Exactly-once Semantics, Creating Streaming Datasets, Schema Inference, Partitioning of Streaming datasets, Operations on Streaming Data, Selection, Aggregation, Projection, Watermarking, Window operations, Types of Time windows, Join Operations, Deduplication

Total Hours	**45**

Text Books:	
1.	Streaming Systems: The What, Where, When and How of Large-Scale Data Processing by Tyler Akidau, Slava Chemyak, Reuven Lax, O'Reilly publication
2.	Designing Data-Intensive Applications by Martin Kleppmann, O'Reilly Media
3.	Practical Real-time Data Processing and Analytics : Distributed Computing and Event Processing using Apache Spark, Flink, Storm and Kafka, Packt Publishing
Reference Books:	
1.	"Stream Processing with Apache Flink" by Fabian Hueske & Vasiliki Kalavri
2.	"Fundamentals of Stream Processing" by Henrique C. M. Andrade, Buğra Gedik, and Deepak S. Turaga
Web References:	
1.	https://spark.apache.org/docs/latest/streaming-programming-guide.html
2.	Kafka.apache.org
Online Resources:	
1.	https://nightlies.apache.org/flink/flink-docs-release-1.16/
2.	https://www.cambridge.org/core/books/fundamentals/stream-processing

Continuous Assessment				End Semester Examination	Total
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C901.1	Understand	Online Quiz	20
C901.2	Understand	Presentation	20
C901.4 & C901.3	Apply	Assignment	20
C901.5	Analyze	Case Study	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	20	20	20
Apply	30	30	30
Analyse	30	30	30
Evaluate	-	-	-

Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	2	3	1	-	1	-	-	-	-	-	-	-	1	2	2
C901.2	1	2	2	-	2	2	-	-	-	-	-	-	2	1	1
C901.3	3	3	3	3	3	1	-	-	-	-	-	-	3	3	1
C901.4	1	1	2	-	1		-	-	-	-	-	-	1	1	1
C901.5	2	1	2	2	1	3	-	-	-	-	-	-	2	1	2

22CD903	MULTIMEDIA AND ANIMATION	3/0/0/3
Nature of Course:	D (Theory Application)	
Prerequisites:	-	

Course Objectives:

1.	To grasp the fundamental knowledge of Multimedia elements and systems
2.	To get familiar with Multimedia file formats and standards
3.	To learn the process of Authoring multimedia presentations
4.	To learn the techniques of animation in 2D and 3D
5.	To explore different popular applications of multimedia

Course Outcomes:
Upon completion of the course, students shall have ability to:

C903.1	Understand the context of Multimedia and its standards	[U]
C903.2	Examine the different types of media elements of different formats on content pages	[AP]
C903.3	Illustrate 2D and 3D creative and interactive presentations for different target multimedia applications.	[AP]
C903.4	Analyze the complexity of multimedia applications in the context of cloud, security and social networking	[AN]
C903.5	Apply different standard animation techniques for real time applications	[AP]

Course Contents:

Module I MULTIMEDIA FILE FORMATS AND STANDARDS **15 Hours**

Definitions – Elements - Multimedia Hardware and Software - Distributed multimedia systems – Challenges - Multimedia metadata - Multimedia databases – Hypermedia - Multimedia Learning - File formats – Text and Image file formats - Graphic and animation file formats - Digital audio and Video file formats - Color in image and video - Color Models - Multimedia data and file formats for the web.

Module II MULTIMEDIA AUTHORING AND APPLICATIONS **15 Hours**

Authoring metaphors - Card and Page Based Tools - Icon and Object Based Tools - Time Based Tools - Cross Platform Authoring Tools - 3D Modeling and Animation Tools – Image, Audio Editing, Movie Tools - Creating interactive presentations - Multimedia Big data computing, social networks, surveillance - Multimedia Cloud Computing - Multimedia ontology.

Module III ANIMATION **15 Hours**

Principles of animation - staging, squash and stretch - Timing, onion skinning, secondary action - 2D, 2 ½ D and 3D animation - Animation techniques: Keyframe, Morphing, Inverse Kinematics, Hand Drawn, Character rigging, Vector animation, Stop motion, Motion graphics - Fluid Simulation - Skeletal animation - Skinning Virtual Reality and Augmented Reality.

Total Hours: 45

Text Books:	
1.	Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, “Fundamentals of Multimedia”, 3rd Edition, Springer, 2021.
2.	John M Blain, “The Complete Guide to Blender Graphics: Computer Modeling & Animation”, CRC press, 3rd Edition, 2016.
3.	Gerald Friedland, Ramesh Jain, “Multimedia Computing”, Cambridge University Press, 2018.
Reference Books:	
1.	Prabhat K.Andleigh, Kiran Thakrar, “Multimedia System Design”, Pearson Education, 1st Edition, 2015
2.	Mark Gaimbruno, “3D Graphics and Animation”, 2nd Edition, New Riders, 2002.
3.	Mohsen Amini Salehi, Xiangbo Li, “Multimedia Cloud Computing Systems”, Springer Nature, 1st Edition, 2021.
4.	Rick parent, “Computer Animation: Algorithms and Techniques”, Morgan Kauffman, 3rd Edition, 2012.
Web References:	
1.	https://www.ucl.ac.uk/slade/know/3396
2.	https://developer.android.com/training/animation/overview
3.	https://opensource.com/article/18/2/open-source-audio-visual-production-tools
4.	https://camstudio.org//
Online Resources:	
1.	https://www.coursera.org/learn/digitalmedia
2.	https://nptel.ac.in/courses/117105083
3.	https://onlinecourses.swayam2.ac.in/ntr20_ed15/preview

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C903.1, C903.2	Understand	Quiz	20
C903.3	Apply	Assignment	20
C903.4	Analyze	Case study	20
C903.5	Apply	Assignment	20

Assessment based on Summative and End Semester Examination

Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	40	20	30
Apply	40	40	40
Analyse	-	20	10

Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component – II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C903.1	3	2	2	2								2	2	2	2
C903.2	3	2	2	2								2	2	2	2
C903.3	3	2	2	2	2	2	2	2				2	2	2	2
C903.4	3	2	2	2		2	2	2				2	2	2	2
C903.5	3	2	2	2	2	2	2	2				2	2	2	2

22IT911	INTELLIGENT MULTIAGENT AND EXPERT SYSTEMS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	To comprehend, the concept of agents, intelligent agent systems, design architectures, agent communication, interaction protocols, key types of possible multi-agent system interaction and agreement
2.	To comprehend, the concept of expert system, expert system architecture, production rules and -implementation tools
3.	To apply the principles and methods of intelligent multi-agents and expert systems
4.	To synthesize multi-agent expert systems to solve small or large scale real life problems

Course Outcomes

Upon completion of the course, students shall have ability to

C911.1	Understand the nation of an agent, intelligent agent systems characteristics and the structure of agent, how agents are distinct from other software paradigms and typical applications of agent based technology	[R]
C911.2	Design intelligent agents that can effectively cooperate in order to solve problems	[AP]
C911.3	Apply the concepts of agent communication, interaction protocols, multi-agent interactions and agreements	[AP]
C911.4	Build agents capable of intelligent autonomous actions using appropriate methodologies	[AN]
C911.5	Understand the concept of expert system, models, production rules, implementation tools and existing system models for developing an expert system	[U]

Course Content

Module I Introduction and Design of Intelligent Agent 15 Hours

Agents and Environment; Performance measure; Nature of Environment; Abstract and Concrete Architecture for intelligent agents; Problem solving and planning: Result sharing, Task sharing and Distributed planning Deductive reasoning agents: AgentO, Practical Reasoning Agents: HOMER architecture; Reactive agents: Subsumption architecture; Hybrid agents: Touring Machines, InteRRaP.

Module II Multi-Agent Communication, Interaction and Agreement Protocols 15 Hours

Agent Communications: Knowledge Query and manipulation Language (KQML), Knowledge Interchange Format (KIF), Ontology, Coordination protocols, Cooperation Protocols, Contract Net, Blackboard Systems, Negotiation, Multi-agent Belief Maintenance, Market Mechanisms. Classifying multi-agent interactions: Multi-agent Encounters Equilibria - Competitive and zero-sum and other interactions; Cooperation: the Prisoner's dilemma and Axelrod's experiments; Reaching Agreements: Interactions between self-interested agents- auctions & voting systems negotiation - Argumentation; Interactions between benevolent agents: Cooperative Distributed Problem Solving (CDPS), partial global planning; coherence and coordination

Module III Multi Agent Methodologies and Expert System Models 15 Hours

Agent Methodologies- Mobile agents; Typical application areas of agent systems: Business Process Management, Distributed Sensing, Information Retrieval and Management, Electronic Commerce, Human-Computer Interfaces, Social Simulation etc. Expert Systems: Introduction, Architecture, Production rules and inference, Basic forms of inference:

abduction; deduction; induction. Rule-based representations (with backward and forward reasoning); logic-based representations (with resolution refutation)	
Total Hours	**45**

Text Books:	
1.	Michael Wooldridge, “An Introduction to Multi Agent Systems", Second Edition, Wiley, 2009.
2.	G. Weiss (ed.), "Multi-Agent Systems A Modern Approach to Distributed Artificial Intelligence", 2nd Edition, MIT Press, 2013.
3.	Dan W. Patterson, "Introduction to AI & Expert System", PHI, 2007
Reference Books:	
1.	Stuart Russell and Peter Norvig, “Artificial Intelligence - A Modern Approach", 3rd edition, Prentice Hall, 2011.
2.	D. Poole and A. Mackworth, "Artificial Intelligence: Foundations of Computational Agents", Cambridge University Press, 2010
3.	Yoav Shoham and Kevin Leyton-Brown, "Multiagent Systems: ", Cambridge University Press, 2009.
Web References:	
1.	https://www.sciencedirect.com/journal/expert-systems-with-applications
2.	https://artint.info/3e/html/ArtInt3e.bib.html
3.	https://onlinelibrary.wiley.com/journal/14680394
Online Resources:	
1.	https://en.wikipedia.org/wiki/Multi-agent_system
2.	https://dl.acm.org/doi/10.5555/1695886
3.	https://www.umsl.edu/~joshik/msis480/chapt11.htm

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C911.2	Apply	Assignment	20
C911.5	Understand	Quiz	20
C911.1 C911.3	Apply	Case Study	20
C911.4	Analyse	Certification	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	10	-	10
Understand	20	20	20
Apply	60	50	40
Analyse	10	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C911.1	2	2	2	2	1	2	2	-	-	-	-	1	2	2	2
C911.2	3	3	2	3	1	1	3	-	-	-	-	1	2	2	2
C911.3	3	3	2	2	1	1	2	-	-	-	-	1	2	2	2
C911.4	3	3	2	3	1	2	2	-	-	-	-	1	2	3	2
C911.5	3	2	2	2	1	2	3	-	-	-	-	1	3	2	2

22AD901	APP DEVELOPMENT	0/0/6/3
Nature of Course	M (Practical Application)	
Pre-Requisite	Cloud Computing	

Course Objectives:

1	To discuss the essence of front-end development skills.
2	To impart the knowledge of React components used in Spring boot development platforms.
3	Ability to understand and use Setup Cloud API.
4	To deploy and test the React App used in Spring Boot.
5	To learn the Spring Cloud concepts using Docker.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C901.1	Identify the basic concepts and design issues of React.	[R]
C901.2	Understand the principles of process and Spring boot.	[U]
C901.3	Illustrate the approaches in scheduling and Spring Cloud to apply in real world problems.	[AP]
C901.4	Apply concepts of Micro services Communication to the issues that occur in Real time applications.	[AP]
C901.5	Identify issues related to Docker, API Gateway.	[AP]
C901.6	Examine common React, Availability and Scalability.	[A]

Course Contents:

REACT INTRODUCTION - Components, Routes, State, Props, hooks, Higher Order Functions, Axios and Services, Ant Design. **Redux:** Core Concept, Data Flow, Store, Actions, Pure function, Reducers, Devtools, Middleware, Webpack, Redux Integration. **Spring boot: Annotations**, Beans, Configuration, HTTP Methods, Crud, Postman Overview. Spring Security: Authentication, Authorization, Security Implementation. Configure Security, Authentication Manager, HTTP Security, Circular Reference Error. JWT Implementation: JWT Overview, JWT Libraries, Helper Methods, Token Generation and Validation, Implementing JWT Authorization, Filter. **OAUTH Implementation**: Introduction, Sample flow, Authorization code grant type flow, Implicit grant flow, Password Grant Type flow, Client, Credential Grand type flow, Refresh token Grand type flow, Validating token,Oauth2 integration with Spring Security. **Building Micro services :** Monolith Architecture and Challenges of Monolith Architecture, What is Micro services & How It Solves the Challenges of Monolith Architecture, Micro services Architecture Benefits and Best Practices, Understanding Spring Cloud and It's Important Modules, Micro service Applications and It's Port Mapping

MICROSERVISES COMMUNICATION OVERVIEW - Micro services Communication using Rest Template, Micro services Communication using Web Client, Micro services Communication using Spring Cloud Open Feign - Understanding service Registry – Spring Cloud Netflix Eureka Server Implementation, Update on Using Spring Boot 3 Version, Register Micro service as Eureka Client, Update on using Spring Boot 3 Version, Register Micro service as Eureka Client, Running Multiple Instances of Micro service, Load Balancing with Eureka, Open Feign and Spring Cloud Load Balancer API gateway using Spring Cloud gateway: Understanding API Gateway - Create and Set up API Gateway Micro service, Update on Using Spring Boot 3 Version, Register API-Gateway as Eureka Client to Eureka Server, Configuring API Gateway Routes and Test using Postman Client, Using Spring Cloud Gateway to Automatically Create Rout.

CENTRALIZED CONFIGURATIONS USING SPRING CLOUD CONFIG SERVER - How to Use Spring Cloud Config Server, Create and Setup Spring Cloud Config Server Project in IntelliJ IDEA, Update on Using Spring Boot 3 Version, Register Config-Server as Eureka Client, Set up Git Location for Config Server,

Refactor Department-Service to use Config Server, Refactor Employee-Service to use Config Server, Refresh Use case - No Restart Required After Config Changes,REACT Frontend Micro service: Create React App using Create React App Tool, Adding Bootstrap in React Using NPM, Write HTTP Client Code to Connect React App with API-Gateway (REST API Call), Create a React Component and Integrate with API Gateway Microservice, RabbitMQ Core Concepts: RabbitMQ Architecture, Install and Setup RabbitMQ using Docker, Explore RabbitMQ using RabbitMQ Management UI, Create and Setup Spring Boot 3 Project in IntelliJ, Connection Between Spring Boot and RabbitMQ, Configure RabbitMQ in Spring Boot Application, Create RabbitMQ Producer, Create REST API to Send Message, Create RabbitMQ Consumer, Configure RabbitMQ for JSON Message Communication, Create RabbitMQ Producer to Produce JSON Message, Create REST API to Send JSON Object, Create RabbitMQ Consumer to Consume JSON Message, Dockering Spriing boot App : Install Docker Desktop, General Docker Workflow, Create Spring Boot Project and Build Simple REST API, Create Docker file to Build Docker Image, Build Docker Image from Dockerfile, Run Docker Image in a Docker Container, Push Docker Image to Docker Hub, Pulll Docker Image from DockerHub

Course Guidelines:

1. Students choose a project topic from a list of approved options or propose their own idea from the area specified in the content and Faculty Coordinator/guide approval required for student-proposed projects
2. Number of students in the project team should be maximum of 4 and Every student shall have a project guide.
3. The entire semester shall be utilized by the students to do their project work by receiving the directions from the project guide.
4. Teams should submit a project proposal, including objectives, scope, timeline, and resources and Faculty Coordinator/guide reviews and approves the proposal.
5. Students should choose projects in line with the Departmental Mission, Vision, and Program Outcomes.
6. Teams should work on their projects, following the approved plan and Regular meetings with faculty advisors for progress updates and guidance.
7. Students should attend periodic reviews to present the progress of the project to faculty and peers' team and Evaluation is based on project outcomes, presentation quality, and teamwork.
8. Teams submit a final project report, including results, conclusions, and recommendations as specified in the guidelines issued by the COE.
9. Students should not be involved in unethical behavior, such as plagiarism, copyright violations, etc while working on projects and when submitting project reports.
10. Every student team will be required to prepare and submit two (2) copies plus (no. of students) copies of the Project report of typical length 30 – 60 pages (excluding Appendices).
11. A final external project viva-voce examination will be conducted to evaluate the student's Individual and team performance based on project outcomes, presentations, reports, and teamwork by an Internal and External Examiners.

Total Hours:	**60**

Text Books:

1	Merih Taze,"Engineers Survival Guide: Advice, tactics, and tricks After a decade of working at Facebook, Snapchat", Microsoft Paperback, 2021.
2	Gerardus Blokdyk, "Secure Microservices A Complete Guide", Edition Paperback, 2021.
3	Theo H King, "Aws: The Ultimate Guide from Beginners to Advanced For the Amazon Web Services", (2020 Edition), Paperback – Import, 2019.

Reference Books:

1	Craig zacker, "Exam ref pl-900 Microsoft power platform", paperback, 2021

Web References:

1	https://awscloud.in/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
75	25	100	60	40	100

Assessment based on Continuous and End Semester Examination			
Bloom's Level	Continuous Assessment (60%) [100 Marks]		End Semester Practical Examination (40%) [100 Marks]
	FA (75 Marks)	SA (25 Marks)	
Remember	-	-	-
Understand	20	20	20
Apply	40	40	40
Analyse	40	40	40
Evaluate	-	-	-
Create	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C901.1	3	3	3	2	3	2						2	2	2	2
C901.2	3	3	3	2	3	2						2	2	2	2
C901.3	3	3	3	3	3	2						2	2	2	2
C901.4	3	3	3	2	3	2						2	2	3	3
C901.5	3	3	3	3	3	3						3	3	2	2
C901.6	3	3	3	2	3	2						2	2	3	3

22CY911	ETL TOOLS	3/0/0/3
Nature of Course	H (Theory)	
Prerequisites	Nil	

Course Objectives:

1.	To Understand the Role of Data Integration in Modern Applications
2.	To apply techniques for data cleansing, transformation, and loading into appropriate destinations like data lakes and data warehouses
3.	To gain hands-on experience with both commercial and open-source ETL tools
4.	To design, automate, and monitor ETL workflows
5.	To understand the principles of data governance and best practices for ensuring data quality

Course Outcomes

Upon completion of the course, students shall have ability to

C911.1	Understand the role of data integration in modern applications and explain key concepts such as data warehousing, big data, and the ETL process	[U]
C911.2	Demonstrate the ability to clean and transform data using techniques, and ensuring consistency in data extraction from various sources and mapping data to appropriate schemas.	[AP]
C911.3	Analyze different data destinations and analyze the effectiveness of incremental loads vs. full loads in various ETL scenarios	[A]
C911.4	Apply ETL tools such as Talend, Apache NiFi, and commercial platforms to implement efficient workflows	[AP]
C911.5	Apply data quality and governance practices to ensure data accuracy, consistency, and compliance with regulations, while implementing improvements in large-scale ETL pipelines	[AP]

Course Contents:

Module 1: Foundations of Data Integration **15 Hours**

Importance of data integration in modern applications - Overview of Data Warehousing and Big Data - Introduction to ETL concepts (Extract, Transform, Load) - Data sources: Structured (SQL, Excel), Semi-structured (XML, JSON), Unstructured (logs, multimedia) - Techniques for data extraction from various sources (APIs, databases, flat files) - Connecting to databases and file systems

Module 2: ETL Concepts and its techniques **15 Hours**

Data cleansing: Handling missing data, data inconsistencies, and formatting issues - Data transformation techniques: Aggregation, sorting, merging, and splitting - Introduction to data mapping and schema design - Types of data destinations: Data lakes, Data warehouses, and Databases - Techniques for loading data into storage solutions - Incremental loads vs full loads - Introduction to commercial tools (e.g., Informatica, Talend, Microsoft SSIS) - Introduction to open-source tools (e.g., Apache NiFi, Pentaho, Apache Airflow)

Module 3: Advanced ETL Practices **15 Hours**

Overview of ETL tool architecture - Using Talend for ETL: Basic components, data integration workflows - Apache NiFi: Flow-based programming for ETL pipelines - Ensuring data quality in ETL processes - Data governance principles and best practices - Handling large-scale datasets in ETL - Automating ETL workflows - Scheduling ETL jobs using ETL tools and cron jobs - Monitoring and error handling in ETL processes

Total Hours	**45**

Text Books:

1.	"ETL with Azure Cookbook: Practical Recipes for Building Scalable ETL Solutions Using Azure Data Factory, Azure Synapse, and Databricks" by Dmitry Anoshin, Vikas Rai
2.	“Data Integration in the Life Sciences: Tools, Techniques, and Applications” by Philipp Cimiano, Barry Smith

Reference Books:

1.	"Mastering Apache NiFi: Effective Big Data Ingestion, Routing, and Processing" by Kamalmeet Singh
2	ETL Architecture: A Practical Guide for Informatica Developers by Ralph Kimball

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Web References:	
1	https://www.datacamp.com/blog/a-list-of-the-16-best-etl-tools-and-why-to-choose-them
2	https://solutionsreview.com/data-integration/the-best-etl-tools-extract-transform-load/
Online Resources:	
1.	https://www.ibm.com/topics/etl
2	https://www.geeksforgeeks.org/etl-process-in-data-warehouse/

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	Bloom's Level	Assessment Component	FA (16%) [80 Marks]
C911.1	Understand	Quiz	20
C911.2	Apply	Quiz	20
C911.3	Analyze	Tutorial	20
C911.4, C911.5	Apply	Seminar	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1: [60 Marks]	CIA2: [60 Marks]	
Remember	-	-	-
Understand	80	-	40
Apply	-	20	10
Analyze	20	80	50
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component – I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C911.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C911.2	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
C911.3	3	2	3	-	3	-	-	-	-	-	-	2	-	2	2
C911.4	3	3	2	2	3	-	-	-	-	-	-	2	-	2	-
C911.5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

22CS911	STATISTICAL PATTERN RECOGNITION	3/0/0/3
Nature of Course	H (Theory Technology)	
Prerequisites	-	

Course Objectives:

1	Introduce the fundamental concepts and techniques of statistical pattern recognition.
2	Learn and apply statistical decision theory for classification and clustering.
3	Explore and implement feature extraction and dimensionality reduction techniques.
4	Analyze and evaluate models for supervised and unsupervised learning.
5	Design and apply statistical models to real-world problems in pattern recognition.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C911.1	Understand the foundational concepts of statistical pattern recognition.	[U]
C911.2	Apply statistical decision-making methods for classification.	[AP]
C911.3	Analyze clustering algorithms and feature extraction techniques	[AN]
C911.4	Evaluate performance measures of classification and clustering techniques.	[EV]
C911.5	Design and implement statistical models for real-world applications.	[AP]

Course Contents:

MODULE I INTRODUCTION TO STATISTICAL PATTERN RECOGNITION 15 Hours

Introduction to pattern recognition and its applications - Statistical decision theory: Bayesian decision-making, risk minimization, and error rate - Parametric and non-parametric classification methods - Maximum likelihood estimation (MLE) - Maximum a posteriori estimation (MAP) - Discriminant functions, decision surfaces.

MODULE II FEATURE EXTRACTION, DIMENSIONALITY REDUCTION, AND CLASSIFICATION 15 Hours

Feature extraction and selection techniques - Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) - Fisher's linear discriminant - Data preprocessing techniques - Support Vector Machines (SVM) and Kernel methods - Neural networks for classification.

MODULE III CLUSTERING AND UNSUPERVISED LEARNING 15 Hours

Clustering techniques: K-means, hierarchical clustering, and density-based clustering - Expectation-Maximization (EM) algorithm, Gaussian Mixture Models (GMM) - Hidden Markov Models (HMM) for sequential data - Advanced models: deep learning and reinforcement learning for pattern recognition - Applications: image processing, speech recognition, bioinformatics.

Total Hours:	**45**

Text Books:

1	Richard O. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", 2nd Edition, Wiley Publication, 2007.
2	Christopher M. Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer Publication, 2009.

Reference Books:

1	Trevor Hastie, Robert Tibshirani, and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", 2nd Edition, Springer Publication, 2017.
2	Sergios Theodoridis and Konstantinos Koutroumbas, "Pattern Recognition", 4th Edition, Academic Press, 2008.
3	Andrew R. Webb and Keith D. Copsey, "Statistical Pattern Recognition" , 3rd Edition, Wiley Publishers, USA, 2011.

Web References:

1	http://cs229.stanford.edu/

2	https://www.coursera.org/learn/machine-learning
Online Resources:	
1	https://ocw.mit.edu/courses/6-867-machine-learning-fall-2006/
2	https://www.youtube.com/watch?v=3j9jkD32dew

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C911.1	Understand	Quiz	20
C911.2	Apply	Case study	20
C911.3	Analysis	Assignment	20
C911.4& C911.5	Apply	Case Study	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	10	10	10
Understand	30	30	30
Apply	60	40	40
Analyse	-	20	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C911.1	3	3	1									2	2	2	1
C911.2	3	3	2		2							1	2	2	2
C911.3	3	3	2	3	2							1	3	3	2
C911.4	3	3	2	3	2							1	3	3	2
C911.5	3	3	3	2	3				2	2	2	2	3	3	3
C911	**3**	**3**	**3**	**2**	**3**				**2**	**2**	**2**	**2**	**3**	**3**	**3**

22CD911	STOCHASTIC AND NETWORK CONTROL	3/0/0/3
Nature of Course:	G (Theory Analytical)	
Pre requisites:	-	

Course Objectives:

1.	Understanding Stochastic Processes in Control System
2.	Modeling and Analysis of Uncertainty.
3.	Control of Large-Scale and Multi-Agent Systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C911.1	Discuss of Networked Control Systems	[U]
C911.2	Formulate Analysis of Large-Scale Networks	[U]
C911.3	Apply of Control in Communication Networks	[AP]
C911.4	Show a Security and Control in Networked Systems	[AP]
C911.5	Schedule and Problem-Solving in Stochastic Control	[AN]

Course Contents:

MODULE I Introduction to Stochastic Control **15 Hours**

Overview of Control Systems-Deterministic vs. Stochastic control systems. Applications of stochastic control in various domains (communications, robotics, finance)-Mathematical Preliminaries-Review of probability theory and random processes-Stochastic processes: Markov processes, Brownian motion, and Wiener processes-Principles of Optimal Control-Deterministic optimal control-Pontryagin's Maximum Principle-Hamilton-Jacobi-Bellman (HJB) equations

MODULE II Stochastic Processes and Models **15 Hours**

Introduction to Stochastic Models-Markov decision processes (MDP)-Poisson processes and applications-Discrete and continuous-time stochastic models-Martingales and Stochastic Calculus-Martingale property and its significance-Stochastic differential equations (SDEs)-Ito's Lemma and stochastic integration-Deterministic optimal control Pontryagin's Maximum Principle**-**Hamilton-Jacobi-Bellman (HJB) equations.

MODULE III Control under Uncertainty and Communication Constraints **15 Hours**

Control with Uncertain Dynamics-Adaptive control in stochastic environments-Robust control techniques for uncertain systems-Communication Constraints in Network Control-Quantization, delays, and packet drops-Event-triggered and time-triggered control-Control over wireless networks-Distributed optimization in networked systems-Algorithmic strategies for distributed control.

Total Hours:	**45**

Text Books:

1.	Ross, Sheldon M, "Introduction to Probability Models", 12th Edition, 2020.
2.	Karlin, Samuel & Taylor, Howard M, "A First Course in Stochastic Processes", 2nd Edition, 1975.
3.	Meyn, Sean P & Tweedie, Richard L, Markov Chains and Stochastic Stability, 2nd Edition, 2009.
4.	Klenke, Achim, Probability Theory: A Comprehensive Course, 2nd Edition, 2014.

Reference Books:

1.	Medhi.J, “Stochastic Processes”, 3rd Edition, 2009.
2.	Snyder, David L & Miller, John C, “Random Processes for Engineers”, 1st Edition, 2014.
3.	Liberzon, Daniel, “Calculus of Variations and Optimal Control Theory: A Concise Introduction” ,1st Edition, 2012.
4.	Doyle, John C, Francis, Bernard A & Tannenbaum, Allen R, “Feedback Control Theory,” 1st Edition, 1992.
Web References:	
1.	https://link.springer.com/search?query=stochastic+control+systems
2.	https://web.math.princeton.edu/~rvan/acm217/acm217.html
Online Resources:	
1.	https://www.youtube.com/results?search_query=stochastic+control+systems
2.	https://ocw.mit.edu/courses/6-231-dynamic-programming-and-stochastic-control-fall 2015/pages/lecture-notes/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C911.1 & C911.2	Understand	Quiz	20
C911.3	Apply	Assignment	20
C911.4	Apply	Case study	20
C911.5	Analyze	Assignment	20

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	40	40	40
Apply	40	40	40
Analyze	-	-	-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C911.1	3	1	1	1								1	2	1	1
C911.2	3	1	1	1								1	2	1	1
C911.3	3	1	1									1	2	1	1
C911.4	3	2	1									1	2	1	1
C911.5	3	1	1	1								1	2	1	1

22AD911	BAYESIAN DATA ANALYSIS	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre-requisite	Nil

Course Objectives:

1	To learn basic concepts of Bayesian analysis.
2	To introduce the Bayesian concepts and methods with emphasis on data analysis.
3	To assess the outcome of prior distributions as well as posterior means.
4	To identify the optimal model and to learn how to apply the same in suitable applications.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C911.1	Understand the basics of probability and relate it to the Bayesian inference.	[U]
C911.2	Apply the inference rules customized for single parameter models.	[AP]
C911.3	Examine the simulation environment for generation of inferences by utilizing various algorithms.	[A]
C911.4	Analyze the inference mechanism for multi-parameter and hierarchical models.	[A]
C911.5	Identify multiple modeling algorithms for predictive analysis and evaluate the outcome metrics	[AP]
C911.6	Apply the inference mechanism effectively in different nonlinear models.	[AP]

Course Contents:

SINGLE PARAMETER MODELS: 15 Hours

Introduction to Probability, Priors and Posterior Analysis, Statistical Models, The Bayes inference. Bayes Rule, Normal model, Conjugate model, Binomial model, Posterior Distribution and Inferences. Markov Chain Monte Carlo simulation, RJags, The Metropolis-Hasting algorithm, Gibbs Sampler, Approximation based on posterior modes.

MULTI-PARAMETER AND HIERARCHICAL MODELS: 15 Hours

Multi-parameter -Normal data with non-informative, conjugate, and semi-conjugate prior distributions, Multivariate normal model, Hierarchical - Exchangeability and setting up, Computation. Bayesian Data Analysis: Model checking, Evaluating, comparing, and expanding models, modeling accounting for data collection, Decision analysis.

NON-LINEAR MODELS: 15 Hours

Mixture models- Setting up and interpreting mixture models, Gaussian process models Multivariate models- Non - normal models and multivariate regression surfaces. Comparison of Population: Inference for Proportions, Inference for Normal Populations, Rates and Sample Size Determination.

Total Hours:	**45**

Text Books:

1	Ronald Christensen, Wesley Johnson, Adam Branscum, Timothy E Hanson, “Bayesian Ideas and Data Analysis: An Introduction for Scientists and Statisticians”, CRC Press, 2019.
2	Andrew Gelman, John B, Carlin, Chapman, “Bayesian Data Analysis”, Hall/CRC Publication, 2013.

Reference Books:

1	Gelman, A., Carlin, J. B., Stern, H. S., Rubin, D. B, “Bayesian Data Analysis”, Third Edition, Chapman & Hall/CRC, 2018.
2	Gill, Jeff, “Bayesian Methods: A Social and Behavioral Science Approach”, CRC. 3rd Edition, 2013.

3	Peter D. Hoff, “A First Course in Bayesian Statistical Methods”, Springer, 2009.
Web References:	
1	https://www.coursera.org/learn/bayesian-statistics
2	https://onlinecourses.swayam2.ac.in/imb21_mg03/preview

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C911.1	Understand	Quiz	20
C911.2	Apply	Tutorial	20
C911.3	Apply	Assignment	20
C911.4	Understand		
C911.5	Apply	Presentation	20
C911.6	Apply		

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C911.1	3	3	3	2	3	2						2	2	2	2
C911.2	3	3	3	2	3	2						2	2	2	2
C911.3	3	3	3	3	3	2						2	2	2	2
C911.4	3	3	3	2	3	2						2	2	3	3
C911.5	3	3	3	3	3	3						3	3	2	2
C911.6	3	3	3	3	3	3						3	3	2	2

22AD917	VIRTUAL REALITY AND AUGMENTED REALITY	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisites	Nil

Course Objectives:

1	To understand the basic concepts of Virtual Reality.
2	To know input and output devices of virtual Reality.
3	To understand the interaction techniques of VR.
4	To outline the design and evaluation methods in VR.
5	To discuss applications of VR in various industries.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C917.1	Understand the requirements of virtual and augmented reality.	[U]
C917.2	Know the usage of hardware and software in VR.	[R]
C917.3	Discover the various manipulation and interactive techniques.	[AP]
C917.4	Resize the working of augmented and virtual reality.	[AP]
C917.5	Implement Virtual/Augmented Reality Applications.	[A]

Course Contents: (Ref - Goldsmith University of London)

MODULE I Introduction to Virtual Reality **15 Hours**

History of VR – Key Elements of VR - VR Paradigms - Input: User Monitoring – World Monitoring - Output devices: Visual Displays – Visual Representation in VR (Aural and Haptic) – Navigation. **Case Study: Virtual Reality in Architecture and Design.**

MODULE II Visual Rendering, Perception and Interactive Technique **15 Hours**

Visual Rendering - Depth perception - Motion perception - Stroboscopic Apparent Motion - Color perception – 3D Manipulation task and technique - Interactive Techniques in Virtual Reality: Body Track - Hand Gesture - 3D Manus - Object Grasp - Features of augmented reality, Difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, Visualization techniques for augmented reality. **Case study: Augmented Reality for Remote Collaboration in Manufacturing.**

MODULE III – Design and 3D interfaces **15 Hours**

Experience Designs – The Process for Designing User Experience for Virtual Reality - Three I's of VR - Immersion, Interaction, Imagination - Emotional Experience – Social Experience - Evaluation of VR – 3D Unity Architecture – Graphics – VR interfaces and AR Kit support – Application of AR and VR.**Case study: Enhancing Museum Experiences through Augmented Reality and Virtual Reality.**

Total Hours:	**45**

Text Books:

1	Vilar, Elisângela, "Virtual and Augmented Reality for Architecture and Design", 1st edition, Taylor and Francis Ltd, June 2022.
2	Erin Pangilinan, Steve Lukas, Vasanth Mohan, "Creating Augmented and Virtual Realities: Theory and Practice for Next-Generation Spatial Computing", Paperback, March 2019.
3	Schmalstieg / Hollerer "Augmented Reality: Principles & Practice", Pearson Education India; First edition October 2016.

Reference Books:

1	Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
2	Alan B Craig, William R Sherman, Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann Publishers, 2009.
3	Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.

4	Oliver Bimber and Ramesh Raskar, “Spatial Augmented Reality: Merging Real and Virtual Worlds”, 2005.
Web References:	
1	http://lavalle.pl/vr/book.html
2	https://www.coursera.org/learn/introduction-virtual-reality
3	https://uxplanet.org/designing-user-experience-for-virtual-reality-vr-applications-fc8e4faadd96
4	https://virsabi.com/virtual-reality-experience-design/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C917.1	Understand	Quiz	20
C917.2	Remember	Tutorial	20
C917.3	Apply	Assignment	20
C917.4	Apply		
C917.5	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C917.1	2	1	3		3								3	3	3
C917.2	3	3	2	3	2								3	2	3
C917.3	3	3	2										3		3
C917.4	2	1	2										2		2
C917.5	2	1	2	3				1	1	1	1	1	3	3	3

22IT921	CYBER THREATS AND VULNERABILITIES	3/0/0/3
Nature of Course:	F (Theory Programming)	
Pre requisites:	Cryptography and Networks Security	

Course Objectives:

1	To express the concepts of cyber security and the importance of cyber intelligence.
2	To illustrate the common Cyber threats.
3	To practice the concepts of applying various tools in cyber security
4	To describe the process of the encryption and vulnerability tools
5	To identify the network exploration and web vulnerabilities.

Course Outcomes

Upon completion of the course, students shall have ability to

C921.1	Explain the fundamentals of Cyber security and understand the importance of Cyber Intelligence.	[U]
C921.2	Identify the malware, ransomware attacks and the key elements of the cyber threats.	[U]
C921.3	Categorize the tools of cyber security.	[AN]
C921.4	Illustrate role of encryption tools and web vulnerability scanning tools.	[AP]
C921.5	Articulate the Concept of network exploration and web vulnerabilities.	[AP]

Course Contents:

MODULE I Application of Cyber Security **15 Hours**

Introduction to Cyber security: Overview of Cyber security principles and concepts – Threat landscape and current trends – Importance of cyber threat intelligence. **Common Cyber Threats:** Malware: types, characteristics and propagation techniques – Social Engineering: Phishing – spear phishing and social media attacks - Ransomware attacks - Man in the middle attacks-Denial of Service (DoS) and Distributed denial of service attacks (DDoS) - Password attacks-drive by download attacks – Keylogging - Packet Sniffing-Bug Bounties-Breaking Caesar Cipher-SQL Injection - Password Strength – Advanced Persistent Threats (APTs) and Targeted Attacks.

MODULE II Applying Tools in Cyber Security **15 Hours**

Tools and Techniques to perform Packet Sniffing, SQL Injection, Password Strength Analysis, Discovery and risk detection in remote hosts by listening open ports – Network Security Vulnerabilities: Network Protocols and vulnerabilities – Wireless Network Vulnerabilities and attacks – Network Scanning and reconnaissance techniques - Network security monitoring tools - Encryption tools - Web vulnerability scanning tools.

MODULE III Network Exploration and Web Vulnerabilities **15 Hours**

HTTP methods enumeration, HTTP proxy check, Discovering directories in web servers, User account enumeration, Detecting XST vulnerabilities and Detecting XSS vulnerabilities-Brute forcing DNS records – **Web Application Security:** Common vulnerabilities in web applications - Session hijacking and Cross-Site Request Forgery (CSRF) attacks - Security best practices for web development - Web application firewalls and security testing tools – **Case Study:** SQL injection, Cross-Site Scripting in real time applications.

Total Hours: 45

Text Books:	
1.	Diogenes Y, Ozkaya E, “Cybersecurity–Attack and Defense Strategies: Counter modern threats and employ state-of-the-art tools and techniques to protect your organization against cybercriminals”, Packt Publishing Ltd, 2019.
2.	Vladlena Benson and John McAlaney, “Emerging Cyber Threats and Cognitive Vulnerabilities”, Academic Press, Elsevier, 2020
Reference Books:	
1.	Hacking: Computer Hacking, “Security Testing, Penetration Testing, and Basic Security” Gary Hall, Erin Watson 2012.
2.	Hadis Karimipour, Pirathayini Srikantha, Hany Farag, Jin Wei-Kocsis, “Security of Cyber-Physical Systems-Vulnerability and Impact”, Springer Nature, 2020.
3.	Fiedelholtz, “ The Cyber Security Network Guide”, Springer Nature, 2021
4.	Ciza Thomas, Paula Fraga – Lamas and Tiago M. Fernandez-Carames, “Computer Security Threats”, Intechopen, 2020.
5.	Information Resources Management Association USA, “Cyber Security and Threats: Concepts, Methodologies, Tools, and Applications”, IGI Global 2018.
Web References:	
1.	https://www.celerium.com/50-cybersecurity-resources
2.	https://www.geeksforgeeks.org/cyber-security-types-and-importance/
Online Resources:	
1.	https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2.	https://onlinecourses.swayam2.ac.in/cec22_lw07/preview
3.	https://onlinecourses.nptel.ac.in/noc22_cs23/preview
4.	https://onlinecourses.nptel.ac.in/noc23_cs44/preview
5.	https://www.udemy.com/topic/cyber-security/free/
6.	https://www.mygreatlearning.com/academy/learn-for-free/courses/introduction-to-cyber-security

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy) - Theory			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C921.1	Understand	Quiz	20
C921.2	Understand	Assignment	20
C921.3	Analyze	Presentation	20
C921.4 & C921.5	Apply	Case Study	20

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component – I (20 Marks)	Component - II (20 Marks)	

Assessment based on Summative and End Semester Examination			
Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	40	20	20
Understand	60	40	40
Apply	-	40	40
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C921.1	3	3	3									3	3		3
C921.2	3	3	3	2								3	3		3
C921.3	3	3	3	2	2				1	1		3	3	2	3
C921.4	3	3	3	2	2				1	1		3	3	2	3
C921.5	3	3	3	3	3				1	1	3	3	3	3	3
C921	**3**	**3**	**3**	**3**	**3**				**1**	**1**	**3**	**3**	**3**	**3**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22IT923	CYBER PHYSICAL SYSTEMS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	Outline the basic concepts, requirements, principles, and techniques in emerging cyber physical systems
2.	Make awareness about the components that define the physical and cyber aspects of real-world technologies
3.	To describe the processing units applicable for cyber physical system
4.	To give insights about implementation of a cyber-physical system from a computational perspective
5.	To provide knowledge on Security and Privacy in Cyber Physical System

Course Outcomes

Upon completion of the course, students shall have ability to

C923.1	Summarize the basic concepts and purpose of the different components of Cyber Physical Systems	[U]
C923.2	Interpret the new system and ability to interact with Cyber Physical System	[U]
C923.3	Illustrate the abstraction of various system architectures and understand the semantics of a CPS model	[U]
C923.4	Choose the appropriate cyber-physical systems protocols for Internet of Things	[AP]
C923.5	Apply the common methods used to secure cyber-physical systems	[AP]

Course Contents:

Module I Framework for Cyber-Physical Systems (CPS) : 15 Hours

Introduction to CPS- IoT Vs CPS- Concept map- CPS analysis by example- Application Domains-Significance of CPS- Hybrid System Vs. CPS- Multi dynamical system- Component of CPS- Physical- Cyber and Computational Components - Introduction to sensors and actuators – Deployment- assignment and coordination

Module II Physical, Cyber and Computational Components: 15 Hours

Network criteria designs- Importance of sensors- causality-sensor reliability-memory requirement- computational complexity redundant sensors-Operational criteria- Test bed- Networking technologies for CPS- sensing networks and data connectivity- M2M communication- characteristics of IP and Non-IP solutions, 6LoWPAN, RPL- CoAP and HTTP- CoAP- Mobile cloud computing- Definition and types

Module III Secure Deployment and Applications of CPS : 15 Hours

Embedded system design flow for CPS- processing units- Overview-ASIC-Processor-DSP, Multimedia processor- VIEW-microcontroller and MPSoC- Reconfigurable logics. Secure Task mapping and Partitioning - State estimation for attack detection - Automotive Vehicle ABS hacking - Power Distribution Case study: Attacks on Smart Grids – Virtual Instrumentation; Applications of CPS.

Total Hours	**45**

Text Books:	
1.	A. Platzer, “Logical Foundations of Cyber Physical Systems”, Springer, 2018.
2.	E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017
3	P.Ashok, G. Krishnamoorthy, and D. Tesar, “Guidelines for managing sensors in Cyber Physical Systems with multiple sensors,” J. Sensors, vol.2011, 2011.
4	Chong Li, Meikang Qiu, “Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies”, CRC press, 2019
Reference Books:	
1.	P.Marwedel, Embedded System Design: Embedded system foundations of Cyber Physical Systems, vol.16.2010
2.	Wolf, Marilyn, “High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing”, Elsevier, 2014
3.	Guido Dartmann, Houbing song, Anke Schmeink, “Big data analytics for Cyber Physical System”, Elsevier, 2019
Web References:	
1.	https://link.springer.com/referencework/10.1007/978-3-642-54477-4
2.	https://www.tandfonline.com/journals/tcyb20
3.	https://www.keaipublishing.com/en/journals/internet-of-things-and-cyber-physical-systems/
4.	https://www.splunk.com/en_us/blog/learn/cyber-physical-systems.html
Online Resources:	
1.	https://www.coursera.org/learn/cyber-physical-systems-1
2.	https://www.udacity.com/course/cyber-physical-systems-design-analysis--ud9876
3.	https://in.mathworks.com/discovery/cyber-physical-systems.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C923.1, C923.2	Understand	Assignment	20
C923.3	Understand	Quiz	20
C923.4	Apply	Certification	20
C923.5	Apply	Case Study	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	50	30	30
Apply	20	50	50
Analyse	-		-
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C923.1	3	1	3	2	3	-	-	-	-	-	-	2	2	2	1
C923.2	3	3	1	3	2	-	-	-	-	-	-	2	3	1	1
C923.3	2	3	3	2	1	-	-	-	-	-	-	1	2	2	2
C923.4	2	2	3	3	2	-	-	-	-	-	-	3	3	2	3
C923.5	3	3	2	2	3	-	-	-	-	-	-	2	2	1	3

22IT924	ETHICAL HACKING AND AUDITING FRAMEWORKS	3/0/0/3
Nature of Course	F (Theory Programming)	
Prerequisites	Nil	

Course Objectives:

1	To understand the basics of Network in security.
2	To understand Sniffing and Spoofing tools.
3	To develop the fundamental understanding of OS environment setup.
4	To apply the concepts of Auditing frameworks.
5	To learn different techniques of penetration testing.

Course Outcomes: Upon completion of the course, students shall have ability to:

C924.1	Understanding the basics of networking with the introduction on the system attacks	[U]
C924.2	Explain the foundations of attacks in terms of industry, society and information systems	[U]
C924.3	Apply appropriate methods, securities and vulnerabilities.	[AP]
C924.4	Explore the methods of services of a remote host.	[A]
C924.5	Design and implement innovative features in NSE scripts.	[AP]
C924.6	Design and implement an insecure login mechanisms system.	[AP]

Course Contents:

Module I: Introduction to Network presence **15 Hours**

Network in security - Sniffing and spoofing - sniffing tools - spoofing crypto and Wi-Fi - **Case study** on tcp dump - Wire shark - Burp Site.

Module II: Introduction to Auditing Frameworks **15 Hours**

Introduction to Nmap - Nmap Environment setup in linux / windows - scanning remote host and listing open ports - Identifying services of a remote host - Identifying live hosts in local networks - scanning using specific port ranges - NSE scripts.

Module III: Penetration testing **15 Hours**

Introduction to OWASP top vulnerabilities - Identifying insecure login mechanisms - Insecure credential storage - insecure logging.

Total Hours:	**45**

Text Books:

1	Lester Evans, Ethical Hacking: The Ultimate Guide to Using Penetration Testing to Audit and Improve the Cyber security of Computer Networks for Beginners, Including Tips on Social Engineering Paperback – Import, 2019.
2.	Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.
3.	Rassoul Ghaznavi-zadeh, Ethical Hacking and Penetration, Step by Step with Kali Linux, 2014.

Reference Books:

1	Kevin Beaver, “Ethical Hacking for Dummies”, 6th Edition, Wiley, 2018.
2	Jon Erickson, “Hacking: The Art of Exploitation”, 2nd Edition, Rogunix, 2007.

Web References:

1	https://owasp.org/www-project-top-ten/
2	https://www.coursera.org/courses?query=ethical%20hacking
3	https://www.udemy.com/course/ethical-hacking-professional/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component	FA (16%) [80 Marks]
C924.1	Understand	Quiz	20
C924.2	Apply	Tutorial	20
C924.3	Apply	Assignment	20
C924.4	Understand		
C924.5 & C924.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C924.1	3	3	3	2	2							2	3	3	2
C924.2	3	3	2	2	2							2	2	2	2
C924.3	3	3	3	3	2							2	2	2	3
C924.4	3	3	3	2	3							2	2	2	3
C924.5	3	3	3	3	2							2	2	2	2
C924.6	3	3	3	3	3							2	2	2	2

22CY921	DATA PRIVACY AND SECURITY	3/0/0/3
Nature of Course:	(Theory, Analytical)	
Prerequisites:	Data Structures and Algorithms	

Course Objectives:

1.	Acquisition of new knowledge and skills from research literature
2.	Quantitative and qualitative analysis of problems
3.	Evaluate proposed technical mechanisms for privacy protection
4.	Identify privacy related aspects of data uses
5.	Apply differentially private mechanisms when the sensitivity to requested information to changes in data is readily available

Course Outcomes:
Upon completion of the course, students shall have ability to:

C921.1	Describe the concept of privacy including personally private information.	[U]
C921.2	Describe how an attacker can infer a secret by interacting with a database	[A]
C921.3	Explain how to set a data backup policy or password refresh policy.	[A]
C921.4	Discuss how to set a breach disclosure policy	[A]
C921.5	Identify the risks of relying on outsourced manufacturing	[AP]

Course Contents:

Module I **15 Hours**

Fundamentals of Data Privacy & Security- Databases and Exploratory Data Analysis, Data Representation and Storage, Authentication and Authorization, Database Security Anonymization-Linkage and re-identification attacks, k-anonymity, l-diversity, t-closeness, Implementing anonymization, Anonymizing complex data

Module II **15 Hours**

Differential Privacy (DP) Privacy and anonymity in mobile environments, Formalism and interpretation of DP, Fundamental DP mechanisms and properties, Interactive and non-interactive DP, DP for complex data, Local Differential Privacy (LDP)

Module III **15 Hours**

Security and Privacy in AI and Machine Learning (AI/ML) : Machine Learning (ML) background, Adversary modeling in AI/ML, Poisoning, evasion, and backdoor attacks, Test-time attacks: Model inversion, model stealing, membership inference, adversarial examples, Architectures and algorithms for privacy-preserving machine learning

Total Hours (Theory):	**45**

Text Books:

1	David Salomon “Data Privacy and Security” Spriger Professional Computing , 2003

Reference Books:

1	Bruce Schneier ,Applied Cryptography: Protocols, Algorithms and Source Code in C
2	Kevin Mitnick The Art of Invisibility Little brown and company 2019

Web References:

1	https://online.york.ac.uk/resources/introduction-to-cyber-security-data-protection/

Online Resources:

1	https://www.coursera.org/learn/privacy-law-data-protection
2	https://online-learning.harvard.edu/course/cybersecurity-managing-risk-information-age

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C921.1	Understand	Case Study	20
C921.2	Analyze	Quiz	20
C921.3	Analyze	Assignment	20
C921.5	Apply	Tutorial	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	-	-	-
Understand	20	-	20
Apply	-	20	20
Analyze	80	80	60
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C921.1	2	2	2	2	2	1	1	1	1	1	2	2	1	1	1
C921.2	2	2	1	1	2	1	1	1	1	1	2	2	1	1	1
C921.3	2	2	1	1	3	1	1	1	1	1	2	2	2	2	2
C921.4	2	2	1	2	1	1	1	1	1	1	3	3	2	3	2
C921.5	2	2	1	2	1	1	1	1	1	1	3	3	2	3	2

22CY944	CYBER CRIME AND FORENSICS	3/0/0/3
Nature of Course:	E (Theory Technology)	
Pre requisites:	Nil	

Course Objectives:

1.	To understand the nature and scope of cybercrime and its impact on individuals, organizations, and society
2.	To develop the skills and knowledge necessary for the investigation and analysis of digital evidence.
3.	To explore advanced techniques and tools related to cybercrime investigations and digital forensics

Course Outcomes:
Upon completion of the course, students shall have ability to:

C944.1	Summarize the concept of cybercrime and the attacks	[U]
C944.2	Understand the legal, regulatory frameworks and jurisdictional challenges	[U]
C944.3	Apply digital forensics principles, tools and techniques	[AP]
C944.4	Apply forensic analysis methodologies to reconstruct cybercrime incidents	[AP]
C944.5	Analyze and respond to malware, network-based attacks and emerging trends	[A]

Course Contents:

Module I INTRODUCTION TO CYBER CRIME **15 Hours**

Overview of cybercrime- classification- Cybercriminal motivations and attack vectors- Impact of cybercrime on individuals, organizations, and society- Cybercrime laws and regulations in India- Privacy and data protection laws

Module II DIGITAL EVIDENCE AND ANALYSIS **15 Hours**

Digital Evidence - Identification, collection, and handling of digital evidence- Chain of custody and evidence- documentation- Legal considerations for evidence admissibility- Digital Forensics Tools Forensic acquisition and imaging-File system analysis and recovery- Network traffic analysis and log examination-Mobile device and cloud forensics- Investigation Process- Incident response and evidence triage- Forensic analysis methodologies- Reconstruction and analysis of digital evidence- Reporting and presenting findings

Module III CYBER FORENSIC ANALYSIS TECHNIQUES **15 Hours**

Forensic analysis techniques- Intrusion detection and prevention systems- Network traffic capture and analysis- Introduction to malware analysis- Static and dynamic malware analysis techniques- Reverse engineering of malicious software-Analysis of real-world cybercrime cases- Investigation challenges in advanced persistent threats- Emerging trends- case studies in cybercrime and digital forensics

Total Hours **45**

Text Books:

1	Marjie T. Britz, "Digital Forensics and Cyber Crime: An Introduction", 3rd Edition, Pearson Education, 2013
2	Nilakshi Jain, Dhananjay R. Kalbande “Digital Forensics”, Wiley Publishers, 2019

Reference Books:

1	Thomas J. Holt, Adam M. Bossler, and Kathryn C. Seigfried-Spellar, "Cybercrime: Investigation and the Digital Forensic" , 2nd Edition, Routledge Publishers,2017
2	Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet", 3rd Edition, Academic Press, 2011

Web References:	
1	https://onlinecourses.nptel.ac.in/noc23_cs127/preview
2	https://onlinecourses.swayam2.ac.in/cec20_lb06/preview

Online Resources:	
1	https://www.geeksforgeeks.org/cyber-crime/
2	https://www.geeksforgeeks.org/introduction-of-computer-forensics/
3	https://www.guru99.com/digital-forensics.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component	FA (16%) [80 Marks]
C944.1	Apply	Quiz	20
C944.2	Apply	Assignment	20
C944.3	Apply	Case study	20
C944.4	Analyze	Assignment	20
C944.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	10	10
Understand	40	40	40
Apply	40	40	40
Analyze	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60Marks)	FA 1 (40 Marks)		SA 2 (60Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C944.1	3	2	2	1	1						1	2	1	1	1
C944.2	3	2	1	1	1						1	2	1	1	1
C944.3	3	2	1	1	1						1	2	2	2	2
C944.4	3	2	1	1	1						1	3	2	3	2
C944.5	3	2	1	1	1						1	3	2	3	2

22CY922	DIGITAL AND MOBILE FORENSICS	3/0/0/3
Nature of Course:	E (Theory Technology)	
Pre requisites:	Cyber Security Essentials	

Course Objectives:

1.	To understand the basics of mobile device forensics, mobile operating systems and architectures
2.	To acquire skills in the acquisition, preservation, and analysis of mobile device data.
3.	To analyze and interpret mobile device for forensic investigations.

Course Outcomes:
Upon completion of the course, students shall have ability to:

C922.1	Summarize the fundamental concepts and principles of mobile device forensics	[U]
C922.2	Demonstrate knowledge of mobile device file systems, data structures, and artifacts	[U]
C922.3	Apply forensic methodologies to extract types of data from mobile devices	[AP]
C922.4	Apply mobile device data acquisition, preservation, and analysis using industry-standard forensic tools and techniques	[AP]
C922.5	Analyze the legal and ethical considerations in mobile device forensics	[A]

Course Contents:

Module I **15 Hours**

MOBILE DEVICE DATA ACQUISITION

Overview of mobile device forensics- Mobile operating systems and architectures- Device types and their implications in forensic analysis- Mobile Device Acquisition and Preservation- Physical and logical acquisition methods for mobile devices- Data extraction tools and techniques- Preservation and documentation of mobile device evidence- case study on android and iOS mobile devices

Module II **15 Hours**

MOBILE APPLICATION AND MOBILE NETWOK ANALYSIS

Overview of file systems used in mobile devices- file system artifacts, metadata, and timestamps- storage locations and encryption mechanisms- Mobile Device Application Analysis and Network Analysis- Examination of application data- app artifacts, databases, and user-generated content- Mobile device communication protocols- network traffic analysis- mobile device connections- mobile browsing data- Wi-Fi data, and Bluetooth interactions- case study on mobile device applications

Module III **15 Hours**

MOBILE DEVICE FORENSIC TECHNIQUES AND PRIVACY

Challenges in Mobile Device Forensics- Analysis of locked and damaged devices- findings and forensic reports- evidence in legal proceedings- Legal framework and regulations- Privacy and data protection laws- Ethical considerations- professional responsibilities- case study on mobile data privacy

Total Hours	**45**

Text Books:

1	"Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation" by Lee Reiber, Second Edition, McGraw Hill Education, 2019
2	“Mobile Network Forensics: Emerging Research and Opportunities” (Advances in Digital Crime, Forensics, and Cyber Terrorism) by Filipo Sharevski, IGI Global publisher, 2018

Reference Books:

1	“Contemporary Digital Forensic Investigations of Cloud and Mobile Applications” by Kim-Kwang Raymond Choo and Ali Dehghantanha, Syngress Publishers, 2016
2	"Digital Evidence and Computer Crime: Forensic Science, Computers, and the Internet" by Eoghan Casey, Third Edition, Academic Press, 2011

Web References:

	https://onlinecourses.swayam2.ac.in/cec20_lb06/preview
2	https://www.coursera.org/learn/forensic-science

Online Resources:	
1	https://mchow01.github.io/docs/android_forensics.pdf
2	https://baou.edu.in/assets/pdf/PGDCL_104_slm.pdf

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component	FA (16%) [80 Marks]
C922.1	Apply	Quiz	20
C922.2	Apply	Assignment	20
C922.3	Apply	Case study	20
C922.4	Analyze	Assignment	20
C922.5	Analyze		

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	10	10
Understand	40	40	40
Apply	40	40	40
Analyze	-	10	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks		
SA 1 (60Marks)	FA 1 (40 Marks)		SA 2 (60Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)	
	1	2	3	4	5	6	7	8	9	10	11	12	1	3
C922.1	2	3	2	3	3	3	-	2	1	1	1	2	3	1
C922.2	2	3	2	3	3	3	-	2	1	1	1	2	3	2
C922.3	2	3	2	3	3	3	-	2	1	1	1	2	3	2
C922.4	2	3	2	3	3	3	-	2	1	1	1	2	3	2
C922.5	2	3	2	3	3	3	-	2	1	1	1	2	3	2

22AD931	GENERATIVE AI	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre-requisite	Nil

Course Objectives:

1	To introduce fundamental concepts of Generative AI and differentiate it from other AI models.
2	To explore advanced generative models such as VAEs, GANs, and Transformers.
3	To apply generative models in practical scenarios like text, image, and data generation.
4	To address challenges like training instability and biases in generative models.
5	To examine the ethical implications and societal impacts of Generative AI.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C931.1	Understand fundamental concepts of generative AI models.	[U]
C931.2	Explore and apply advanced generative models like GANs and VAEs.	[U]
C931.3	Analyze the training methods and architecture of generative models.	[A]
C931.4	Identify ethical and legal challenges related to generative AI.	[A]
C931.5	Develop applications using generative models for real-world problems	[AP]

Course Contents:

FOUNDATIONS OF GENERATIVE AI **15 Hours**

Generative AI Overview - Definition and importance in current AI landscape - Probability in AI: Understanding random variables and probability distribution - Generative vs. Discriminative Models: Key differences and applications - Autoencoders: Introduction and applications in generative tasks - Variational Autoencoders (VAEs): Concept, theory, and hands-on applications - Generative Adversarial Networks (GANs) - Introduction and structure - Energy-Based Models: Contrastive divergence and applications in generative modelling - Reinforcement Learning in Generative AI: Basic principles and integration. Applications of Generative AI: Image synthesis, video generation, text generation - Overview of Transformer Models - **Case Study**: Image generation using Variational Autoencoders (VAE).

ADVANCED GENERATIVE MODELS AND TECHNIQUES **15 Hours**

Deep Generative Models - StyleGAN and Style Transfer: Architecture and real-world applications – Cycle GAN and Domain Adaptation - Progressive GANs - Text Generation with Transformers: GPT-2/3, BERT, and related models - Diffusion Models - Generative Models for Text-to-Image: Implementing DALL· E and CLIP - GAN Variants - Training Challenges in GANs - Attention Mechanisms in Generative Models - **Case Study:** Implementation of a GAN for image-to-image translation.

APPLICATIONS, ETHICS, AND FUTURE TRENDS **15 Hours**

Real-World Applications - Generative AI in Healthcare - Generative AI in Gaming – Deepfakes - Ethical Issues in Generative AI - Generative AI for Music and Audio - Generative AI for Data Augmentation - Legal Aspects of AI-Generated Content - Future Trends in Generative AI - Human-AI Collaboration: Role of AI in augmenting human creativity - **Case Study:** Ethical considerations of AI-generated content in journalism.

Total Hours:	**45**

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.
2	David Foster, "Generative Deep Learning", 1st Edition, O'Reilly Media, 2019.

3	Christopher M. Bishop, "Pattern Recognition and Machine Learning", 1st Edition, Springer, 2006
Reference Books:	
1	Jakub Langr, "GANs in Action: Deep learning with Generative Adversarial Networks", 1st Edition, Manning Publications, 2019.
2	Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", 1st Edition, O'Reilly Media, 2022.
Web References:	
1	https://developers.google.com/machine-learning/gan
2	https://huggingface.co/transformers
3	http://jalammar.github.io/illustrated-transformer/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C931.1	Understand	Quiz	20
C931.2	Understand	Tutorial	20
C931.3	Analyze	Group Assignment	20
C931.4	Analyze		
C931.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C931.1	3	3	3	2	3	2						2	2	2	2
C931.2	3	3	3	2	3	2						2	2	2	2
C931.3	3	3	3	3	3	2						2	2	2	2
C931.4	3	3	3	2	3	2						2	2	3	3
C931.5	3	3	3	3	3	3						3	3	2	2

22AD932	QUANTUM ARTIFICIAL INTELLIGENCE	3/0/0/3
Nature of Course	F (Theory)	

Pre Requisite: Machine Learning

Course Objectives:

1	Introduce the fundamentals of quantum computing and qubits.
2	Explore and implement key quantum algorithms.
3	Develop problem-solving techniques using quantum tree search.
4	Understand the architecture and models of quantum computers.
5	Familiarize with open-source quantum computing libraries and simulation tools.

Course Outcomes:

Upon completion of the course, students shall have ability to

C 932.1	Understand the computation with Qubits.	[U]
C932.2	Apply Quantum algorithms - Fourier Transform and Grover's amplification.	[AP]
C932.3	Apply Quantum problem solving using tree search.	[AP]
C932.4	Explore the models of Quantum Computer and Quantum Simulation tools.	[U]
C932.5	Develop an open-source Quantum computer libraries for applications.	[A]

Course Contents:

Module 1: Introduction to artificial intelligence **15 hours**

Introduction - artificial intelligence - computation - Cantor's diagonal argument - complexity theory - Decision problems - P and NP - Church–Turing Thesis - Von Neumann architecture - Problem Solving - Rules - Logic-based operators - Frames - Categorial representation - Binary vector representation - Production System - Deduction systems - Reaction systems - Conflict resolution - Human problem-solving - Information and measurement - Reversible Computation - Reversible circuits - Toffoli gate**. Case Study:** Optimization of Machine Learning Algorithms Using Quantum Computing

Module 2 : Quantum physics **15 hours**

Introduction to quantum physics - Unitary Evolution - Quantum Mechanics - Hilbert space - Quantum Time Evolution - Von Neumann Entropy - Measurement - Heisenberg's uncertainty 69 principle - Randomness - Computation with Qubits - Computation with m Qubit - Matrix Representation of Serial and Parallel Operations - Quantum Boolean Circuits - Periodicity - Quantum Fourier Transform - Unitary Transforms - Search and Quantum Oracle - Grover's Amplification - Circuit Representation - Speeding up the Traveling Salesman Problem - The Generate-and-Test Method - Quantum Problem-Solving - Heuristic Search - Quantum Tree Search - Tarrataca's Quantum Production System.

Case Study: Quantum Neural Networks: A New Paradigm in AI

Module 3 : General Model of a Quantum Computer **15 hours**

A General Model of a Quantum Computer - Cognitive architecture - Representation - Quantum Cognition - Decision making - Unpacking Effects - Quantum Walk on a graph - Quantum annealing - Optimization problems - Quantum Neural Computation - Applications on Quantum annealing Computer - Development libraries - Quantum Computer simulation tool kits.

Case Study: Quantum Reinforcement Learning for Autonomous Systems

Total Hours:	**45**

Text Books:	
1	Andreas Wichert, “Principles of Quantum Artificial Intelligence”, First edition, World Scientific Publishing, 2023.
2	Peter Wittek, “Quantum Machine Learning”, First edition, Academic Press, 2022.
Reference Books:	
1	Eleanor Rieffel and Wolfgang Polak, “Quantum Computing: A Gentle Introduction”,MIT Press, 2022.
2	Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson, 4th Edition, 2022.
Web References:	
1	https://qiskit.org/textbook/ch-states/what-is-quantum.html
2	https://brilliant.org/wiki/p-vs-np/
3	https://quantum.country/qcvc
Online Resources:	
1	https://plato.stanford.edu/entries/qm-computing/
2	https://quantum-computing.ibm.com/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C932.2	Apply	Tutorial	20
C932.1, C932.4	Understand	Assignment	20
C932.3	Apply	Case Study	20
C932.5	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C932.1	3	3	3	2	3	2						2	2	2	2
C932.2	3	3	3	2	3	2						2	2	2	2
C932.3	3	3	3	3	3	2						2	2	2	2
C932.4	3	3	3	2	3	2						2	2	3	3
C932.5	3	3	3	3	3	3						3	3	2	2

22AD933	PROMPT ENGINEERING	3/0/0/3

Nature of Course F (Theory)

Pre Requisite: Deep learning and its applications

Course Objectives:

1	Equip students with a solid understanding of large language models (LLMs) and the principles of prompt engineering.
2	Enable students to design effective prompts tailored for various applications like customer support and content creation.
3	Provide students with skills to apply advanced prompting methods for complex task resolution.
4	Develop the ability to evaluate and refine prompt performance through feedback and metrics.
5	Foster awareness of ethical considerations in AI, emphasizing bias identification and responsible prompt design practices.

Course Outcomes:

Upon completion of the course, students shall have ability to

C933.1	Understand Language Models and Prompt Mechanics.	[U]
C933.2	Design Effective Prompts.	[A]
C933.3	Implement Advanced Prompting Techniques.	[AP]
C933.4	Evaluate and Optimize Prompt Performance.	[AP]
C933.5	Address Ethical Considerations in AI Applications.	[A]

Course Contents:

Module 1: Foundations of Prompt Engineering **15 hours**

Introduction to Prompt Engineering - Definition and importance Applications in AI models (GPT, Codex, DALL·E, etc.)- Different prompt types (text generation, image generation, code generation) - Basics of large language models (LLMs)- GPT-4, GPT-3.5, and other LLM architectures- Understanding model behavior through prompt tuning-Role of training data in model behaviour-Prompt Design Techniques - Writing effective prompts-Precision vs. creativity in prompts- Role of constraints, context, and tokens-Evaluating Prompt Effectiveness - Metrics for assessing prompt outcomes- Biases and limitations in language models- Optimization strategies. **Case Study:** Customer Support Chatbot Development.

Module 2: Advanced Techniques in Prompt Engineering **15 hours**

Multi-step Prompts and Complex Tasks - Decomposing tasks into simpler prompts- Sequential prompting for task orchestration- Multi-modal prompts (text, image, and code integration)-Prompt Optimization - Fine-tuning prompts for specific results- Hyperparameter adjustment (temperature, max tokens, stop sequences)- Dynamic prompt generation (prompt chaining and looping)- Bias Mitigation and Ethical Considerations - Understanding and addressing bias in prompt outputs- Ethical implications in generative models- Fairness and transparency in prompt design- Domain-Specific Prompt Engineering- Specialized prompts for domains like healthcare, law, and finance-Leveraging domain knowledge to craft accurate prompts. **Case Study:** Automated Content Generation for Marketing.

Module 3: Applications of Prompt Engineering **15 hours**

Interactive AI Systems with Prompts- Designing conversational agents using prompts- Maintaining context and state in conversational AI-Creative Prompt Use Cases - Generating creative outputs (stories, poetry,

art, music)- Enhancing creativity with structured and unstructured prompts-Prompt Engineering for Business Applications - Automating tasks using prompts (document processing, summarization, report generation)- AI-driven decision-making with prompt workflows. **Case Study:** Code Generation and Documentation Automation	
Total Hours:	**45**

Text Books:	
1	Lewis Tunstall, Leandro von Werra, and Thomas Wolf, "Natural Language Processing with Transformers: Building Language Applications with Hugging Face", O'Reilly Media, 2023.
2	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow", O'Reilly Media, 2022.

Reference Books:	
1	Edward Grefenstette, "Language Models for AI: An Introduction to Neural Network-Based Language Models”, Cambridge University Press, 2022.
2	Palash Goyal, "Deep Learning for Natural Language Processing: Creating Neural Networks with Python", Springer, 2022.

Web References:	
1	https://www.deeplearning.ai/short-courses/chatgpt-prompt-engineering-for-developers/
2	https://learn.microsoft.com/en-us/training/modules/apply-prompt-engineering-azure-openai/

Online Resources:	
1	https://platform.openai.com/docs/guides/prompt-engineering/strategy-write-clear-instructions
2	https://github.com/dair-ai/Prompt-Engineering-Guide

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C933.3	Apply	Tutorial	20
C933.1	Understand	Assignment	20
C933.4	Apply	Case Study	20
C933.2, C933.5	Analyze	Quiz	20
Assessment based on Summative and End Semester Examination			
Revised Bloom’s	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%)**

Level	CIA1 : [60 Marks]	CIA2 : [60 Marks]	[100 Marks]
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

<table>
<tr><th colspan="7">Assessment based on Continuous and End Semester Examination</th></tr>
<tr><th colspan="6">Continuous Assessment (40%)
[200 Marks]</th><th rowspan="3">End Semester Examination
(60%)
[100 Marks]</th></tr>
<tr><th colspan="3">CA 1 : 100 Marks</th><th colspan="3">CA 2 : 100 Marks</th></tr>
<tr><th rowspan="2">SA 1
(60 Marks)</th><th colspan="2">FA 1 (40 Marks)</th><th rowspan="2">SA 2
(60 Marks)</th><th colspan="2">FA 2 (40 Marks)</th></tr>
<tr><th>Component - I
(20 Marks)</th><th>Component - II
(20 Marks)</th><th>Component - I
(20 Marks)</th><th>Component - II
(20 Marks)</th></tr>
</table>

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C933.1	3	3	3	2	3	2						2	2	2	2
C933.2	3	3	3	2	3	2						2	2	2	2
C933.3	3	3	3	3	3	2						2	2	2	2
C933.4	3	3	3	2	3	2						2	2	3	3
C933.5	3	3	3	3	3	3						3	3	2	2

22AD934	INTELLIGENT ROBOTIC AUTOMATION	3/0/0/3
Nature of Course	F (Theory Programming)	
Pre-Requisite	Nil	

Course Objectives:

1	Understand the Robot types and its end effectors.
2	Develop the Analytical and Experimental skills necessary to Design and Implement robotic assistance for both minimally invasive surgery and Image guided interventions.
3	Recall the robot application for pick and place.
4	Simulations in RoboAnalyzer / Matlab to verify kinematics and dynamics of robots.
5	Inculcate the controlling applications of robotics using sensor responses

Course Outcomes:

Upon completion of the course, students shall have ability to:

C934.1	Identify and describe different types of medical robots and their potential applications.	[U]
C934.2	Understand various robot classifications, specifications and applications.	[U]
C934.3	Apply coordinate transformations to map position and orientation coordinates from end effector to robot base.	[AP]
C934.4	Understand the challenges in the design of a medical robotic system given the specific requirements for a particular application.	[U]
C934.5	Analyze forward and inverse kinematics to manipulate objects by robots.	[A]

Course Contents:

MODULE I: Introduction **15 Hours**

Introduction: Robot Anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and Links-Robot classifications -Architecture of robotic Systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system. End Effectors and Robot Controls: Mechanical Grippers-Slider crank mechanism, Screw type, Rotary actuators, cam Type-Magnetic grippers -Vacuum grippers -Air operated Grippers-Gripper force Analysis-Gripper Design-Simple Problems-Robot controls **Case Study** - State of art of robotics in the field of healthcare.

MODULE II: Micro/Nano Robotics **15 Hours**

Robot Cell Design and Micro/Nano Robotics System: Robot work cell design and Control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions- Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot. Micro/Nanorobotics system Overview-Scaling effect- Top down and bottom-up approach- Actuators of Micro/Nano robotics system-Nanorobot communication Techniques-Fabrication of micro/nano Grippers-Wall climbing micro robot working Principles-Biomimetic Robot-Swarm Robot-**Case Study** - Nano robot in targeted drug delivery system.

MODULE III: Robot Kinematics **15 Hours**

Robot Transformations and Sensors: Robot Kinematics- Types – 2D & 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple Transformation Simple problems. Sensors in robot – Touch sensors -Tactile sensor – Proximity and range sensors – Robotic vision Sensor-Force sensor -Light sensors, Pressure sensors. Motion Instructions- Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command-based programming - Move master command language **Case Study** - Robot welding application using VAL program.

	Total Hours:	**45**
Text Books:		
1	Mikell P Groover& Nicholas Godrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, “Industrial Robotics, Technology Programming and Applications”, McGraw Hill, 2nd Edition, 2019.	
2	J John Craig , “Introduction to Robotics“, Pearson Education, 4th Edition, 2021	
Reference Books:		
1	Klafter. R.D, Chmielewski. T.A. and Noggin‟s., “Robot Engineering: An Integrated Approach”, Prentice Hall of India Pvt. Ltd., 2022.	
2	S.R. Deb, “Robotics Technology and flexible automation “, Tata McGraw-Hill Education., 2021	
Web References:		
1	https://community.sap.com/t5/enterprise-resource-planning-blogs-by-sap/sap-intelligent-robotic-process-automation-best-practice-content-for-s/ba-p/13399775	
2	https://www.koombea.com/blog/intelligent-automation/	
Online Resources:		
1	https://www.ibm.com/topics/intelligent-automation	
2	https://www.sap.com/products/technology-platform/process-automation/what-is-rpa.html	

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C934.1	Understand	Tutorial	20
C932.2, C934.4	Understand	Assignment	20
C932.3	Apply	Case Study	20
C932.5	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20

Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C934.1	3	3	3	2	3	2						2	2	2	2
C934.2	3	3	3	2	3	2						2	2	2	2
C934.3	3	3	3	3	3	2						2	2	2	2
C934.4	3	3	3	2	3	2						2	2	3	3
C934.5	3	3	3	3	3	3						3	3	2	2

22AD935	ADVANCED MACHINE LEARNING	3/0/0/3

Nature of Course	G (Theory Analytical)
Pre-requisite	Nil

Course Objectives:

1	To understand the advanced topics and techniques in machine learning.
2	To explore deep learning models and their applications.
3	To study optimization techniques in machine learning.
4	To apply machine learning models to real-world problems and data.
5	To examine recent advancements and trends in machine learning research.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C935.1	Understand advanced machine learning models and theories.	[U]
C935.2	Apply neural networks, deep learning, and optimization techniques.	[AP]
C935.3	Analyze large datasets using machine learning methods. A	[A]
C935.4	Investigate the challenges and limitations of advanced machine learning.	[A]
C935.5	Develop and evaluate machine learning models for specific tasks.	[AP]

Course Contents:

ADVANCED TOPICS IN MACHINE LEARNING **15 Hours**

Review of basic machine learning concepts - Overview of supervised and unsupervised learning - Ensemble methods: Bagging, Boosting, and Stacking - Dimensionality reduction techniques: PCA, LDA, t-SNE - Regularization: L1, L2, Ridge, and Lasso - Hyperparameter tuning and model selection.

DEEP LEARNING AND NEURAL NETWORKS **15 Hours**

Neural Networks: Architectures and training methods - Deep Learning models: CNNs, RNNs, LSTMs, and Autoencoders - Transfer learning and Pre-trained models (e.g., VGG, ResNet) - Generative Adversarial Networks (GANs) and their applications - Deep Reinforcement Learning - **Case Study:** Developing a CNN for image classification.

MACHINE LEARNING OPTIMIZATION TECHNIQUES **15 Hours**

Gradient Descent and its variants (SGD, Adam) - Bayesian Optimization - Metaheuristic approaches in machine learning optimization - Distributed and Parallel Computing for ML - Ethical considerations and biases in machine learning - **Case Study:** Hyperparameter optimization in deep learning.

Total Hours:	**45**

Text Books:

1	Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", 1st Edition, MIT Press, 2016.
2	David Foster, "Generative Deep Learning", 1st Edition, O'Reilly Media, 2019.
3	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", 2nd Edition, Springer, 2016.

Reference Books:

1	Jakub Langr, "GANs in Action: Deep learning with Generative Adversarial Networks", 1st Edition, Manning Publications, 2019.
2	Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers", 1st Edition, O'Reilly Media, 2022.
3	Ian Goodfellow, "Generative Adversarial Networks", MIT Press, 2020.

Web References:	
1	https://developers.google.com/machine-learning/gan
2	https://huggingface.co/transformers
3	http://jalammar.github.io/illustrated-transformer/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C935.1	Understand	Quiz	20
C935.2	Apply	Tutorial	20
C935.3	Analyze	Group Assignment	20
C935.4	Analyze		
C935.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C935.1	3	3	3	2	3	2						2	2	2	2
C935.2	3	3	3	2	3	2						2	2	2	2
C935.3	3	3	3	3	3	2						2	2	2	2
C935.4	3	3	3	2	3	2						2	2	3	3
C935.5	3	3	3	3	3	3						3	3	2	2

22AD936	EXPLAINABLE AI	3/0/0/3

Nature of Course	F (Theory Programming)
Pre-Requisite	Generative AI

Course Objectives:

1	To learn the concepts of Explainable AI (XAI)
2	To provides a snapshot of interpretable AI techniques that reflects the current discourse and provides directions of future development of Intelligent Systems
3	Explore different techniques and methods for making AI systems explainable.
4	Examine the ethical and societal implications of XAI.
5	To learn the real-world datasets and scenarios.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C936.1	Analyze the trade-offs between model complexity and interpretability	[U]
C936.2	Identify and evaluate risks surrounding the use of AI in a business context	[A]
C936.3	Apply XAI techniques to real-world datasets	[A]
C936.4	Understand the model agnostic and the model specific explainability methods.	[U]
C936.5	Apply generative AI in your context, identifying the key considerations and decisions required at each step	[AP]

Course Contents:

MODULE I: Risk Data Analytics **15 hours**

Types of Risk Data, Financial Data, Market Data, Business Data, Process Automation, Risk and Security, Underwriting and Credit scoring, Algorithmic trading, Time Series, Meaning and Components, Trend Analysis, Seasonality and cyclical behavior, Moving Average, Exponential smoothing methods – Single exponential, double exponential, HOLT-WINTERS, ARIMA.

MODULE II: Credit Risk Foundation **15 hours**

Overview of Consumer Credit Products, Credit Risk Fundamentals, Credit Rating Agencies, External Analysis for Credit Information, Verification Frameworks Risk modeling– Fundamentals-Different approaches for risk modeling-Binomial Logistic, Multinomial Logistic, Survival Analysis, Penalized Models, Hazard Models. **Case Study** - Distinction between applied risk analysis and generic (fundamental) risk analysis.

MODULE III: Risk Regulations **15 hours**

BASEL II Concepts - Pillar 1, 2 and 3, BASEL II vs BASEL III, IFRS9 standards, Comparison between requirements by FSA and APRA, Comparison between IFRS9 standard and CECL (FASB), CCAR, Regulation and calculation overview, Asset Classes, V Model Validation-Regulation's Context: Data Cleaning & Model Diagnostics, Variable Selection, Candidate Models, Residual Diagnostics. **Case Study** - Work with real-world climate data to develop the analytical skills required for climate risk management

Total Hours:	**45 hours**

Text Books:

1	Jimmy Skoglund," Financial Analysis and Risk Management", Springer Publication.2022
2	Richard Apostolik, "Foundations of Financial Risk: An Overview of Financial Risk and Risk-based Financial Regulation" Wiley,2021

Reference Books:

1	Harald Scheule, “Credit Risk Analytics: Measurement Techniques, Applications, and Examples in SAS”, Wiley and SAS Business Series, Bart Baesens, Daniel Roesch, Wiley.2022
2	Anthony Saunders and Linda Allen, “Credit Risk Measurement: New Approaches to Value at Risk and Other Paradigms”, John Wiley & Sons; 2nd edition 2020
Web References:	
1	https://www.investopedia.com/terms/r/risk-analysis.asp
2	https://onlinelibrary.wiley.com/journal/15396924
Online Resources:	
1	https://www.ey.com/en_in/services/consulting/financial-services-risk-management/cafta/certificate-in-financial-risk-management
2	https://www.coursera.org/specializations/risk-management

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C936.2	Analyze	Tutorial	20
C936.1	Understand	Assignment	20
C936.3, C936.5	Apply	Case Study	20
C936.4	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination					
Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C936.1	3	3	3	2	3	2						2	2	2	2
C936.2	3	3	3	2	3	2						2	2	2	2
C936.3	3	3	3	3	3	2						2	2	2	2
C936.4	3	3	3	2	3	2						2	2	3	3
C936.5	3	3	3	3	3	3						3	3	2	2

22AD937	AI FOR HUMANITY	3/0/0/3

Nature of Course: D (Theory Applications)

Prerequisite: Nil

Course Objectives:

1	Understand the foundational concepts of AI and machine learning
2	Explore the potential and limitations of AI technologies in various domains.
3	Examine the ethical implications and societal impact of AI.
4	Develop strategies for implementing AI solutions that align with human values and ethical principles.
5	Evaluate real-world case studies to understand the practical applications and challenges of AI.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C937.1	Develop critical thinking skills to evaluate AI solutions and their impact on society.	[AP]
C937.2	Acquire problem solving skills to design AI solutions that address humanitarian challenges.	[AP]
C937.3	Learn to communicate complex AI concepts to non-technical stake holders.	[U]
C937.4	Develop collaboration skills to work effectively in interdisciplinary teams.	[AP]
C937.5	Develop a responsible and ethical approach to AI development and deployment.	[AP]

Course Contents:

MODULE I CORE TECHNOLOGIES OF AI **15 Hours**

Overview of AI and Machine Learning - History and Evolution of AI - Types of AI: Narrow AI vs. General AI - Machine Learning Basics - Deep Learning and Neural Networks - Natural Language Processing - AI in Healthcare, Education, and Environmental Sustainability - Bias and Fairness in AI - Privacy Concerns and Data Security - Transparency and Accountability - Case Studies: AI for Disaster Relief, Public Health, and Climate Change.

MODULE II DESIGNING HUMAN CENTRIC AI & ITS FRAMEWORK **15 Hours**

User-Centered Design in AI - Ensuring Inclusivity and Accessibility - Human-AI Collaboration and Augmentation - Metrics for Assessing AI Performance - Real-World Evaluation and Testing -Case Studies of AI Failures and Lessons Learned - Regulatory and Policy Frameworks - AI Governance and Policy - International Regulations and Standards - The Role of Governments and NGOs – Case Study: Regulations for ethical AI deployment.

MODULE III FUTURE OF AI AND COMMUNITY **15 Hours**

Emerging Trends in AI - The Impact of AI on Employment and Society - Future Directions for AI Research and Development - AI's Impact on Job Markets - Automation and the Changing Nature of Work - AI in Decision-Making Processes - Case Studies: Existing AI Policies and Their Effectiveness.

Total Hours:	**45**

Text Books:

1	Andeed ma, James Ong,Siok Siok Tan, "AI for Humanity: Building a Sustainable AI for the Future",Wiley Publishers, 2024.
2	Fang Chen, Liyun Li, Jian Long Zhou, "Humanity driven AI", Springer Cham Publishers, 2022.

Reference Books:

1	Hamilton Mann, “Artificial Integrity: The Paths to Leading AI Toward a Human-Centered Future”, Wiley Publishers, 2024.
2	Juan M.Lavista Ferres,William B.Weeks,Brad Smith, “AI for Good: Applications in Sustainability, Humanitarian Action, and Health”, Wiley Publishers, 2024.
Web References:	
1	https://onlinecourses.swayam2.ac.in/imb24_mg116/preview

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C937.1, C937.2	Apply	Tutorial	20
C937.3	Understand	Assignment	20
C937.4, C937.5	Apply	Case Study	20
C937.6	Understand	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C937.1	3	2	2	3	2	2		2				2	2	2	2
C937.2	3	2	3	3	2	2		2				2	2	3	2
C937.3	3	2	2	2	2	2		2				2	3	3	2
C937.4	3	3	3	3	2	2		2				2	2	3	2
C937.5	3	3	3	3	2	2		2				2	3	3	2

22AD938	AUTONOMOUS VEHICLES AND DRONES	3/0/0/3
Nature of Course: D (Theory Applications)		
Prerequisite: Nil		
Course Objectives:		
1	To develop practical and engineering knowledge with autonomous vehicles, and drone technologies	
2	To build experience in modern sensor technologies that enable automation and autonomy	
3	To Understand the regulatory procedures of drones, pilot certification and licensing and basic safety measures required of UAS / UAV.	
Course Outcomes: Upon completion of the course, students shall have ability to:		
C938.1	Apply the concepts and classification of Drones / SLAM like Simultaneous Localization And Mapping.	[AP]
C938.2	Explore PID controllers, state estimation, and feedback control systems specific to autonomous systems.	[AP]
C938.3	Understand the principles of communication systems used in autonomous vehicles and drones.	[U]
C938.4	Apply AI and machine learning techniques to enable decision-making and improve autonomy in vehicles and drones.	[AP]
C938.5	Design intuitive user interfaces for controlling and monitoring autonomous vehicles and drones.	[A]

Course Contents:

MODULE I INTRODUCTION AND FUNCTIONAL ARCHITECTURE **15 Hours**

Basic Concept- autonomous systems- AI in autonomous systems, Autonomous systems vs robots-Major functions in an autonomous vehicle system-Motion Modelling - Coordinate frames and transforms-Point mass model - Case study: Agriculture autonomous drones - Modern sensor technologies.

MODULE II SLAM **15 Hours**

Modeling in autonomous systems Vehicle modelling (kinematic and dynamic bicycle model - two-track models),-Sensor Modelling – encoders- inertial sensors- Sensors and sensor fusion - GPS-Localization and mapping fundamentals-LIDAR and visual SLAM, Navigation - Global path planning-Local path planning- Vehicle control - Control structures,-PID control, Linear quadratic regulator, Sample controllers. Case study: Autonomous Drones for Construction – Wheeled robots and odometry.

MODULE III DRONES **15 Hours**

Overview-Definition,- applications- components platforms- propulsion,-on-board flight control,-payloads- communications,-concepts of flight-regulatory norms and regulations,-Machine learning and deep learning for autonomous driving, Case study(Commercial Drones and Kits).

Total Hours:	**45**

Text Books:

1	Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot, “Creating Autonomous Vehicle Systems” Morgan & Claypool Publishers, 2018
2	Kevin M. Lynch and Frank C, Park, “Modern Robotics: Mechanics, Planning, and Control”, 1st Edition,2021

Reference Books:	
1	Mohammad H. Sadraey, “Design of Unmanned Aerial Systems” First Edition, John Wiley & Sons, Inc., USA 2020.
2	Terry Kilby and Belinda Kilby Make, “Getting Started with Drones”, First Edition, Maker Media Inc, San Francisco CA, 2016.
Web References:	
1	https://www.coursera.org/learn/Drones

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C938.1, C938.2	Apply	Tutorial	20
C938.3	Understand	Assignment	20
C938.4	Apply	Case Study	20
C938.5	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C938.1	3	2	2	3	2	2						2	2	2	2
C938.2	3	2	3	3	2	2						2	2	3	2
C938.3	3	2	2	2	2	2						2	3	3	2
C938.4	3	3	3	3	2	2						2	2	3	2
C938.5	3	3	3	3	2	2						2	3	3	2

22AD939	AI FOR REMOTE SENSING	3/0/0/3

Nature of Course: D (Theory Applications)

Prerequisite: Nil

Course Objectives:

1	Understand the fundamental concepts of remote sensing and AI.
2	Learn how to preprocess and analyze remote sensing data using AI techniques.
3	Explore various AI algorithms and models used in remote sensing applications.
4	Apply AI methods to solve real-world problems using remote sensing data.
5	Evaluate and interpret the results of AI-driven remote sensing analysis.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C939.1	Able to Understand the various Remote Sensing Fundamentals.	[U]
C939.2	Develop the AI Models for Remote Sensing Applications.	[U]
C939.3	Apply AI Techniques in Remote Sensing.	[AP]
C939.4	Understand the Ethical and Sustainable Use of AI in Remote Sensing.	[U]
C939.5	Implement the Use of Remote Sensing Software and Tools.	[AP]

Course Contents

MODULE I INTRODUCTION TO REMOTE SENSING **15 Hours**

Definition and scope of remote sensing - Historical development - Overview of electromagnetic radiation - Electromagnetic Spectrum and Radiation - Properties of EMR - Interaction of EMR with the atmosphere and Earth's surface - Spectral signatures - Remote Sensing Platforms and Sensors - Types of sensors: optical, thermal, radar, LiDAR - Image Acquisition and Preprocessing .

MODULE II IMAGE ENHANCEMENT AND VISUALISATION **15 Hours**

Contrast enhancement - Band combinations (true color, false color) - Image classification techniques (supervised, unsupervised) - Image Interpretation and Analysis - Visual interpretation techniques - Digital image analysis - Feature extraction - Applications of Remote Sensing - Environmental monitoring (forests, water bodies, land use) - Agricultural applications.

MODULE III FUTURE TRENDS IN REMOTE SENSING **15 Hours**

Emerging technologies - Remote sensing in climate change studies - Ethical considerations and data privacy - Real-world case studies - Hyperspectral imaging - Radar remote sensing - LiDAR technology - multi-temporal analysis – Case study: Disaster management.

Total Hours:	**45**

Text Books:

1	Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman, “Remote Sensing and Image Interpretation”, Seventh edition, Wiley Publishers, 2022
2	Peter M. Atkinson, Nicholas Tate, “Advances in Remote Sensing and GIS Analysis”, Wiley Publishers, 2021.

Reference Books:

1	Jian Guo Liu, Philippa J. Mason, ”Image Processing and GIS for Remote Sensing: Techniques and Applications, 2nd Edition”, Wiley Publishers, 2020.
2	Victor Mesev, ”Integration of GIS and Remote Sensing, Wiley Publishers, 2021.

Web References:

1	https://onlinecourses.nptel.ac.in/noc24_ce26/preview

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C939.1, C939.2	Apply	Tutorial	20
C939.3	Understand	Assignment	20
C939.4, C939.5	Apply	Case Study	20
C939.6	Understand	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C939.1	3	2	2	3	2	1		2				2	2	2	2
C939.2	3	2	3	3	2	1		2				2	2	3	2
C939.3	3	2	2	2	2	1		2				2	3	3	2
C939.4	3	3	3	3	2	1		2				2	2	3	2
C939.5	3	3	3	3	2	1		2				2	3	3	2

22AD941	PREDICTIVE ANALYTICS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Machine Learning Techniques and Database Management Systems	

Course Objectives:

1.	To Develop skills to process and analyze complex data sets
2.	To learn, how to develop models to predict categorical and continuous outcomes, using techniques such as decision trees, logistic regression, random forest.
3.	To understand the different types of Data visualization, Distributions and summary statistics.
4.	To know the use of the binary classifier and numeric predictor nodes to automate model selection.
5.	To advice on when and how to use each model. Also learn how to combine two or more models to improve prediction

Course Outcomes

Upon completion of the course, students shall have ability to

C941.1	Illustrate the process to successfully design, build, evaluate and implement predictive models for a various business application.	[U]
C941.2	Select appropriate predictive modeling approaches to identify cases to progress with.	[R]
C941.3	Identify the real-world business problems and model with analytical solutions.	[AP]
C941.4	Apply predictive modeling approaches and evaluate the performance.	[AP]
C941.5	Convert any real-world decision-making problem to hypothesis and apply suitable statistical testing.	[A]

Course Contents:

PREDICTION AND CLASSIFICATION METHODS: 15 Hours

Explanatory vs Predictive Modeling – Multiple Linear Regression, Classification Tress, Avoiding Overfitting - Regression Trees, Improving Prediction: Random Forests and Boosted Trees, Logistic Regression, Discriminant Analysis.

MEDIA ANALYTICS: 15 Hours

Social Network Analytics - Directed vs. Undirected Networks - Visualizing and Analyzing Networks - Social Data Metrics and Taxonomy - Using Network Metrics in Prediction and Classification – Text Mining - Bag-of-Words vs. Meaning Extraction at Document Level – **Case Study:** Catalog Cross-Selling - Predicting Bankruptcy**.**

PERFORMANCE EVALUATION: 15 Hours

Evaluating Predictive Performance - Judging Classifier Performance - Judging Ranking Performance - Oversampling: Oversampling the Training Set, Evaluating Model Performance Using a Non-oversampled Validation Set.

Total Hours	**45**

Text Books:

1.	Jeffrey S. Strickland, “Predictive Analytics using R”, Lulu Publications, ISBN 978-1-312-84101-7, 2017.
2.	Galit Shmueli, Peter C. Bruce, Inbal Yahav, Nitin R. Patel, Kenneth C. Lichtendahl, “Data mining for Business Analytic: Concepts, Techniques, And Applications In R”, Wiley Publications, 2018.

3.	Daniel T. Larose, Chantal D. Larose, “Data Mining and Predictive Analytic”, Wiley, 2nd Edition 2015.
4.	Dr. Anasse Bari, Mohamed Chaouchi, Tommy Jung, “Predictive Analytics For Dummies”, Wiley, 2nd Edition, 2016.
5.	Richard Hurley, “Predictive Analytics: The Secret to Predicting Future Events Using Big Data and Data Science Techniques Such as Data Mining, Predictive Modelling, Statistics, Data Analysis, and Machine Learning”, 10th Edition, Ationa Publications 2019.
Reference Books:	
1.	Dinov Ivo D., “Data Science and Predictive Analytics”, Springer International Publishing AG, 5th Edition, 2018.
2.	Tamhane Ajit C, “Predictive Analytics- Parametric Models for Regression and Classification Using R”, John Wiley & Sons Inc, 1st Edition, 2020.
3.	John D. Kelleher, Brian Mac Namee, Aoife D'Arcy, “Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, and Case Studies”, The MIT Press, 1st Edition, 2015.
4.	G.James, D.Witten, T.Hastie, R.Tibshirani, “An introduction to statistical learning with applications in R” ,Springer,2013.
Web References:	
1.	https://www.ibm.com/in-en/analytics/predictive-analytics
2.	https://cloud.google.com/learn/what-is-predictive-analytics
3.	https://www.sas.com/en_in/insights/analytics/predictive-analytics.html
4.	https://www.mathworks.com/discovery/predictive-analytics.html
Online Resources:	
1.	https://www.edx.org/course/introduction-to-analytics-modeling
2.	https://www.ey.com/en_in/ey-faas-learning-solutions/certificate-in-predictive-analytics-in-python
3.	https://www.skillsoft.com/channel/predictive-analytics-84e64131-1557-11e7-9f21-659139b59eba
4.	https://intellipaat.com/data-analytics-master-training-course

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%)**

			[80 Marks]
C941.1	Understand	Quiz	20
C941.2	Remember	Tutorial	20
C941.3	Apply	Assignment	20
C941.4	Apply		
C941.5	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C941.1	2	3	1		1								1	2	2
C941.2	1	2	2		2								2	1	1
C941.3	3	3	3	3	3								3	3	1
C941.4	1	1	2		1								1	1	1
C941.5	2	1	2	2	1								2	1	2

22AD942	INFORMATION EXTRACTION AND RETRIEVAL	3/0/0/3

Nature of Course	G (Theory Analytical)
Prerequisites	Data mining

Course Objectives:

1	To outline basic terminology and components in information retrieval.
2	To understand the concepts of IR models.
3	To explore information extraction and integration.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C942.1	Understand the basic concepts in Information Retrieval.	[U]
C942.2	Analyze the searching and indexing techniques.	[A]
C942.3	Understand the link analysis for ranking.	[U]
C942.4	Apply classification and clustering techniques on text documents.	[AP]
C942.5	Evaluate the effectiveness of information retrieval methods.	[E]
C942.6	Able to understand extraction of information and integration.	[U]

Course Contents:

Module I - Introduction **15 Hours**

History, Components of IR – Open-source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search - Characterizing the web. **Querying:** Pre-processing - wildcard queries, Phrase Queries - Relevance Feedback - Query expansion. **Models:** Boolean and vector-space retrieval models - Term weighting - TF - IDF weighting - cosine similarity –- efficient processing with sparse vectors – Language Model based IR - Probabilistic IR –Latent Semantic Indexing. **Searching and Indexing:** Web Search Architectures - crawling - meta crawlers - Focused Crawling - Inverted indices - web indexes – Near-duplicate detection - Index Compression – XML retrieval.

Module II - Link Analysis, Classification and Clustering **15 Hours**

Link Analysis: Hubs and Authorities – Page Rank and HITS algorithms- Evaluation- metrics Recall, Precision and F measure – Evaluations on Benchmark Text Collections – Text Representation – Word Statistics – Morphology – Index Term Selection using Thesauri –Metadata and Markup Languages. **Classification-** Text classification and clustering - Categorization algorithms: Naive Bayes; decision trees; and nearest neighbour, Support Vector Machine – **Clustering algorithms:** Flat clustering, Hierarchical Clustering, Agglomerative clustering, K-means, Expectation Maximization (EM) - Semantic Matching using Neural Networks. Recommendation System.

Module III: Information Extraction **15 Hours**

Integration of Information extraction- Entity Extraction-Rule based methods and Statistical methods-Extracting Data from Text – XML – Ontologies, thesauri, semantic web – Collecting and Integrating Specialized Information on the Web - Evaluation of Information extraction Technologies **Case Study:** Organizations and Information systems data in Traditional file Environment, Biomedical Texts and Business Texts.

Total Hours:	**45**

Text Books:

1	Christopher D.Manning, Prabhakar Raghavan,Hinrich Schutze, “Introduction to information retrieval”, Cambridge university press, first south asian edition, 2012.
2	Ricardo Baeza-Yates, Berthier Ribeiro-Neto, “Modern information retrieval: The concepts and technology behind search”,ACM press books, second edition, 2011.
3	Marie Francine Moens, “Information Extraction: Algorithms and Prospectus in a Retrieval Context”, 2010.

Reference Books:

1	Stephen Buettcher, Charles L.A. Clarke and Gordon V. Carmack, “Information Retrieval: Implementing and Evaluating Search Engines”, MIT Press, 2010
2	Bruce Croft, Donald Metzler and Trevor Strohman, “Search Engines: Information Retrieval in Practice”, 1st Edition Addison Wesley, 2009.

3	Mark Levene, “An Introduction to Search Engines and Web Navigation”, 2nd Edition, Wiley, 2010.
Web References:	
1	Information Retrieval,Wiley
2	https://www.coursera.org/courses/information/retrieva
3	https://www.sciencedirect.com/topics/computer-science/information-retrieval-systems
4	https://en.wikipedia.org/wiki/Information_retrieval

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C942.1	Understand	Quiz	20
C942.2	Analyze	Tutorial	20
C942.3	Understand	Assignment	20
C942.4	Apply		
C942.5	Apply	Presentation	20
C942.6	Understand		

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination				
Continuous Assessment (40%) [200 Marks]				**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks		**CA 2 : 100 Marks**		
SA 1	**FA 1 (40 Marks)**	**SA 2**	**FA 2 (40 Marks)**	

(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C942.1	3	3	3	2	3	2						2	2	2	2
C942.2	3	3	3	2	3	2						2	2	2	2
C942.3	3	3	3	3	3	2						2	2	2	2
C942.4	3	3	3	2	3	2						2	2	3	3
C942.5	3	3	3	3	3	3						3	3	2	2
C942.6	3	3	3	3	3	3					3	3	2	3	3

22AD943	COMPUTATIONAL STATISTICS FOR DATA SCIENCE	3/0/0/3
Nature of Course	C (Theory Concept)	
Prerequisites	Python for Data Science	
Course Objectives:		
1	To introduce computational statistics concepts.	
2	To study the basics of probability and statistical model.	
3	To determine which type of sampling distribution would be suitable for a given type of application problem.	
4	To design and create small real time applications using statistical model.	
Course Outcomes: Upon completion of the course, students shall have ability to:		
C943.1	Understand the basic computational statistics.	[U]
C943.2	Understand the concepts of exploratory data analysis.	[U]
C943.3	Describe the attributes of sampling distributions that can be applied over data.	[A]
C943.4	Create Rules for multi variable distribution.	[AP]
C943.5	Apply knowledge to design solutions to different problems.	[AP]

Course Contents:

MODULE I EXPLORATORY DATA ANALYSIS **15 Hours**

Elements of structured data – Rectangular Data – Estimates of Location – Estimates of variability – Exploring the data distribution – Exploring Binary and Categorical Data – Exploring two or more variables. Case Study: Analysis of E-commerce Sales Data.

MODULE II DATA AND SAMPLING DISTRIBUTIONS **15 Hours**

Random sampling and sample bias – selection bias – sampling distribution of a statistic – The bootstrap – Confidence intervals – Normal distribution – Long tailed distribution – Binomial distribution – Poisson distribution – Graphical Neural Network. Case Study: Analyzing Election Polling Data Using Sampling and Distribution Techniques.

MODULE III BAYESIAN MODELLING AND APPLICATIONS **15 Hours**

Bayesian Statistics – Markov Chain Monte Carlo Methods for Bayesian modeling – PyMC3 for Bayesian Modeling and Inference – Applications of Statistical Models – **Case Study:** Hybrid Feature Vector-Assisted Action Representation for Human Action Recognition Using Support Vector Machines, Use PyMC3 to model the disease dynamics of and infer the parameters of an SIR model of COVID-19 from real-world data. Case Study: Modeling COVID-19 Dynamics with PyMC3.

Total Hours:	**45**

Text Books:

1	Hao Helen Zhang, Richard A. Levine, Thomas C. M. Lee, Walter W. Piegorsch, “Computational Statistics in Data Science”, Wiley, March 2022.
2	Peter C.Bruce and Andrew C.Bruce, “Statistics for Data Scientists”, O’Reilly, 2018.
3	Geof H. Givens and Jennifer A. Hoeting,” Computational Statistics” Second Edition, Wiley Publications, 2018.

Reference Books:

1	Debabrata Samanta, Raghavendra Rao Althar, Sabyasachi Pramanik, Soumi Dutta, “Methodologies and Applications of Computational Statistics for Machine Intelligence”, IGI Global, 2021.
2	Dawn Griffiths, “Head First Statistics: A Brain-Friendly Guide”, O’Reilly, 2018.

3	Christian Heumann, Michel Schomaker, “Introduction to statistics and Data Analysis”, Springer Publishers, 2020.
Web References:	
1	https://www.coursera.org/specializations/compstats
2	https://www.stat.colostate.edu/computationalstatistics/
3	https://www.analyticssteps.com/blogs/introduction-graph-neural-network-gnn

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C943.1	Understand	Quiz	20
C943.2	Remember	Tutorial	20
C943.3	Apply	Assignment	20
C943.4	Apply		
C943.5	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C943.1	3	3	2	2	3	3	3	3			2	2	3	3	3
C943.2	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C943.3	3	3	3	3	2	2	2	3			2	3	3	3	2
C943.4	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C943.5	3	3	3	3	2	2	2	3	2	3	2	2	3	3	3

22AD944	ETHICS IN DATA SCIENCE	3/0/0/3
Nature of Course	C (Theory Concept)	
Prerequisites	Data Science	
Course Objectives:		
1	To understand the need of ethics in data science.	
2	To know about privacy and their risk.	
3	To be familiar with choice of attributes.	
4	Interpret and apply a professional code of ethics relevant to the data science profession.	
5	To identify ethics in real time with the help of case studies.	
Course Outcomes: Upon completion of the course, students shall have ability to		
C944.1	Identify and analyze the ethical needs in data science.	[U]
C944.2	Articulate the privacy degree and risk.	[U]
C944.3	Apply ethical frameworks to help them analyze ethical challenges.	[AP]
C944.4	Analyze the errors in processing the data and design.	[A]
C944.5	Develop the data based on guiding principles.	[AP]
C944.6	Examine ethics in various real time examples.	[A]

Course Contents:

MODULE I Introduction to Ethics and Data Privacy **15 Hours**

Ethics – Data Science needs ethics – Five C's - Informed Consent – Limitations in informed Consent - Privacy – History of Privacy – Degree of Privacy – Modern Privacy risk - Policy guidelines. Case Study: Social Sciences and Behavioural Case.

MODULE II Significance of Ethics **15 Hours**

Algorithmic Bias –Policy Guidelines - Ethical Rules- Ethical Frameworks - Ethical Challenges – Best Practices for practitioners and users - Data Validity – Choice of attribute and measure – Errors in Data Processing – Errors in Model Design. Case Study: Algorithmic Bias, Ethical Guidelines, and Data Validity

MODULE III Building Ethics

Code of Ethics – Wrap up – Ethics and security training – Developing guiding principles – Building ethics into data driven culture – Regulation – Case Study: Algorithm Fairness, Social Credit Scores, Target Ads.

Total Hours:	**45**

Text Books:	
1	Bill Franks, "97 Things About Ethics Everyone in Data Science Should Know", O'Reilly Media, Inc, August 2022.
2	Mike Loukides, Hilary Mason, Dj Patil, "Ethics in Data Science", O'Reilly Media, Inc, 2020.
Reference Books:	
1	Shannon Vallor, William J. Rewak, S.J., "An Introduction to Data Ethics", Santa Clara University, 2021.
2	John D. Kelleher, Brendan Tierney, "Data Science", MIT Press, 2020.
Web References:	
1	https://www.coursera.org/learn/data-science-ethics

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C944.1, C944.2	Apply	Tutorial	20
C944.3	Understand	Assignment	20
C944.4, C944.5	Apply	Case Study	20
C944.6	Understand	Quiz	20
Assessment based on Summative and End Semester Examination			
Revised Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C944.1	3	3	2	2	3	3	3	3			2	2	3	3	3
C944.2	3	3	2	2	3	3	3	3	1	1	2	2	2	3	3
C944.3	3	3	3	3	2	2	2	3			2	3	3	3	2
C944.4	3	3	2	2	3	3	3	3	1	1	2	2	3	2	2
C944.5	3	3	3	3	2	2	2	3	2	3	2	2	3	3	3

22AD945	**VIDEO ANALYTICS**	**3/0/0/3**

Nature of Course	F (Theory)

Pre Requisite: Deep Learning and its applications

Course Objectives:

1	understand the basics of image processing techniques for computer vision
2	Learn the techniques used for image pre-processing.
3	Discuss the various object detection techniques.
4	understand the various Object recognition mechanisms.
5	elaborate on the video analytics techniques.

Course Outcomes:

Upon completion of the course, students shall have ability to

C 945.1	Analyze the basics of image processing techniques for computer vision and video analysis.	[A]
C945.2	Apply the techniques used for image pre-processing.	[AP]
C945.3	Develop various object detection techniques.	[AP]
C945.4	Understand the various face recognition mechanisms.	[U]
C945.5	Elaborate on deep learning-based video analytics.	[U]

Course Contents:

Module 1: Introduction to image pre-processing **15 hours**

Computer Vision – Image representation and image analysis tasks - Image representations – digitization – properties – color images – Data structures for Image Analysis - Levels of image data representation - Traditional and Hierarchical image data structures - Local pre-processing - Image smoothing - Edge detectors - Zero-crossings of the second derivative - Scale in image processing - Canny edge detection - Parametric edge models - Edges in multispectral images - Local pre-processing in the frequency domain - Line detection by local preprocessing operators - Image restoration. Enhancing Public Safety: A Case Study on Real-Time Video Analytics in Smart City Surveillance. **Case Study:** Real-Time Surveillance Systems Using Video Analytics for Smart Cities

Module 2 : Face Recognition And Gesture Recognition **15 hours**

Object detection– Object detection methods – Deep Learning framework for Object detection– bounding box approach-Intersection over Union (IoU) –Deep Learning Architectures-R-CNN-Faster R-CNN-You Only Look Once(YOLO)-Salient features-Loss Functions-YOLO architectures- Face Recognition-Introduction-Applications of Face Recognition-Process of Face Recognition- DeepFace solution by Facebook-FaceNet for Face Recognition- Implementation using FaceNetGesture Recognition. Case study AI-Driven Traffic Management: Leveraging Video Analytics for Smart Transportation Systems. **Case Study:** Video Analytics in Retail: Enhancing Customer Experience and Business Intelligence

Module 3 : Video Analytics **15 hours**

Video Processing – use cases of video analytics-Vanishing Gradient and exploding gradient problem - RestNet architecture-RestNet and skip connections-Inception Network-GoogleNet architecture Improvement in Inception v2-Video analytics-RestNet and Inception v3. Case Study: Video Analytics in Retail: Improving Customer Insights and Security through Intelligent Monitoring. **Case Study** : Automated Traffic Management Systems: Leveraging Video Analytics for Smart Transportation

Total Hours:	**45**

Text Books:	
1	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, 4nd edition, Thomson Learning, 2023.
2	Vaibhav Verdhan, 2021, Computer Vision Using Deep Learning Neural Network Architectures with Python and Keras, Apress, 2023.
Reference Books:	
1	Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Verlag London Limited, 2023.
2	Caifeng Shan, FatihPorikli, Tao Xiang, Shaogang Gong, “Video Analytics for Business Intelligence”, Springer, 2022.
Web References:	
1	https://www.briefcam.com/technology/video-analytics/
2	https://www.sciencedirect.com/topics/computer-science/video-analytics
3	https://www.viisights.com/
Online Resources:	
1	https://senstar.com/products/video-analytics/
2	https://archive.nptel.ac.in/courses/110/106/110106072/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C945.2	Apply	Tutorial	20
C945.4, C945.5	Understand	Assignment	20
C945.3	Apply	Case Study	20
C945.1	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C945.1	3	3	3	2	3	2						2	2	2	2
C945.2	3	3	3	2	3	2						2	2	2	2
C945.3	3	3	3	3	3	2						2	2	2	2
C945.4	3	3	3	2	3	2						2	2	3	3
C945.5	3	3	3	3	3	3						3	3	2	2

22AD946	WEB AND SOCIAL MEDIA MINING	3/0/0/3
Nature of Course	H (Theory Technology)	
Pre requisites	Data Warehousing and Mining	

Course Objectives:

1	To provide an overview of common text mining and social media data analytic activities.
2	To introduce the various tools for Text Mining and carry out Pattern Discovery, Predictive Modeling.
3	To understand the complexities of processing text and network data from different data sources.
4	To enable students to solve complex real-world problems for sentiment analysis and Recommendation systems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C946.1	Interpret the terminologies, metaphors and perspectives of social media analytics.	[U]
C946.2	Apply a wide range of classification, clustering, estimation and prediction algorithms on Textual data.	[AP]
C946.3	Perform social network analysis to identify important social actors, subgroups and network properties in social media sites.	[A]
C946.4	Provide solutions to the emerging problems with social media such as behavior analytics and recommendation systems.	[A]
C946.5	Design new solutions to opinion extraction, sentiment classification and data summarization problems.	[AP]

Course Contents:

Module 1: Text and Web Mining: **18 Hours**

Text Representation- tokenization, stemming, stop words, TF-IDF, Feature Vector Representation, NER, Text Clustering, Text Classification, Topic Modeling, Query optimization, page ranking. Web Crawling-Crawler Algorithms, Implementation Issues, Evaluation, Session & visitor Analysis, Visitor Segmentation, Analysis of Sequential & Navigational Patterns, Predictions based on web user transactions.

Module 2: Social Media Mining **15 Hours**

Social network and web data and methods. Graphs and Matrices. Basic measures for individuals and networks. Information visualization. **Making connections**: Link analysis. Random graphs and network evolution. **Social contexts**: Affiliation and identity; Social network analysis, Recommendation system

Module 3: Sentimental and Behavioral Analytics **12 Hours**

Content Analysis; Natural Language Processing; Clustering & Topic Detection; Simple Predictive Modeling; Sentiment Analysis; Sentiment Prediction. **Behavior Analytics**: Individual Behavior, Collective Behavior. **Case study:** Usage of Linguistic Inquiry and Word Count (LIWC) analysis software program and similar tools.

Total Hours: 45

Text Books:

1.	Matthew A. Russell, Mikhail Klassen “Mining the Social Web”, Third Edition, 2019.
2.	Bing Liu, “Web Data Mining-Exploring Hyperlinks, Contents, and Usage Data”, Springer, Second Edition, 2011.
3.	Reza Zafarani, Mohammad Ali Abbasi and Huan Liu, “Social Media Mining – An Introduction”, Cambridge University Press, 2014.

Reference Books:

1.	Bing Liu, “Sentiment Analysis and Opinion Mining”, Morgan & Claypool Publishers, 2012.
2.	Nitin Indurkhya, Fred J Damerau, “Handbook of Natural Language Process”, 2nd Edition, CRC Press, 2010.
3.	Matthew A.Russell, “Mining the social web”, 2nd edition- O'Reilly Media, 2013.
4.	Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, First Edition, 2009.

Web References:

1.	https://www.g2.com/articles/social-media-data-mining

2.	www.gsb.stanford.edu/faculty-research/behavioral-lab
Online Resources:	
1.	https://www.coursera.org/projects/basic-sentiment-analysis-tensorflow
2.	https://cs.ccsu.edu/~markov/ccsu_courses/WebMining.html
3	https://www.coursera.org/learn/text-mining?specialization=data-mining

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C946.1	Understand	Quiz	20
C946.2	Apply	Tutorial	20
C946.3	Apply	Group Assignment	20
C946.4	Understand		
C946.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

* SA 1 & SA 2 are continuous internal examination conducted each for 100 marks
* FA1 & FA 2 is internal components conducted as per syllabus requirements. Each Component evaluated for 10 marks each.
* ES exams conducted and evaluated for 100 marks.

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C946.1	3	3	3	2	2	2		2	2	2	2	2			
C946.2	3	3	3	3	3	3		2	2	2	2	3			
C946.3	3	3	3	3	3	3		2	3	2	2	3			
C946.4	3	3	3	3	3	3		2	3	3	2	3			
C946.5	3	3	3	3	3	3		2	3	3	2	3			

22AD947	BUSINESS ANALYTICS	3/0/0/3
Nature of Course	F (Theory Programming)	
Pre-Requisite	Nil	

Course Objectives:

1	To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
2	To become familiar with the processes needed to develop, report, and analyze business data.
3	To learn how to use and apply Excel and Excel add-ins to solve business problems.
4	Learn calculations of measures of central tendency
5	It leads the way for better understanding and viewing of data.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C947.1	To understand the Business Analytics in practice	[U]
C947.2	To understand concepts of Descriptive Analytics	[U]
C947.3	To learn about Data mining for business	[A]
C947.4	To understand concepts of Prescriptive Analytics	[AP]
C947.5	To learn about the R environment Unit	[AP]

Course Contents:

MODULE I: INTRODUCTION TO BUSINESS ANALYTICS **15 hours**

Definition of Business Analytics, Categories of Business Analytical methods and models, Business Analytics in practice, Big Data - Overview of using Data, Types of Data- Business decision modeling.

MODULE II: DESCRIPTIVE ANALYTICS **15 hours**

Overview of Description Statistics (Central Tendency, Variability), Data Visualization -Definition, Visualization Techniques – Tables, Cross Tabulations, charts, Data Dashboards using Advanced Ms-Excel or SPSS, Data Exploration & Reduction, Data mining and business intelligence. Data Analysis and Frequency Distribution (DAFD), Scales of Measurement. Measures of Central Tendency, Pythagorean, Means, Dispersion, Skewness and Kurtosis. **Case Study -** Selective Inventory Control Techniques: ABC, VED, FNSD & XYZ

MODULE III: PRESCRIPTIVE ANALYTICS **15 hours**

Overview of Linear Optimization, Non-Linear Programming Integer Optimization, Cutting Plane algorithm and other methods, Data mining for business, Classification, Association, Cause Effect Modeling - Decision Analysis – Relative frequency and Subjective -Risk and uncertainty methods - Text analytics Web analytics. **Case Study** - KDD Process

Total Hours:	**45**

Text Books:

1	Camm, Cochran, Fry, Ohlmann, Anderson, Sweeney, Williams – “Essentials of Business Analytics” Cengage Learning.2022
2	Albright Winston, “Business Analytics - Data Analysis - Data Analysis and Decision Making” Cengage Learning, Reprint 2022

Reference Books:

1	Sahil Raj, “Business Analytics” First Edition, John Wiley & Sons, Inc., USA 2020.

2	James Evans, “Business Analytics”, Pearson., First Edition, Maker Media Inc, San Francisco CA, 2019
Web References:	
1	https://www.ibm.com/topics/business-analytics
2	https://www.datacamp.com/blog/what-is-business-analytics
Online Resources:	
1	https://www.learnquest.com/course-detail-v3.aspx?cnum=BACS-200-IN
2	https://online.hbs.edu/courses/business-analytics/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C947.2	Apply	Tutorial	20
C947.1	Understand	Assignment	20
C947.3, C947.5	Analyze	Case Study	20
C947.4	Apply	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C947.1	3	3	3	2	3	2						2	2	2	2
C947.2	3	3	3	2	3	2						2	2	2	2
C947.3	3	3	3	3	3	2						2	2	2	2
C947.4	3	3	3	2	3	2						2	2	3	3
C947.5	3	3	3	3	3	3						3	3	2	2

22AD948	SPEECH PROCESSING	3/0/0/3
Nature of Course	C (Theory Concept)	
Prerequisites	Nil	

Course Objectives:

1	Understand the fundamental concepts of speech production and perception.
2	Study the characteristics and processing techniques of speech signals.
3	Learn methods for speech analysis, synthesis, and recognition.
4	Explore the applications of speech processing in modern technologies.
5	Discuss challenges and current research trends in speech processing.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C948.1	Understand the mechanisms of speech production and perception.	[U]
C948.2	Identify various techniques used in speech analysis and processing.	[U]
C948.3	Apply speech synthesis and recognition techniques in real-world applications.	[AP]
C948.4	Analyze speech processing challenges and evaluate potential solutions.	[A]
C948.5	Implement practical speech processing systems in various domains.	[AP]

Course Contents:

MODULE I Introduction to Speech Processing **15 Hours**

Basics of Speech Production and Perception - Acoustic Phonetics and Linguistics - Speech Signal Representation and Features - Time-domain Methods for Speech Processing - Applications of Speech Processing: **Case Study** on Voice Assistants.

MODULE II Speech Analysis and Synthesis **15 Hours**

Frequency-domain Methods: Fourier Transform, Spectrograms - Linear Predictive Coding (LPC) - Cepstral Analysis, MFCC - Speech Synthesis: Text-to-Speech Systems - Case Study: Synthesis Techniques in Assistive Technologies.

MODULE III – Speech Recognition and Advanced Topics **15 Hours**

Basics of Automatic Speech Recognition (ASR) - Hidden Markov Models (HMM) and Gaussian Mixture Models (GMM) - Deep Learning in Speech Processing: DNN, CNN, RNN - Speaker Recognition and Verification - Case Study: Applications of Speech Recognition in Virtual Assistants.

Total Hours:	**45**

Text Books:

1	Lawrence R. Rabiner, Ronald W. Schafer, Digital Processing of Speech Signals, Pearson, 2016.
2	Thomas F. Quatieri, Discrete-Time Speech Signal Processing, Pearson, 2018.
3	Ben Gold, Nelson Morgan, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, John Wiley & Sons, 2021.

Reference Books:

1	Sadaoki Furui, Digital Speech Processing, Synthesis, and Recognition, CRC Press, 2018.
2	Douglas O'Shaughnessy, Speech Communications: Human and Machine, IEEE Press, 20020.

Web References:

1	https://www.coursera.org/learn/speech-processing
2	https://www.sciencedirect.com/book/9780123738037/digital-speech-processing-synthesis-and-recognition
3	https://online.stanford.edu/courses/sohs-ym0013-introduction-speech-processing

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C948.1	Understand	Quiz	20
C948.2	Remember	Tutorial	20
C948.3	Apply	Assignment	20
C948.4	Apply		
C948.5	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C948.1	2	1	3		3								3	3	3
C948.2	3	3	2	3	2								3	2	3
C948.3	3	3	2										3		3
C948.4	2	1	2										2		2
C948.5	2	1	2	3				1	1	1	1	1	3	3	3

22AD949	RISK ANALYTICS	3/0/0/3
Nature of Course	F (Theory Programming)	
Pre-Requisite	Business Analytics	

Course Objectives:

1	To introduce the importance of Risk analytics and its relevance in the current financial landscape.
2	To explore the different types of financial analytics and understand their applications in corporate financial analytics.
3	To introduce the fundamental analysis and technical analysis and explain their features and implementation in financial analytics.
4	To introduce financial data analytics and its various types such as market data, business data, and process automation.
5	To explore credit risk modeling and provide an overview of consumer credit products.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C949.1	Understand the importance of financial analytics and its relevance in the current financial landscape.	[U]
C949.2	Analyze and apply different types of financial analytics in corporate financial analytics, investment financial analytics, and financial analytics for current financial challenges.	[A]
C949.3	Analyze financial data analytics and its various types such as market data, business data, and process automation.	[A]
C949.4	Understand the credit risk modeling and provide an overview of consumer credit products, credit rating agencies	[U]
C949.5	Evaluate fundamental analysis and technical analysis and their features and implementation in financial analytics	[AP]

Course Contents:

MODULE I: Risk Data Analytics **15 Hours**

Types of Risk Data, Financial Data, Market Data, Business Data, Process Automation, Risk and Security, Underwriting and Credit scoring, Algorithmic trading, Time Series, Meaning and Components, Trend Analysis, Seasonality and cyclical behavior, Moving Average, Exponential smoothing methods – Single exponential, double exponential, HOLT-WINTERS, ARIMA.

MODULE II: Credit Risk Foundation **15 Hours**

Overview of Consumer Credit Products, Credit Risk Fundamentals, Credit Rating Agencies, External Analysis for Credit Information, Verification Frameworks Risk modeling– Fundamentals-Different approaches for risk modeling-Binomial Logistic, Multinomial Logistic, Survival Analysis, Penalized Models, Hazard Models. **Case Study** - Distinction between applied risk analysis and generic (fundamental) risk analysis.

MODULE III: Risk Regulations **15 Hours**

BASEL II Concepts - Pillar 1, 2 and 3, BASEL II vs BASEL III, IFRS9 standards, Comparison between requirements by FSA and APRA, Comparison between IFRS9 standard and CECL (FASB), CCAR, Regulation and calculation overview, Asset Classes, V Model Validation-Regulation's Context: Data Cleaning & Model Diagnostics, Variable Selection, Candidate Models, Residual Diagnostics. **Case Study** - Work with real-world climate data to develop the analytical skills required for climate risk management

Total Hours:	**45**

Text Books:	
1	Jimmy Skoglund, “Financial Analysis and Risk Management”, Springer Publication, 2022.
2	Richard Apostolik “Foundations of Financial Risk: An Overview of Financial Risk and Risk-based Financial Regulation” Wiley, 2021.
Reference Books:	
1	Harald Scheule, Credit Risk Analytics: Measurement Techniques, Applications, and Examples in SAS, Wiley and SAS Business Series, Bart Baesens, Daniel Roesch, Wiley, 2022.
2	Anthony Saunders and Linda Allen, “Credit Risk Measurement: New Approaches to Value at Risk and Other Paradigms”, John Wiley & Sons; 2nd edition, 2020.
Web References:	
1	https://www.investopedia.com/terms/r/risk-analysis.asp
2	https://onlinelibrary.wiley.com/journal/15396924
Online Resources:	
1	https://www.ey.com/en_in/services/consulting/financial-services-risk-management/cafta/certificate-in-financial-risk-management
2	https://www.coursera.org/specializations/risk-management

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C949.1	Understand	Tutorial	20
C949.4	Understand	Assignment	20
C949.5	Apply	Case Study	20
C949.2, C949.3	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40

Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C949.1	3	3	3	2	3	2						2	2	2	2
C949.2	3	3	3	2	3	2						2	2	2	2
C949.3	3	3	3	3	3	2						2	2	2	2
C949.4	3	3	3	2	3	2						2	2	3	3
C949.5	3	3	3	3	3	3						3	3	2	2

22AD951	VIRTUAL REALTY IN GAME DEVELOPMENT	3/0/0/3

Nature of Course	F (Theory Programming)

Course Objectives:

1	To Identify 3D Immersive Environments and content creation specifically for 3D Game development.
2	To gain knowledge in game creation pipeline, from design, implementation and testing.
3	To Understand how game players move in virtual environments.
4	To familiar with immersive games using various head mounted displays.
5	To analyze the differences between Desktop and VR based Computer Games.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C951.1	Understand about 3D digital games in both desktop and immersive context.	[U]
C951.2	Recognize basic principles and requirements of virtual reality.	[U]
C951.3	Identify the 3D Game content including character generation and control.	[AN]
C951.4	Develop software for using game controllers and tracking for motion control.	[AN]
C951.5	Learn about immersive gaming differs from classical desktop gaming.	[U]
C951.6	Apply principles and algorithms to narrative experiences and application specifically for VR.	[AP]

Course Contents:

MODULE I: Game Content Creation and Asset Production **15 Hours**

Introduction to Game Content Creation using 3DS Max - Overview of Game Creation Software: Introduction to Unity3D - Game Asset Production Pipeline for Unity - Materials and Textures: Texture Unwrapping and Creating Materials in Unity3D and Photoshop - Terrains and Landscapes: Painting, Sculpting, Trees, and Plants - Shaders: Water, Fog, Cloud, Rain, Fire. **Case Study:** Asset Creation in "Assassin's Creed Odyssey"

MODULE II: Game Design and Mechanics **15 Hours**

Planning Levels - Gameplay Mechanics: First-Person Perspective, Moving through the Scene - VR Hardware Requirements: Motion Tracking and Stereo Vision HMDs - VR Software Scripting: C# and VR Toolkits for Unity3D - Cameras for Desktops and HMDs - Lights and Skybox Creation: Indirect Illumination and Environmental Effects. **Case Study:** Level Design and Mechanics in "Portal".

MODULE III: Advanced VR and Immersive Gaming **15 Hours**

Displays: Desktop Systems, Immersive Systems, HMDs (Google Cardboard, HTC Vive, GearVR, Oculus Rift) - Virtual Reality Limitations and Immersive Gaming - Interaction: Motion Control, Controller, Gaze Input Interaction - Virtual Agents: Animation, Artificial Intelligence, Unity NavMesh - Audio and Sound Effects: Background Sounds and Triggered Sounds. **Case Study:** Immersive Interaction in "Half-Life: Alyx"

Total Hours:	**45**

Text Books:

1	John Williamson, "Virtual Reality Blueprints", O'Reilly Media, 2018.
2	Jonathan Linowes, Ryan O'Donnell, "Unity 2020 Virtual Reality Projects", O'Reilly Media, 2020.
3	Jesse Glover "Enhancing Virtual Reality Experiences with Unity 2022", O'Reilly Media, 2022

Reference Books:

1	Erin Pangilinan, Steve Lukas, and Vasanth Mohan "Creating Augmented and Virtual Realities" by, O'Reilly Media, 2019.

	Micheal Rodriguez and Brian Ries "Augmented Reality Game Development", O'Reilly Media, 2021.
Web References:	
1	https://sdlccorp.com/post/a-comprehensive-guide-to-virtual-reality-game-development-for beginners/
2	https://docs.unity3d.com/Manual/VROverview.html
3	https://www.tomlooman.com/unreal-engine-vr-getting-started/
4	https://developer.mozilla.org/en-US/docs/Games/Techniques/3D_on_the_web/WebXR
Online References:	
1	https://gamedevacademy.org/the-complete-virtual-reality-game-development-course/
2	https://developer.mozilla.org/en-US/docs/Web/API/WebXR
3	https://www.perforce.com/
4	https://polydin.com/virtual-reality-game-development/
5	https://www.udemy.com/course/oculus-quest-development-with-unity/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C951.1	Understand	Quiz	20
C951.2	Apply	Tutorial	20
C951.3	Apply	Group Assignment	20
C951.4	Understand		
C951.5 & C951.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C951.1		1	3	3	3							1	3	3	3
C951.2	1	2	3	3	3	1						1	3	3	3
C951.3	2	2	3	3	2							1	3	3	3
C951.4	2	1	3	3	3							1	3	3	3
C951.5	2	1	2	3	2	1						1	3	3	3
C951.6	3	3	3	3	2				2	2		1	3	3	3

22AD952	AUGMENTED REALITY AND VIDEO STREAMING	3/0/0/3

Nature of Course	F (Theory Programming)

Course Objectives:

1	To understand key concepts of Augmented Reality and distinguish it from Virtual Reality and their applications.
2	To analyze various AR user interfaces and their impact on user interaction and experience.
3	To explore AR business models and market trends, focusing on market share, forecasts, and applications in gaming, healthcare, and retail.
4	To gain expertise in AR feature extraction techniques and their role in enhancing AR experiences.
5	To understand principles of video streaming technologies and the importance of Content Delivery Networks in efficient streaming.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C952.1	Demonstrate a clear understanding of Augmented Reality concepts and differentiate them from Virtual Reality.	[U]
C952.2	Evaluate and critique various AR user interfaces, assessing their effectiveness and impact on user experience.	[AN]
C952.3	Analyze and interpret market trends and business models in AR, including applications in gaming, healthcare, and retail.	[AN]
C952.4	Apply AR feature extraction techniques effectively to enhance AR applications.	[AP]
C952.5	Explain the principles of video streaming technologies and assess the role of Content Delivery Networks in optimizing streaming performance.	[AP]

Course Contents:

MODULE I: AR Technologies and Applications **15 Hours**

Definitions and characteristics of Augmented Reality (AR) and its comparison with Virtual Reality (VR). Exploration of AR user interfaces, including smartphones, AR eyeglasses, and head-mounted displays (HMDs). AR business models and market analysis, including AR/VR market share and forecasts for AR/VR headsets. **Case study**: IKEA Place.

MODULE II: AR Feature Extraction & Cloud Technologies **15 Hours**

Overview of AR technological components and Interest Point Detection (IPD). In-depth study of feature extraction techniques: SIFT (Scale Invariant Feature Transform), SURF (Speeded-Up Robust Features), FAST (Features from Accelerated Segment Test), BRIEF (Binary Robust Independent Elementary Features), ORB (Oriented FAST and Rotated BRIEF), and BRISK (Binary Robust Invariant Scalable Key points). AR cloud computation and offloading, including cloud-based cooperative computation. **Case study:** Google Lens.

MODULE III: Video Streaming & CDN Technologies **15 Hours**

Introduction to video streaming services such as Skype and YouTube, and their use of H.264/MPEG-4 AVC encoding - Detailed explanation of MPEG-DASH (Dynamic Adaptive Streaming over HTTP) and its role in adaptive streaming - Examination of Content Delivery Networks (CDNs), including hierarchical content delivery, caching mechanisms, and the differences between traditional CDN and Mobile CDN technologies. **Case study:** YouTube and MPEG-DASH.

Total Hours:	**45**

Text Books:

1	Tony Parisi, “Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile,” O'Reilly Media, 2020.

2	Raffaello D'Andrea, “Aerial Robotics: A Comprehensive Approach to the Study of Aerial Vehicles,” O'Reilly Media, 2022.
3	Irene Y. Chen, “Building Virtual Reality with Unity and Steam VR,” Apress, 2020.
Reference Books:	
1	David M. Matuszak, “Creating Augmented and Virtual Realities: Emerging Technologies for Business,” Business Expert Press, 2021.
2	Blake J. Harris, “The History of the Future: Oculus, Facebook, and the Revolution That Swept Virtual Reality,” HarperCollins, 2019.
Web References:	
1	https://edgemontlibrary.org/virtual-reality-books-a-curated-2024-updated-list-of-the-top-20/
2	https://callaba.io/potential-of-vr-and-ar-for-live-video-streaming
3	https://www.agora.io/en/blog/building-live-video-streaming-into-your-ar-experience-on-magic-leap-2/
4	https://www.deepar.ai/use-cases/ar-for-live-video-streaming
Online References:	
1	https://www.coursera.org/courses?query=augmented%20reality
2	https://www.careervira.com/en-US/course/ar-augmented-reality-and-video-streaming-services-emerging-technologies
3	https://digitaldefynd.com/best-augmented-reality-courses/

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C952.1	Understand	Quiz	20
C952.2	Apply	Tutorial	20
C952.3	Apply	Group Assignment	20
C952.4	Understand		
C952.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom’s Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30

Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C952.1		1	3	3	3							1	3	3	3
C952.2	1	2	3	2	3	1						1	3	3	3
C952.3	2	2	3	2	2							2	3	3	3
C952.4	2	1	3	3	3							1	3	3	3
C952.5	2	1	2	2	2	1						1	3	3	3

22AD953	APP DEVELOPMENT USING VRAR	3 / 0 / 0 / 3
Nature of Course:	H (Theory technology)	
Pre requisites:	NIL	

Course Objectives:

1	To Learn design and implement key VR functionalities such as tracking, teleporting, and interaction with virtual objects using Unity.
2	To Understand how Unity's AR Foundation supports building AR apps by integrating virtual elements with the real world.
3	To Gain hands-on experience in developing intuitive user interactions within VR environments, including object manipulation and locomotion systems.
4	To Learn integrate essential AR features such as plane detection, environment tracking, and object placement in augmented reality projects.
5	To Acquire skills to test, debug, and optimize VR and AR applications for improved performance and user experience across different platforms.

Course Outcomes:

Upon completion of the course, students shall have ability to

C953.1	Compare and Contrast VR and AR experiences.	[AN]
C953.2	Demonstrate and develop VR apps in Unity.	[AP]
C953.3	Demonstrate and develop AR apps in Unity.	[AP]
C953.4	Correlate the knowledge in VR and AR technologies in terms of used devices, building of the virtual environment and modalities of interaction and modelling.	[AN]
C953.5	Acquire knowledge about the application of VR and AR technologies in medicine, education, cultural heritage and games.	[AP]

Course Contents:

MODULE I: Introduction to AR & VR: **15 Hours**

Categorizing the realities – Virtual Reality, Augmented Reality & Mixed Reality, Introduction, features and application areas of Virtual Reality, Augmented Reality & Mixed Reality. All you need to know about VR – Integration of VR techniques, Contents objects and scale, Gaze-Based Control, Handy Interactables, IDE setup with package files, concepts and features of VR, VR project example All you need to know about AR - Working with AR techniques, compatibility with the environment, system architecture, AR terminology, application areas of AR, Integration of AR toolkits with existing IDE's (Unity-Vuforia, Visual Studio, Netbeans, intellij IDEA, Android, iOS), connectivity of smart devices with AR. **Case Study:** Single application using both VR and AR technologies.

MODULE II: VR and AR App Development with Unity: **15 Hours**

VR SDK's – VR SDK'S and Frameworks – OpenVR SDK, Stream VR SDK, VRTK, Oculus SDK,

Google VR SDK. VR Concept Integration - Motion Tracking, Controllers, Camera, Hardware and Software requirements Setting up Unity with VR - Framework/SDK Integration with Unity, Debugging VR projects, Unity XR API's, Mobile VR Controller Tracking, Object Manipulation, Text optimizing and UI for VR. AR Foundation – Detection of surfaces, identifying feature points, track virtual objects in real world, face and object tracking. AR Algorithms - Briefing on SLAM Algorithm (Simultaneous Localization and Mapping), understanding uncertain spatial relationship, Anatomy of SLAM, Loop detection and Loop closing Unity AR concepts- Pose tracking, Environmental detection, Ray casting and physics for AR, Light estimation, Occlusion, working with AR Core and ARKit. **Case study:** Creating 3D objects using Blender, Use of OpenCV for AR App Development.

MODULE II: Programming Languages for AR & VR applications: 15 Hours

C# with Unity – OOL concepts, classes in C#, setting up visual studio or code editor for C#, 3D models compatibility with C#, C# for AR and VR C++ with Unreal Engine – Building and compiling C++ programs with unreal engine, variables and memory, looping and if else structures with unreal engine, functions and macros, adding actors to the scene, dynamic memory allocations, spell book. Trending Application Areas - Gaming and Entertainment, Architecture and Construction, Science and Engineering, Health and Medicine, Aerospace and Defence, Education, Telerobotics and Telepresence Human Factors, Legal and Social Considerations - Human Factors Considerations, Legal and Social Considerations, The Future. **Case study:** Google Daydream.

	Total Hours: 45

Text Books:

1.	Jonathan Linowes , "Augmented Reality with Unity AR Foundation", O'Reilly, August 2021, ISBN: 9781838982591.
2.	Steve Aukstakalnis, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR", Addison-Wesley Professional, September 2016, ISBN: 9780134094328.
3.	Allan Fowler- Beginning iOS AR Game Development Developing Augmented Reality Apps with Unity and C#, 1st Edition, Apress Publications, 2018, ISBN 978-1484236178.
4.	William Sherif- Learning C++ by Creating Games with UE4 ||, Packt Publishing, 2015, ISBN 978-1-78439-657-2.

Reference Books:

1.	Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183.
2.	Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436.

Web References:	
1.	https://www.coursera.org/learn/augmented-reality
2.	https://www.coursera.org/specializations/unity-xr
3.	https://learn.unity.com/learn/pathway/vr-development
4.	https://github.com/topics/augmented-reality
Online Resources:	
1.	https://www.coursera.org/unity
2.	https://www.udemy.com/
3.	https://xrbootcamp.com/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C953.1	Understand	Quiz	20
C953.2	Apply	Tutorial	20
C953.3	Apply	Group Assignment	20
C953.4	Understand		
C953.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination					
Continuous Assessment (40%) [200 Marks]					End Semester Examination (60%) [100 Marks]
CA 1: 100 Marks			CA 2: 100 Marks		
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)	
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C953.1		1	3	3	3							1	3	3	3
C953.2	1	2	3	3	3	1						2	3	3	3
C953.3	2	2	3	3	2							1	3	3	3
C953.4	3	1	3	3	3							2	3	3	3
C953.5	2	1	2	3	2	1						1	3	3	3

22AD954	EXTENDED REALITY FOR UX/UI DESIGN	3 / 0 / 0 / 3
Nature of Course:	H (Theory technology)	
Pre requisites:	NIL	

Course Objectives:

1	Understand the fundamental concepts and history of AR, VR, and XR technologies.
2	Explore the XR pipeline, focusing on display technologies, machine perception, and content generation.
3	Develop skills in 3D rendering techniques and object representations using polygonal meshes.
4	Implement tracking and pose estimation methods for enhanced interactivity in XR applications.
5	Design and prototype an immersive XR project that integrates learned concepts and techniques.

Course Outcomes:

Upon completion of the course, students shall have ability to

C954.1	Identify the concepts and terminologies related to AR, VR, and XR technologies, including their history and applications.	[U]
C954.2	Illustrate the three main components of the XR pipeline and their roles in creating immersive experiences.	[AN]
C954.3	Demonstrate proficiency in 3D rendering techniques and implement object representations using polygonal meshes in XR environments.	[AP]
C954.4	Tracking and pose estimation methods, identifying appropriate techniques for different XR applications.	AN]
C954.5	Compute the concepts and skills to design and prototype an immersive XR project that demonstrates their understanding of AR, VR, and XR technologies.	[AP]

MODULE I: Introduction to XR Technologies: **15 hours**

The fundamentals of augmented reality (AR), virtual reality (VR), and extended reality (XR) are introduced, including the course schedule and essential concepts - The historical evolution of AR/VR/XR technologies and their diverse applications across various industries are explored - An overview of the XR pipeline focuses on display technologies, machine perception, and content generation - Understanding project structures and themes is emphasized, along with an introduction to the XR programming platform, establishing a strong foundation for XR development. **Case study:** Pokémon GO – A Landmark in Augmented Reality.

MODULE II: Scene Capture and Dynamics: **15 hours**

3D scene representations and rendering techniques are the focus, discussing topics such as polygonal meshes and efficient rendering methods, including rasterization - Tracking and pose estimation for XR applications are examined, covering rigid transforms, camera pose estimation, and body/hand tracking - The module also explores 3D scene capture techniques, depth estimation, and lighting techniques, enabling the creation of realistic environments - Practical assignments reinforce these concepts,

culminating in the development of project prototypes and simulations of physical objects. **Case study:** Architectural Visualization Using XR Technologies.

MODULE III: Advanced XR: **15 hours**

Cutting-edge display technologies such as micro-LED-based and waveguide-based displays - The challenges of mobile augmented reality (AR) are addressed, including limitations of computer vision on mobile hardware, UX/UI challenges, and content creation difficulties - Through theoretical discussions and practical applications, a comprehensive understanding of the complexities involved in developing AR applications for various devices is provided. **Case study:** Mobile Augmented Reality in Retail – IKEA Place App

	Total Hours: 45

Text Books:

1.	Jens M. G. E. P. Schneider, "Designing for XR: Creating the User Experience for Augmented and Virtual Reality", Springer, 2023.
2.	Cornel Hillmann, "UX for XR: User Experience Design and Strategies for Immersive Technologies", Apress, 2021.
3.	Stefan T. K. de Bie, "UX Design for AR and VR: A Guide for Creating Immersive User Experiences", Routledge, 2021.

Reference Books:

1.	Jesse Schell, "The Art of Game Design: A Book of Lenses", A K Peters/CRC Press.
2.	Tony Parisi, "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", O'Reilly Media, 2019.

Web References:

1.	https://www.wizeline.com/spatial-ux-design-in-extended-reality-best-practices-for-awesome-3d-experiences/
2.	https://www.uxmatters.com/topics/design/immersive-experience-design/
3.	https://www.nobledesktop.com/classes-near-me/blog/ux-design-in-extended-reality
4.	https://app.uxcel.com/glossary/extended-reality-design

Online Resources:

1.	https://www.coursera.org/specializations/xr-ux-design
2.	https://www.thevrara.com/
3.	https://www.amazon.com/Designing-Virtual-Reality-Paul-Brown/dp/0367337010
4.	https://xd.adobe.com/ideas/
5.	https://www.linkedin.com/learning/topics/virtual-reality

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C954.1	Understand	Quiz	20
C954.2	Apply	Tutorial	20
C954.3	Apply	Group Assignment	20
C954.4	Understand		
C954.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination							
Continuous Assessment (40%) [200 Marks]							**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**				
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**			
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**		

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C954.1	2			1						2			2	1	2
C954.2	3	1	1	2						1	2		2	2	3
C954.3	3	1	1	1						1	1		1	2	3
C954.4	2	1	1	2						2	2		2	1	2
C954.5	2	2	1	1						1	1		1	1	2

22AD955	METAVERSE TECHNOLOGIES	3 / 0 / 0 / 3
Nature of Course:	H (Theory technology)	
Pre requisites:	NIL	

Course Objectives:

1	To Present and discuss Metaverse characteristics, concepts and layers.
2	To Explain and analyse Metaverse technologies, tools, platforms, and applications.
3	To Discuss design theories and practices relevant to the Metaverse.
4	To Explore cybersecurity and cybercrime in the Metaverse.
5	To Examine open challenges in the Metaverse.

Course Outcomes:
Upon completion of the course, students shall have ability to

C955.1	Understand the characteristics, and interdisciplinary nature of the Metaverse, the opportunities and risks it presents.	[U]
C955.2	Analyze Metaverse layers, the technologies used in creating them, as well as design theories and practices for Metaverse.	[AN]
C955.3	Examine and discuss Metaverse platforms, applications and the latest technological developments	[AP]
C955.4	Evaluate cybersecurity issues, understand cybercrime, and discuss the open challenges.	[AN]
C955.5	Assess the potential for economic models and business opportunities within the Metaverse	[AP]

Course Contents:

Module I: Metaverse Fundamentals: 15 hours

Metaverse evolution - Metaverse importance and characteristics - The interdisciplinary nature of the Metaverse - Metaverse opportunities and risks - Computer-mediated communication (social presence theory, social information processing theory, media richness theory, cyborg theory) - Avatar-mediated communication, The seven layers of Metaverse, **Metaverse Technologies:** AR/VR/MR/XR - 3D reconstruction - Game engines - Smart glasses, wearables, haptic devices, headsets and headwear, Blockchain, smart contracts, tokens, NFTs – Cryptography - Artificial Intelligence (AI) - Internet of Things (IoT) - Edge computing and 5G, 6G. **Case study:** Motion sickness and cybersickness.

Module II: Tools and technologies for Metaverse UX and UI: 15 hours Tools and services for avatar systems - Spatial user interface design - Cross-platform user experience design - Multimodal user interface - Technologies and devices for human computer interaction in Metaverse. **Metaverse platforms:** Decentraland, SANDBOX, Roblox, Axie Infinity, uHive, Hyper Nation, Nakamoto (NAKA), Metahero (HERO), Star Atlas (ATLAS) Bloktopia (BLOK), Stageverse, Spatial, PalkaCity, Viverse, Sorare, Illuvium, Upland, Second Life, Sansar, Sensorium Galaxy. **Case study:** Community Governance.

Module III: Metaverse applications: 15 hours

Gaming and entertainment, Travel and tourism, Education and learning, Remote working, Commerce and business, Real estate, Banking and Finance, Healthcare, social media, Fashion. Cybersecurity concerns in Metaverse - Cybersecurity risks in Metaverse - Best practices for preventing cyberattacks in Metaverse - Implementing cybersecurity in the Metaverse. **Case study:** The sandbox.

Total Hours: 45

Text Books:

1.	Terry Winters, “The Metaverse”, Independently published, 2021, ISBN - 979-8450959283.
2.	Ball, M., 2022, “The Metaverse and How It Will Revolutionize Everything “, Liveright, ISBN: 978-1324092032
3.	Christodoulou, K. Katelaris, L., Themistocleous, M, Christoudoulou P. and Iosif E, 2022, “NFTs

	and the Metaverse Revolution: Research Perspectives and Open Challenges", Blockchains and the Token Economy: Theory and Practice, Eds: Lacity M., Treiblmaier H., (2022), Palgrave Macmillan, Cham, pp. 139-178
4.	Damar, M. (2021). Metaverse shape of your life for future: A bibliometric snapshot. Journal of Metaverse, 1(1), 1–8.
5.	Day, J. (2022) Metaverse will see cyberwarfare attacks unlike anything before: 'Massively elevated', February 28, https://www.express.co.uk/news/science/1570844/metaverse-news-cyberwarfare-attacks-virtual-worlds-russia-china-spt.
Reference Books:	
1.	Davis, A., Khazanchi, D., Murphy, J., Zigurs Ilze, & Owens, D. (2009). Avatars, people, and virtualworlds: Foundations for research in metaverses. Journal of the Association for Information Systems, 10(2), 90–117. https://doi.org/10.17705/1jais.00183.
2.	Nidagundi, P., 2022, "Metaverse Development: Handbook For Software Developer, Analyst,Consultant, Startups and Business Owners" ISBN: 979-8418729293.
3.	Polyviou, A., Pappas, I.O. (2022). Metaverses and Business Transformation. In: Elbanna, A., McLoughlin, S., Dwivedi, Y.K., Donnellan, B., Wastell, D. (eds) Cocreating for Context in theTransfer and Diffusion of IT. TDIT 2022. IFIP Advances in Information and Communication Technology, vol 660. Springer, Cham. Link: https://link.springer.com/chapter/10.1007/978-3-031-17968-6_25.
4.	Themistocleous, M., Christodoulou, K., & Katelaris, L. (2023). An Educational Metaverse Experiment: The first on-chain and in-Metaverse academic course. Information Systems. EMCIS 2022.
Web References:	
1.	https://www.sciencedirect.com/science/article/pii/S0268401222000767
2.	https://link.springer.com/chapter/10.1007/978-3-030-96068-1_8
3.	https://axveco.com/en/metaverse/
4.	https://hbr.org/2022/01/data-privacy-in-the-metaverse-understanding-the-risks
Online Resources:	
1.	https://www.coursera.org/learn/metaverse
2.	https://www.reddit.com/r/Metaverse/

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C955.1	Understand	Quiz	20
C955.2	Apply	Tutorial	20
C955.3	Apply	Group Assignment	20
C955.4	Understand		
C955.5	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1: [60 Marks]	**CIA2: [60 Marks]**	
Remember	20	20	20

Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1: 100 Marks			**CA 2: 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C955.1	2	1	3							1			3	3	3
C955.2	3	3	2	3						1	1		3	2	3
C955.3	3	3	2							1	1		3	3	2
C955.4	2	1	2	3						2	2		2	1	2
C955.5	2	1	2					1	1	1	1		3	2	3

22AD956	VIRTUAL REALITY DESIGN AND COMMUNICATION	3/0/0/3

Nature of Course	F (Theory)

Pre Requisite: Machine Learning

Course Objectives:

1	Understand the fundamentals of Virtual Reality (VR) technology.
2	Develop proficiency in designing and creating virtual environments.
3	Apply VR design principles for effective communication.
4	Analyze the impact of VR on communication and media.
5	Address ethical and practical challenges in VR applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C 956.1	Demonstrate understanding of VR concepts, systems and technologies.	[U]
C956.2	Design and create interactive virtual environments.	[AP]
C956.3	Relate VR techniques to enhance communication and user interaction.	[AP]
C956.4	Critically evaluate the use of VR in media and social interaction.	[A]
C956.5	Understand ethical and technical challenges in VR applications.	[U]

Course Contents:

Module 1: Introduction to Virtual Reality **15 hours**

Introduction to VR Concepts -Definitions and History of VR - Types of Virtual Reality (Immersive, Semi-Immersive, and Non-Immersive) - Key Components of VR Systems (Hardware and Software) – VR Hardware and Devices - VR Headsets and Displays - Input Devices (Controllers, Gloves, Haptic Feedback) - Tracking Systems (Positional and Motion Tracking) - VR Software Development - VR Development Platforms - Unity, Unreal Engine.

Module 2 : Virtual Environment Design **15 hours**

Design Principles for VR-User Experience (UX) in VR - Ergonomics and Comfort in Virtual Spaces - 3D Modeling and Asset Creation - Basics of 3D Modeling for VR - Tools for 3D Modeling (Blender, Maya) - Integrating 3D Models into VR Environments - Spatial Audio and Interactivity- 3D Audio Design and Spatial Sound - Interaction Models in VR - Immersive Storytelling and Narrative Techniques.

M**odule 3 : Communication in Virtual Reality** **15 hours**

Collaborative VR Environments - Multi-User VR and Virtual Meetings- VR for Education and Training- VR in Communication and Media- VR Journalism and 360° Video - Social VR and Networking in Virtual Worlds- Ethics and Challenges in VR Communication.

Total Hours:	**45**

Text Books:

1	Tony Parisi," Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", O'Reilly Media,2023
2	Steven M. LaValle," Virtual Reality", Cambridge University Press,2023

Reference Books:	
1	Grigore C. Burdea, Philippe Coiffet," Virtual Reality Technology", Wiley-Interscience, 2022.
2	d Jounghyun Kim," Designing Virtual Reality Systems: The Structured Approach", Springer, 2022.
Web References:	
1	https://docs.unity3d.com/Manual/VROverview.html
2	https://www.blender.org/support/tutorials/
3	https://developer.oculus.com/documentation/
Online Resources:	
1	https://ocw.mit.edu/courses/comparative-media-studies-writing/cms-845-virtual-reality-and-immersive-media-spring-2023/
2	https://plato.stanford.edu/entries/virtual-reality/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C956.2	Apply	Tutorial	20
C956.1, C956.5	Understand	Assignment	20
C956.3	Apply	Case Study	20
C956.4	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

<table>
<tr><td colspan="6">Assessment based on Continuous and End Semester Examination</td></tr>
<tr><td colspan="5">Continuous Assessment (40%)
[200 Marks]</td><td rowspan="3">End Semester Examination (60%)
[100 Marks]</td></tr>
<tr><td colspan="2">CA 1 : 100 Marks</td><td colspan="3">CA 2 : 100 Marks</td></tr>
<tr><td rowspan="2">SA 1
(60 Marks)</td><td colspan="2">FA 1 (40 Marks)</td><td rowspan="2">SA 2
(60 Marks)</td><td colspan="2">FA 2 (40 Marks)</td></tr>
<tr><td>Component - I
(20 Marks)</td><td>Component - II
(20 Marks)</td><td>Component - I
(20 Marks)</td><td>Component - II
(20 Marks)</td></tr>
</table>

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C956.1	3	3	3	2	3	2						2	2	2	2
C956.2	3	3	3	2	3	2						2	2	2	2
C956.3	3	3	3	3	3	2						2	2	2	2
C956.4	3	3	3	2	3	2						2	2	3	3
C956.5	3	3	3	3	3	3						3	3	2	2

22AD957	3D MODELING USING VR	3/0/0/3
Nature of Course	F (Theory Programming)	
Pre-Requisite	Augmented Reality and Video Streaming	

Course Objectives:

1	To introduce 3D Modeling and VR for the Geospatial Sciences is an introductory-level science course that introduces students to emerging topics at the interface of concepts and tools that capture/sense.
2	To explore the concepts/tools that allow for immersive access to geospatial information.
3	To introduce the high-level perspective on the major challenges and opportunities facing the development of current 3D technologies.
4	To introduce the role of game engines in the geospatial sciences. Topics that will be covered include an introduction to the 3D Modeling and 3D sensing technologies.
5	To explore hands-on experience in creating 3D models of Penn State Campus, the creation of a virtual Penn State Campus, accessing and exploring a virtual campus in Unity.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C957.1	Understand and apply the concepts of 3D modeling and VR, they will be in a position to distinguish concepts such as virtual, mixed, and augmented reality.	[U]
C957.2	Use a variety of software solutions for 3D model creation such as SketchUp, City Engine (theoretical), Unity.	[AP]
C957.3	Implement workflows to created 3D content from existing and historic and future environments.	[A]
C957.4	Understand the emerging possibilities of environmentally sensed information.	[U]
C957.5	Create 3D models and make them accessible in an interactive way through the use of game engines and Evaluate scenarios for the future of food considering resilience in the context of climate change, human population growth and socio-economic, and cultural factors.	[AP]

Course Contents:

MODULE I: Introduction and Overview of 3D Modeling and Virtual Reality **15 Hours**

Overview - Distinguishing VR, AR, and MR Systems - VR Systems - 3D Modeling and VR in the Geospatial Sciences - Applications of 3D Modeling - Important VR Concepts - Workflows for 3D Model Construction - Manual Static 3D Modeling - Data-Driven Modeling - Procedural Modeling **Case Study** - 3D and VR Application Building Workflows, Photogrammetry.

MODULE II: Procedural Modeling and SketchUp **15 Hours**

Concept of Procedural Modeling - CityEngine and its CGA Shape Grammar - Procedural Modeling for UP Campus - SketchUp: Essential Training - SketchUp: Essential Concepts - Optimization and Rendering -SketchUp and Sketchfab.**Case Study** -360° Movie for Google Cardboard.

MODULE III: 3D Spatial Analysis and Unity **15 Hours**

Flood Analysis - Sun Shadow Volume Analysis - Unity3D Game Engine - Unity Interface and Basic Unity Concepts - Walkthrough: Using Unity to Build a Stand-Alone Windows Application - 3D Applications in Unity - Animations and State Change in Unity - Common Mechanics Used in VR Development - Unity-based VR Applications for Mobile Devices, **Case Study** - LiDAR Volcano Visualization.

Total Hours:	**45**

Text Books:	
1	Peter Shirley, Michael Ashikhmin and Steve Marschner, “Fundamentals of Computer Graphics”, A K Peters/CRC Press; 3 edition, 2022.
2	K. S. Hale and K. M. Stanney, “Handbook on Virtual Environments”, 2nd edition, CRC Press, 2022.
Reference Books:	
1	George Mather, Foundations of Sensation and Perception: Psychology Press; 2 editions, 2021.
2	Doug A. Bowman, Ernst Kruijff, Joseph J. LaViola, and Ivan Poupyrev, 3D User Interfaces, AddisonWesley, 2021.
Web References:	
1	https://www.roadtovr.com/vr-painting-drawing-modeling-animation-art-tools-quest-pc/
2	https://shapelabvr.com/vr-3d-modeling/
Online Resources:	
1	https://www.classcentral.com/subject/vr
2	https://www.coursera.org/learn/3d-models-virtual-reality

Assessment Methods & Levels (based on Blooms’Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom’s Level**	**Assessment Component**	**Marks**
C957.1, C957.2	Understand	Quiz	5
C957.5	Apply	Assignment	5
C957.3, C957.4,	Analyze	Tool based Assignment	10

Assessment based on Summative and End Semester Examination – Theory			
Bloom’s Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (25%) [100 Marks]**
	CIA-I (60 marks)	**CIA-II (60 marks)**	
Remember	10	10	20
Understand	40	40	30
Apply	30	30	40
Analyse	20	20	10
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C957.1	3	3	3	2	3	2						2	2	2	2
C957.2	3	3	3	2	3	2						2	2	2	2
C957.3	3	3	3	3	3	2						2	2	2	2
C957.4	3	3	3	2	3	2						2	2	3	3
C957.5	3	3	3	3	3	3						3	3	2	2

22AD958	SENSORS AND ACTUATORS IN AR/VR	3/0/0/3
Nature of Course: D (Theory Applications)		
Prerequisite: Basic electronics and signal processing		
Course Objectives:		
1	Understand the types of sensors and actuators used in VR/AR systems.	
2	Understand the principles of sensor operation and data acquisition.	
3	Able to design and implement actuator systems for haptic feedback and environmental interaction.	
4	Integrate sensors with VR/AR platforms for real-time data processing.	
5	Evaluate the performance and limitations of sensor and actuator technologies in VR/AR applications.	
Course Outcomes: Upon completion of the course, students shall have ability to:		
C958.1	Recognize the different types of sensors used in VR/AR systems	[U]
C958.2	Demonstrate the ability to integrate various sensors into VR/AR platforms.	[AP]
C958.3	Design actuator systems for haptic feedback, motion control, and environmental interaction in VR/AR environments.	[AP]
C958.4	Evaluate the effectiveness of haptic systems in delivering realistic and engaging user experiences.	[AP]
C958.5	Analyze case studies to understand best practices in integrating sensors and actuators in real-world VR/AR applications.	[A]

Course Contents:

MODULE I INTRODUCTION **15 Hours**

Overview of VR/AR systems - Role of sensors and actuators in creating immersive experiences - Introduction to sensor and actuator technology - Introduction to sensor and actuator technology - Positional tracking sensors (gyroscopes, accelerometers, magnetometers) - Depth sensors - Motion capture sensors - Environmental sensors - Data acquisition and signal processing techniques - Sensor fusion and real-time data analysis - Calibration and error correction - Types of actuators - Actuator selection and integration in VR/AR systems.

MODULE II ADVANCED SENSOR AND ACTUATOR TECHNOLOGIES **15 Hours**

Wearable sensors and actuators for VR/AR - Emerging technologies: flexible sensors, soft robotics - Integration of AI and machine learning for sensor data interpretation - Design and Development of VR/AR Systems - Project management for VR/AR system development - Prototyping and testing VR/AR systems with integrated sensors and actuators - ser experience (UX) considerations and usability testing.

MODULE III FUTURE TRENDS AND CHALLENGES **15 Hours**

Future directions in sensor and actuator technology for VR/AR - Challenges in scaling VR/AR systems - Ethical considerations and accessibility in VR/AR design – Case study: Design and implementation of a VR/AR system integrating sensors and actuators.

	Total Hours:	**45**

Text Books:

1	Grigore C. Burdea, “Virtual Reality Technology”, Second edition, Wiley Publishers, 2020
2	Chetankumar G Shetty, “Augmented Reality, First edition”, McGraw-Hill Publishers, 2020.

Reference Books:

1	William Tardif, “Virtual Reality”, Bengion Cosalas publishers, 2021.

Web References:

1	https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/?v=c86ee0d9d7ed

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C958.1	Understand	Tutorial	20
C958.2, C958.3	Apply	Assignment	20
C958.4	Apply	Case Study	20
C958.5	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination			
Revised Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C958.1	3	3	2	3	2	2		2				3	2	2	2
C958.2	3	3	3	3	2	2		2				3	2	3	2
C958.3	3	3	3	2	2	2		2				3	3	3	2
C958.4	3	3	3	3	2	2		2				3	2	3	2
C958.5	3	3	3	3	2	2		2				3	3	3	2

22AD959	MIXED REALITY AND ADVANCED SYSTEMS	3/0/0/3

Nature of Course: D (Theory Applications)

Prerequisite: Nil

Course Objectives:

1	Understand the principles and applications of mixed reality
2	Explore advanced systems like AI, ML, and IoT in MR environments
3	Understand human-computer interaction in MR settings.
4	Develop prototypes incorporating MR technologies.
5	Examine the future of MR in areas such as healthcare, gaming, education, and entertainment.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C959.1	Design and implement interactive MR applications using development platforms	[AP]
C959.2	Apply principles of human-computer interaction (HCI) to create intuitive, user-friendly MR experiences	[AP]
C959.3	Develop problem-solving methodologies and rapid prototyping techniques to build MR solutions	[AP]
C959.4	Analyze current trends and emerging technologies in MR	[A]
C959.5	Able to assess the ethical, privacy, and societal impacts of MR technologies	[A]

Course Contents:

MODULE I INTRODUCTION **15 Hours**

Overview of MR, VR, and AR: Definitions and distinctions - Historical development and milestones in mixed reality - MR hardware components: Headsets (HoloLens, Oculus), Input devices (Controllers, Gloves), Sensors - Programming for MR: Introduction to MR SDKs, ARKit, ARCore - AI and MR: Role of AI in Mixed Reality applications (Natural Language Processing, Computer Vision).

MODULE II HCI IN MR **15 Hours**

Human perception in MR environments: Depth, spatial awareness, and latency - Designing for usability and user experience in MR - Ethical concerns in MR: Privacy, accessibility, and inclusivity - roject ideation and concept development: From prototype to final product - Testing and debugging MR applications.

MODULE III FUTURE OF MR AND EMERGING TECHNOLOGIES **15 Hours**

Future trends: MR and 5G, edge computing, cloud-based MR - Wearable and Haptic Technologies - Augmented Reality Glasses - Blockchain and Decentralized Systems - Biometric Data and Brain-Computer Interfaces (BCI).

Total Hours: 45

Text Books:

1	Alan B. Craig," Understanding Augmented Reality: Concepts and Applications", Second edition, Morgan Kaufman,2023
2	Dawid Borycki ,"Programming for Mixed Reality with Windows 10, Unity, Vuforia, and UrhoSharp", Microsoft press,2021.

Reference Books:

1	Sai Rohit Chenchu Boga," Integration of Augmented Reality and Virtual Reality in Building Information Modeling",IRMA publishers,2018.
Web References:	
1	https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/?v=c86ee0d9d7ed

Continuous Assessment				**End Semester Examination**	**Total**
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	**Bloom's Level**	**Assessment Component**	**FA (16%) [80 Marks]**
C959.1, C959.2	Apply	Tutorial	20
C959.3	Apply	Assignment	20
C959.4	Analyze	Case Study	20
C959.5	Analyze	Quiz	20

Assessment based on Summative and End Semester Examination

Revised Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	30	20	20
Understand	30	30	20
Apply	20	50	40
Analyse	20	-	20
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C959.1	3	3	2	3	2	2		2			2	3	2	2	2
C959.2	3	3	3	3	2	2		2			2	3	2	3	2
C959.3	3	3	3	2	2	2		2			2	3	3	3	2
C959.4	3	3	3	3	2	2		2			2	3	2	3	2
C959.5	3	3	3	3	2	2		2			2	3	3	3	2

22AD001	FUNDAMENTALS OF DATABASE SYSTEMS	1/0/4/3

Nature of Course	G (Theory Analytical)
Pre requisites	Nil

Course Objectives:

1	To discuss the fundamentals of data models to conceptualize and depict a database system using ER diagrams.
2	To illustrate the relational database implementation using SQL with effective relational database design concepts.
3	To employ the normalization concepts to improve the database design.
4	To explain the fundamental concepts of transaction processing concurrency control techniques and Database Security.
5	To introduce the concepts of other Databases and NoSQL.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C001.1	Distinguish database systems from file systems and describe data models and DBMS architecture.	[U]
C001.2	Convert the ER-model to relational tables, populate relational databases and formulate SQL queries on data.	[AP]
C001.3	Apply different normal forms to retrieve the data efficiently by removing Anomalies.	[AP]
C001.4	Infer the basic database storage structures and access techniques.	[A]
C001.5	Examine the concepts of Transaction processing, concurrency locking protocols.	[A]

Course Contents:

MODULE I DATA MODELS AND SQL **15 Hours**

Introduction to Database – File System Vs Database system – Users - Data models: Hierarchical - Network - Object Oriented - Entity Relationship – Relational Data Models - Database System Architecture - Data Abstraction - Data Independence - Integrity Constraints - Concept of Relations - Schema-Instance distinction - Table and key definitions – Views - Relational Query Languages: DDL – DML – TCL - DCL – SQL - Embedded SQL - Introduction to NoSQL.

MODULE II RELATIONAL DATABASE DESIGN AND STORAGE STRUCTURE **15 Hours**

Relational Database Design – Principles of a good schema design-functional dependencies - Armstrong's axioms for FD's - definitions of 1NF - 2NF - 3NF- BCNF- 4NF - Data Storage and Indexes - file organizations - primary and secondary index structures - B+ trees index structures - Static and dynamic hashing Techniques.

MODULE III TRANSACTION PROCESSING AND SECURITY **15 Hours**

Transaction Processing - ACID property - Serializability of scheduling - Concurrency control : Lock based concurrency control – Timestamp Based Database recovery. Database Security: Authentication - Authorization and access control - **Case Study :** Web databases, Distributed databases – MongoDB

Total Hours: 45

Text Books:

1	Abraham Silberschatz, Henry F. Korth, S. Sudharshan, "Database System Concepts", 7thEdition, Tata McGraw Hill, March 2019.
2	Gupta G K, "Database Management Systems", Tata McGraw Hill Education Private Limited,New Delhi, 2012.

Reference Books:

1	RamezElmasri, ShamkatB.Mavathe, "Database Systems", 6th Edition, Pearson Education,2013.
2	Michael McLaughlin, "Oracle Database 12c PL/SQL Programming", Tata McGraw Hill Education Private Limited, New Delhi, 2014.
3	Gaurav Vaish, "Getting Started with NoSQL", Packt Publishing, March 2013.

Web References:

1	http://www.nptel.ac.in
2	http://www.sqlcourse.com
3	http://www.edureka.co/mongodb
4	https://alison.com/courses/IT-Management-Software-and-Databases
Online Sources:	
1	https://www.coursera.org/learn/database-management
2	https://www.udemy.com/database-management-system/
3	http://www.nptelvideos.in/2012/11/database-management-system.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C001.1	Understand	Quiz	20
C001.2	Apply	Tutorial	20
C001.3	Apply	Assignment	20
C001.4	Analyze		
C001.5	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-
Assessment based on Continuous and End Semester Examination			

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C001.1	2	2	2								2	2	2		2
C001.2	2	2	2								2	2	2		2
C001.3	2	2	2								2	2	2		2
C001.4	3	3	3								2	2	2		2
C001.5	3	3	3								2	3	3		2

22AD002	INFORMATION RETRIEVAL TECHNIQUES	3/0/0/3

Nature of Course	F (Theory Programming)
Prerequisites	Nil

Course Objectives:

1	To understand the basics of Information Retrieval.
2	To understand data modeling and Retrieval Evaluation.
3	To develop the fundamental understanding of Classification and Clustering in Information Retrieval.
4	To apply the concepts of web retrieval and crawling for a search engine.
5	To learn different techniques of the recommender system.

Course Outcomes: Upon completion of the course, students shall have ability to:

C002.1	Use an open source search engine framework and explore its capabilities.	[U]
C002.2	Explain the foundations of information retrieval, design, analysis and implementation of IR systems.	[U]
C002.3	Apply appropriate methods of classification or clustering.	[AP]
C002.4	Explore the methods and techniques to classify text documents.	[A]
C002.5	Design and implement innovative features in a search engine.	[AP]
C002.6	Design and implement a recommender system.	[AP]

Course Contents:

MODULE I Introduction - IR, Modelling and Retrieval Evaluation **15 Hours**

Motivation - IR System Architecture - Retrieval Process - Web: Introduction and Characteristics - The Impact of The Web on IR - IR Versus Web Search -Challenges - Search Engines. Basic IR Models - Boolean Model - Vector Model - Probabilistic Model - Set Theoretic Models - Algebraic Models - Structured Text Retrieval Models - Models for Browsing - Retrieval Evaluation and Metrics - Precision and Recall - Reference Collection - User -based Evaluation - Relevance Feedback and Query Expansion - Explicit Relevance Feedback.

MODULE II Classification and Clustering **15 Hours**

A Characterization of Text Classification - Unsupervised Algorithms: Clustering - Naive Text Classification - Supervised Algorithms - Decision Tree - K-NN Classifier - SVM Classifier - Feature Selection or Dimensionality Reduction - Evaluation metrics - Accuracy and Error - Organizing the classes - Indexing and Searching - Inverted Indexes - Sequential Searching - Multidimensional Indexing.

MODULE III Web Retrieval, Web Crawling and Recommender Systems **15 Hours**

The Web - Search Engine Architectures - Cluster based Architecture - Distributed Architectures - Search Engine Ranking - Link based Ranking - Evaluations - Search Engine User Interaction - Browsing - Applications of a Web Crawler - Taxonomy - Architecture and Implementation - Scheduling Algorithms - Evaluation. Recommender Systems Functions - Data and Knowledge Sources - Recommendation Techniques - Content based Recommender Systems - Collaborative Filtering - Matrix factorization models - Neighborhood models. Case Study: IR using Python - PyTerrier.

Total Hours:	**45**

Text Books:

1	Ricardo Baeza -Yates and Berthier Ribeiro-Neto, - Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books, 2011.
2.	Stefan Büttcher, Charles L. A. Clarke, Gordon V. Cormack "Information Retrieval Techniques", 2016.
3.	Ricci, F, Rokach, L. Shapira, B.Kantor, - Recommender Systems Handbookll, First Edition, 2011.

Reference Books:

1	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to information Retrieval", Cambridge university press, first south asian edition 2012.
2	Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, - Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010.

3	G. Salton and M. J. McGill, Introduction to Modern Information Retrieval, McGraw-Hill, 1983.
Web References:	
1	https://www.lisbdnetwork.com/online-information-retrieval-syste/
2	https://www.youtube.com/watch?v=McVpRWiAP2I&list=PLMyP8LIIL3ht_WV4EXjN-uD3EPEK3hIyu
3	https://www.youtube.com/watch?v=h9gpufJFF-0

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C002.1	Understand	Quiz	20
C002.2	Apply	Tutorial	20
C002.3	Apply	Assignment	20
C002.4	Understand		
C002.5 & C002.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C002.1	3	3	3	2	2							2	3	3	2
C002.2	3	3	2	2	2							2	2	2	2
C002.3	3	3	3	3	2							2	2	2	3
C002.4	3	3	3	2	3							2	2	2	3
C002.5	3	3	3	3	2							2	2	2	2
C002.6	3	3	3	3	3							2	2	2	2

22AD004	DATA VISUALIZATION USING R	3/0/0/3

Nature of Course	F (Theory Programming)
Prerequisite	Nil

Course Objectives:

1	Understand the principles of data and graphic design.
2	Evaluate the credibility, ethics, and aesthetics of data visualizations.
3	Know how to evaluate and criticize data visualizations based on principles of analytic design.
4	Be in the position to explore and present their data with visual methods.
5	Importance of analytics and visualization in the era of data abundance.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C004.1	Use RStudio to develop, test, and execute R scripts.	[AP]
C004.2	Use RStudio to perform basic data analysis functions including Input/Output, basic Exploratory Data Analysis (EDA), and graphical output.	[AP]
C004.3	Understand which graphical formats are useful for which types of data and questions	[AP]
C004.4	Share data and graphics in open forums.	[AP]
C004.5	Create well-designed data visualizations with appropriate tools.	[AP]
C004.6	Know how to construct compelling visualizations using the free statistics software R	[AP]

Course Contents:

MODULE I INTRODUCTION TO R **15 Hours**

Introduction to R and R studio- Data Inputting in R- Functions and Programming in R – Data Manipulation in R - Statistical Modelling in R- Advanced Data handling - Combined and restructuring data frames.

MODULE II INTRODUCTION TO DATA VISUALIZATION **15 Hours**

Introduction to Data Visualization –principles of analytic design plotting techniques- gg plot- Bar charts- Histograms- pie chart – Multidimensional data- visualization relations between variables.

MODULE III BASIC PLOTS, MAPS, AND CUSTOMIZATION **15 Hours**

Scatter plot- Line plot- Box plots- Customize plots- Scatter plot matrices -Conditioning plots -Lattice graphs - Interaction plots - Themes and faceting- v2.2.3 - Maps with Leaflet. **Case study:** Data Visualization for covid-19 dataset.

Total Hours:	**45**

Text Books:

1	Hadley Wickham, Garrett Grolemund , "R for data science : Import, Tidy, Transform, Visualize, And Model Data", O;reilly 2017.
2	Rajesh K Maurya , Swati R Maurya, "R Programming for Data Analytics & Visualization", SYBGEN learning, 2021.

Reference Books:

1	Tony Fischetti, Brett Lantz, "R: Data Analysis and Visualization", Packt Publishing, 2016.
2	Thomas Rahlf, "Data Visualisation with R", Springer, 2019.
3	Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly, 2019.

Web References:

1	https://www.coursera.org/learn/data-visualization-r
2	https://slcladal.github.io/dviz.html

Continuous Assessment				End Semester Examination	Total
Formative Assessment	**Summative Assessment**	**Total**	**Total Continuous Assessment**		
80	**120**	**200**	**40**	**60**	**100**

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C004.1	Apply	Quiz	20
C004.2	Apply	Tutorial	20
C004.3	Apply	Assignment	20
C004.4	Apply		
C004.5	Apply	Presentation	20
C004.6			

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

ourse Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C004.1	3	3	3	2	3	2						2	2	2	2
C004.2	3	3	3	2	3	2						2	2	2	2
C004.3	3	3	3	3	3	2						2	2	2	2
C004.4	3	3	3	2	3	2						2	2	3	3
C004.5	3	3	3	3	3	3						3	3	2	2
C004.6	3	3	3	3	3	3						3	3	2	2

22AD005	INTRODUCTION TO DATA ANALYTICS	3/0/0/3

Nature of Course	F (Theory Programming)
Prerequisite	Nil

Course Objectives:

1	Understand the Big Data Platform and its Use cases
2	Learn to build and maintain reliable, scalable, distributed systems with Apache Hadoop
3	Provide an overview of Apache Hadoop
4	To able to apply Hadoop ecosystem components
5	Develop a big data solution using Hive.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C005.1	Understand Big Data and its analytics in the real world	[U]
C005.2	Recognize the analytics tool.	[U]
C005.3	Analyze the Big Data framework like Hadoop to efficiently store and process Big Data to generate analytics	[A]
C005.4	Design of Algorithms to solve Data Intensive Problems using Map Reduce Paradigm	[AP]
C005.5	Implement Big Data Activities using Hive ,Hiveql and Hbase.	[AP]
C005.6	Design applications with Zookeeper	[AP]

Course Contents:

INTRODUCTION TO BIG DATA **15 Hours**

Evolution of Big data — Best Practices for Big data Analytics — Big data characteristics-Four Vs, Drivers for Big data, Big data analytics, Big data applications-.Classification of Analytics – Top Analytics Tools.

HADOOP AND MAP REDUCE PROGRAMMING MODEL **15 Hours**

Apache Hadoop & Hadoop EcoSystem – Moving Data in and out of Hadoop -Hadoop Architecture, Hadoop Storage: HDFS Understanding inputs and outputs of MapReduce-MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression.

HIVE AND HIVEQL, HBASE **15 Hours**

Hive Architecture and Installation, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts Advanced Usage, Schema Design, Advance Indexing - PIG, Zookeeper - how it helps in monitoring a cluster, HBase uses Zookeeper and how to Build Applications with Zookeeper.

Total Hours:	**45**

Text Books:

1	Seema Acharya, SubhashiniChellappan, “Big Data and Analytics”, Wiley Publications, First Edition,2015
2	Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007. 2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O"reilly Media, 2011

Reference Books:

1	Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, “Big data for dummies”, John Wiley & Sons, Inc. (2013)
2	Tom White, “Hadoop The Definitive Guide”, O’Reilly Publications, Fourth Edition, 2015

Web References:

1	https://nptel.ac.in/courses/106104189
2	https://www.coursera.org/learn/google-data-analytics-capstone

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C005.1 C005.2	Understand	Quiz	20
C005.3	Analyze	Tutorial	20
C005.4	Apply	Assignment	20
C005.5	Apply		
C005.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination				
Continuous Assessment (40%) [200 Marks]				**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks		**CA 2 : 100 Marks**		
SA 1	**FA 1 (40 Marks)**	**SA 2**	**FA 2 (40 Marks)**	

(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C005.1	3	3	3	2	3	2						2	2	2	2
C005.2	3	3	3	2	3	2						2	2	2	2
C005.3	3	3	3	3	3	2						2	2	2	2
C005.4	3	3	3	2	3	2						2	2	3	3
C005.5	3	3	3	3	3	3						3	3	2	2
C005.6	2	2	2									2	2	2	2

22AD006	INTRODUCTION TO DEEP LEARNING	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisite	Nil

Course Objectives:

1	To explain the basic concepts of neural networks.
2	To discuss the fundamentals of deep networks.
3	To examine the major architectures in deep networks.
4	To demonstrate the applications of deep learning.
5	To Analyze, critique, and revise data visualizations

Course Outcomes:

Upon completion of the course, students shall have ability to:

C006.1	Describe the fundamentals of Neural networks.	[U]
C006.2	Distinguish neural and deep networks.	[U]
C006.3	Build Deep Learning models with Keras in TensorFlow.	[AP]
C006.4	Identify the appropriate deep network architecture for an application.	[AP]
C006.5	Apply various deep learning techniques to design efficient algorithms for real-world applications.	[AP]
C006.6	Analyze the performance of a deep learning network.	[A]

Course Contents:

Module I: Foundations of Neural Networks **15 Hours**

Neural Networks – Training Neural Networks – Activation Functions - Loss Functions – Hyper parameters. Supervised Learning and Unsupervised Learning. Fundamentals of Deep Networks – Introduction to Deep Learning – Common Architectural Principles of Deep Networks – Building Blocks of Deep Networks.

Module II: Major Architectures of Deep Networks **15 Hours**

Unsupervised Pre-Trained Networks – Convolution Neural Networks - Transfer learning Techniques - Recurrent Neural Networks - Stochastic Gradient Descent – Recursive Neural Networks, Long Short-Term Memory (LSTM) Networks - Introduction to Deep Learning Tools: Tensor Flow, Keras.

Module III: Applications **15 Hours**

Object Detection – Automatic Image Captioning – Image generation with Generative adversarial networks – Video to Text with LSTM models – Attention models for Computer Vision – **Case Study:** Named Entity Recognition – Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks – Sentence Classification using Convolutional Neural Networks – Dialogue Generation with LSTMs.

Total Hours: 45

Text Books:

1	Adam Gibson, Josh Patterson, “Deep Learning, A Practitioner’s Approach”, O'Reilly Media, 2017.
2	Ian Good fellow, Yoshua Bengio and Aaron Courville, “Deep Learning”, MIT Press, 2017.
3	Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
4	Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.

Reference Books:

1	Daniel Graupe, “Deep Learning Neural Networks: Design and Case Studies”, World Scientific Publishing ,2016.
2	Yu and Li Deng, “Deep Learning: Methods and Applications”, Now Publishers Inc,2014.
3	Zurada,J.M. “Introduction to Artificial Neural Systems”, Jaico Publishing House,2012.
4	Giancarlo Zaccone , Md. RezaulKarim , Ahmed Menshawy, ”Deep Learning with tensorflow : Explore neural networks and build intelligent systems with Python", Packt Publisher, 2020.

5	Antonio Gulli, Sujit Pal "Deep Learning with Keras", Packt Publishers, 2017.
Web References:	
1	http://deeplearning.cs.cmu.edu/
2	http://deeplearning.net/
Online Resources:	
1	http://nptel.ac.in/courses/
2	https://www.udacity.com/course/deep-learning--ud730
3	https://bigdatauniversity.com/courses/introduction-deep-learning/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C006.1	Understand	Quiz	20
C006.2	Apply	Tutorial	20
C006.3	Apply	Assignment	20
C006.4	Understand		
C006.5 & C006.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C006.1	3	3	3	2	3	2	2		2			2	2	2	2
C006.2	3	3	3	3	3	2	2		2			2	3	3	2
C006.3	3	3	3	3	3	3	3		3			3	3	3	3
C006.4	3	3	3	3	3	3	3		3	2		3	3	3	3
C006.5	3	3	3	3	3	3	3	2	3	2	2	3	3	3	3
C006.6	3	3	3	3	3	3	3	2	3	2	2	3	3	3	3

22AD007	AUTONOMOUS SYSTEMS AND DRONES	3/0/0/3
Nature of Course: D (Theory Applications)		
Prerequisite: Nil		
Course Objectives:		
1	To gain insight into the basic elements of drone systems used in civilian missions.	
2	To introduce SLAM (Simultaneous Localization and Mapping) including drones and autonomous SLAM with sensors.	
3	To Understand the regulatory procedures of drones, pilot certification and licensing and basic safety measures required of UAS / UAV.	
Course Outcomes: Upon completion of the course, students shall have ability to:		
C007.1	Understand the evolution and classification of Drones / SLAM (Simultaneous Localization And Mapping)	[U]
C007.2	Illustrate the commercial applications used by various types of drones	[A]
C007.3	Apply their knowledge in different types of flight controllers	[AP]
C007.4	Gain knowledge on UAVs technology side of things (sensors, platforms, navigation, power source, communication, range, altitude and speed).	[AP]
C007.5	Learn the essential components and platforms for Drones	[U]
C007.6	Develop the ability to build commercial drones using drone kits.	[AP]

Course Contents:

MODULE I INTRODUCTION AND FUNCTIONAL ARCHITECTURE **15 Hours**

Basic Concept- autonomous systems- Al in autonomous systems, -Autonomous systems vs robots-Major functions in an autonomous vehicle system-Motion Modelling - Coordinate frames and transforms-Point mass model. Case study: Agriculture autonomous drones.

MODULE II SLAM **15 Hours**

Modeling in autonomous systems Vehicle modelling (kinematic and dynamic bicycle model - two-track models),-Sensor Modelling – encoders- inertial sensors- GPS- Localization and mapping fundamentals-LIDAR and visual SLAM, Navigation - Global path planning- Local path planning- Vehicle control - Control structures,-PID control, Linear quadratic regulator,Sample controllers. Case study: Autonomous Drones for Construction.

MODULE III DRONES **15 Hours**

Overview-Definition,- applications- components platforms- propulsion,-on-board flight control,-payloads-communications,-concepts of flight-regulatory norms and regulations,-Machine learning and deep learning for autonomous driving, Case study(Commercial Drones and Kits).

	Total Hours:	**45**

Text Books:

1	Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot,"Creating Autonomous Vehicle Systems" Morgan & Claypool Publishers, 2018
2	John Baichtal "Building your own Drones A beginners Guide to Drones, UAVs and ROVs", Que Publishing 2016.

Reference Books:

1	Mohammad H. Sadraey "Design of Unmanned Aerial Systems" First Edition, John Wiley & Sons, Inc., USA 2020.
2	Terry Kilby and Belinda Kilby Make "Getting Started with Drones" First Edition, Maker Media Inc,San Francisco CA, 2016

Web References:

1	https://www.coursera.org/learn/Drones

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C007.1, C007.5	Understand	Quiz	20
C007.2	Analyze	Tutorial	20
C007.3,4	Apply	Assignment, Presentation	40
C007.6	Apply		

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C007.1	3	3	3	3	2								2	2	2
C007.2	3	2	3	3	2								2	3	2
C007.3	3	2	3	3	2										
C007.4	3	3	3	3	2										
C007.5	3	3	3	3	2									2	
C007.6	3	3	3	3	2	2	2	2	2		2		3	3	3

22AD008	CRYPTO CURRENCIES	3/0/0/3

Nature of Course C (Theory Concept)

Prerequisites: Cloud Computing

Course Objectives:

1	To explain the fundamental ideas of crypto currencies.
2	To explore the Block chain concept and mining.
3	To examine the concept of distributed ledger and Bitcoin.
4	To discuss various aspects of Ethereum.
5	To understand legal issues of crypto currencies and associated security challenges.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C008.1	Discuss the fundamentals of cryptographic systems.	[U]
C008.2	Interpret the structure and implementation of the Blockchain.	[U]
C008.3	Describe the operation of Bitcoin.	[U]
C008.4	Apply mining strategies for implementation of crypto currencies.	[AP]
C008.5	Illustrate the legal issues of crypto currencies.	[AP]
C008.6	Articulate the security issues and challenges of crypto currencies.	[AP]

Course Contents:

Fundamentals of Cryptography and Blockchain **15 Hours**

Introduction to Cryptography & Crypto currencies: Cryptographic Hash Functions - Hash Pointers and Data Structures - Digital Signatures – Secret Key Encryption - Public-key encryption - Public Keys as Identities - A Simple Crypto currency. **The Blockchain:** Introduction -Advantage over conventional distributed database - Blockchain Network- Mining Mechanism - Distributed Consensus Structure of a Block – Block Header – Block identifiers – The Genesis Block – Linking Blocks – Merkle Trees – Simplified Payment Verification. The Rise and Evolution of Cryptocurrency: A Case Study

Crypto currencies **15 Hours**

History - Distributed Ledger - Nakamoto consensus - Proof of Work- Proof of Stake - Proof of Burn – Introduction to Bitcoin - Transactions, Blocks, Mining, and the Blockchain - Bitcoin Transactions - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Altcoins. Bitcoin: A Case Study on the Pioneering Cryptocurrency

Real world Applications and Challenges **15 Hours**

Legal aspects of virtual currency - Stockholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy - post-quantum cryptography - Segregated witness benefits – Mimblewimble - Bitcoin as a Platform – Append only log – Smart property – Security Principles – User Security best practices. **Case Study:** pycoin.

Total Hours: 45

Text Books:

1	Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, Steven Goldfeder, Princeton University Press; 2nd Ed.2019.
2	Mastering Bitcoin: Unlocking Digital Cryptocurrencies by Andreas M. Antonopoulos, 2nd Edition, O'Reilly Publishers, 2010.
3	Bitcoin, Blockchain, and Crypto Assets: A Comprehensive Introduction by Fabian Schär and Aleksander Berentsen, MIT Press, 2020.

Reference Books:

1	An Introduction to Cryptocurrencies - The Crypto Market Ecosystem by Nikos Daskalakis, Panagiotis Georgitseas, Routledge, 2020.
2	Fundamentals of Blockchain by Ravindhar Vadapalli, Blockchainprep, 2020.
3	Cryptography and Network Security: Principles and Practice by William Stallings, 7th Edition, Pearson education, 2017.

Web References:	
1	https://www.coursera.org/learn/crypto-finance
2	https://www.udemy.com/course/complete-course-on-blockchain-and-crypto-currency/
3	https://courses.dcxlearn.com/p/blockchain-and-cryptocurrency-the-basics
Online Resources:	
1	https://media2.mofo.com/documents/170900-understanding-blockchain-cryptocurrencies.pdf
2	https://scet.berkeley.edu/wp-content/uploads/BlockchainPaper.pdf
3	https://bitcoin.org/bitcoin.pdf

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative Assessment based on Capstone Model

Course Outcome	Bloom's Level	Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)	FA (16%) [80 Marks]
C008.1 & C008.2	Understand	Quiz	20
C008.3	Apply	Tutorial	20
C008.4	Apply	Assignment	20
C008.5	Understand		
C008.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination

Bloom's Level	Summative Assessment (24%) [120 Marks]		End Semester Examination (60%) [100 Marks]
	CIA1 : [60 Marks]	CIA2 : [60 Marks]	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination

Continuous Assessment (40%) [200 Marks]						End Semester Examination (60%) [100 Marks]
CA 1 : 100 Marks			CA 2 : 100 Marks			
SA 1 (60 Marks)	FA 1 (40 Marks)		SA 2 (60 Marks)	FA 2 (40 Marks)		
	Component - I (20 Marks)	Component - II (20 Marks)		Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C008.1	3	3	3	2	2								3		2
C008.2	3	3	3	2	2								3		2
C008.3	3	3	3	3	2								2		2
C008.4	3	3	3	2	2	2	2	2	2	2		2	2		2
C008.5	3	3	3	3	2	2	2	2	2	2		2	2	2	2
C008.6	3	3	3	3	2	2	2	2	2	2		2	2	2	2

22AD009	AI IN HEALTH CARE APPLICATIONS	3/0/0/3

Nature of Course	F (Theory Programming)
Prerequisite	Artificial Intelligence

Course Objectives:

1	To Identify healthcare myths and digital transformation.
2	To gain knowledge in Precision Medicine and Intelligent Personal Health records.
3	To Understand AI Healthcare operations and Innovation.
4	To familiar with AIOps Strategy.
5	To analyse the future healthcare technologies.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C009.1	Understand about Health care myths and Digital Transformation.	[U]
C009.2	Recognize Health Records analytics.	[U]
C009.3	Identify the various healthcare operations.	[A]
C009.4	Develop an understanding in security services.	[A]
C009.5	Learn about telemedicine and their innovation.	[U]
C009.6	Apply principles and algorithms to evaluate a model.	[AP]

Course Contents:

MODULE I: INTRODUCTION **15 Hours**

AI health care myths - Human centered AI - Prescription for Personal Health - Ambient Computing Healthcare - Continuous monitoring using AI-Precision medicine -Intelligent Personal Health records - Digital Transformation- Case Study in Personalized Healthcare

MODULE II: AI HEALTHCARE OPERATIONS **15 Hours**

Aiops strategy- Clinical Impact of Aiops - Data Analytics and AI-Design and Innovation - Aiops for Healthcare Delivery-AIOps for service performance - HIPAA, PH1, PII Protection - AIOps Usecase. Leveraging AIOps for Enhanced IT Operations

MODULE III: FUTURE OF HEALTHCARE **15 Hours**

Role of Medical Imaging Computing - AI in Radiology and Practical Use cases - Chronic Disease Management-AI Telemedicine - Telehealth Innovation-Digital Medication- Case Study: Cancer diagnostics and treatment decisions.

Total Hours:	**45**

Text Books:

1	Kerrie L. Holley, Siupo Becker, “AI -First Healthcare”, O'Reilly Media, Inc., 2018.
2	Adam Bohr, Kaveh Memarzadeh, “Artificial Intelligence in Healthcare”, Elsevier Science, 2020.

Reference Books:

1	Robert Shimonski, Robert Shimonski”, “How Artificial Intelligence Is Changing IT Operations and Infrastructure Services” , wiley, 2020.

Web References:

1	https://www.coursera.org/specializations/ai-healthcare
2	https://www.udemy.com/course/the-complete-healthcare-artificial-intelligence-course-2021

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)

Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C009.1	Understand	Quiz	20
C009.2	Apply	Tutorial	20
C009.3	Apply	Assignment	20
C009.4	Understand		
C009.5 & C009.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C009.1		1	3	3	3							1	3	3	3
C009.2	1	2	3	3	3	1						1	3	3	3
C009.3	2	2	3	3	2							1	3	3	3
C009.4	2	1	3	3	3							1	3	3	3
C009.5	2	1	2	3	2	1						1	3	3	3
C009.6	3	3	3	3	2				2	2		1	3	3	3

22AD010	SCALABLE SYSTEM FOR DATA SCIENCE	3/0/0/3

Nature of Course	C (Theory Concept)
Prerequisite	Cloud Computing, Data Science

Course Objectives:

1	To study the fundamental Systems aspects of designing and using Big Data platforms.
2	To study the approaches and design patterns to translate existing data-intensive algorithms and analytics into these distributed programming abstractions.
3	To get exposure to scalable systems for data science applications.
4	To study the types of Big Data, Design goals of Big Data platforms.
5	To design and create small real time applications.

Course Outcomes:

Upon completion of the course, students shall have ability to:

C010.1	Understand the basics of scalable systems.	[U]
C010.2	Understand the concepts of processing large volumes of big data.	[U]
C010.3	Describe the attributes of big data storage systems.	[A]
C010.4	Create the understanding of machine learning over big data.	[AP]
C010.5	Apply their knowledge to design solutions to different problems.	[AP]
C010.6	Analyze various application related to machine learning	[AP]

Course Contents:

MODULE I BIG DATA & DISTRIBUTED SYSTEMS **15 Hours**

Introduction to Big Data - Storage, compute, visualization, Files vs. Overview of Relational Databases vs. NoSQL Databases - Big Data systems: HBase/Big Table, Cassandra/Key-Value Store, Graph DB overview - Clusters, Cloud computing, Edge computing - Cloud storage- Case study: Big Data Analytics for Enhanced Business Insights.

MODULE II PROCESSING LARGE VOLUMES OF BIG DATA **15 Hours**

Big Data Processing with MapReduce and Spark - Spark Basics – RDD – transformations – action - Shuffle - Spark internals - Spark tuning – Google File System – Hadoop File System. Case Study: Analyzing Social Media Data with MapReduce

MODULE III MACHINE LEARNING AT SCALE **15 Hours**

ML over Big Data –TensorFlow – Parameter server and Federated learning - Spark ML for ML pipelines - **Case Study:** Scalable training and inferencing over graph neural networks, Scalable pattern mining and analysis over Twitter streams, Distributed video analytics over drone (Tello) video feeds.

Total Hours:	**45**

Text Books:

1	J. Leskovec, A. Rajaraman and JD Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2nd Edition, 2020.
2	Mahoney, Michael W. "Randomized algorithms for matrices and data - Foundations and Trends in Machine Learning”, 3rd Edition, 2011.

Reference Books:

1	Woodruff, David P, "Sketching as a tool for numerical linear algebra”, Foundations and Trends in Theoretical Computer Science, 2014.
2	Cathy O’Neil and Rachel Schutt, "Doing Data Science: Straight Talk from the Frontline", O’ Reilly, 2020.

Web References:

1	https://cds.iisc.ac.in/courses/ds256/
2	https://cds.iisc.ac.in/wp-content/uploads/DS256.2017.L1.Introduction.pdf

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C010.1	Understand	Quiz	20
C010.2	Understand	Tutorial	20
C010.3	Analyze	Assignment	20
C010.4	Apply		
C010.5	Apply	Presentation	20
C010.6			

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C010.1	3	3	3	2	3	2						2	2	2	2
C010.2	3	3	3	2	3	2						2	2	2	2

C010.3	3	3	3	3	3	2						2	2	2	2
C010.4	3	3	3	2	3	2						2	2	3	3
C010.5	3	3	3	3	3	3						3	3	2	2
C010.6	3	3	3	3	3	3						3	3	2	2

22AD011	BRAIN AND NEUROSCIENCE	3/0/0/3
Nature of Course:	F (Theory)	
Pre requisites:	Introduction to Artificial Intelligence	

Course Objectives:

1	To provide students with broad knowledge of the field of neuroscience.
2	To synthesize knowledge of the discipline of neuroscience.
3	Demonstrate a broad foundation in the concepts and methodologies of the interdisciplinary field of neuroscience.
4	To describe the functions of the brain and contribution of the nervous system.

Course Outcomes:
Upon completion of the course, students shall have ability to

C011.1	Understand the function of the Nervous system at various levels.	[U]
C011.2	Analyze neuroscience nature and computation.	[A]
C011.3	Interpret and report nervous system techniques.	[U]
C011.4	Understand role of neural activity in development	[U]
C011.5	Analyze the brain at the behavioral level of analysis.	[A]
C011.6	Apply and integrate with real time usecases	[AP]

Course Contents: (Ref – University College of London)

Module I **15 hours**

Introduction to neuroscience – Cells of the Nervous system - Building a Brain: Development - Organization of the Nervous System - The senses - Outline of neuroanatomy – Role of experiments and computation in neuroscience; Methods in neuroscience; The interdisciplinary nature of neuroscience - Cognitive neuroscience , Case study - Illuminate memory neuroscience

Module II **15 hours**

Neural Systems: Organization of the vertebrate brain - Development of the Nervous system Neurogenesis, migration, Axon pathfinding ,Role of neural activity in development –eye-hearing olfaction, Case study : The Simpsons Neuron

Module III **15 hours**

Brain and behavior: Brain – Organization of the brain and its function - Behavior and cognition; Systems : Motor, sensory and learning; Regions; Networks; Neuron; Ion channels. Convergence of Artificial Intelligence and neuroscience**Case Study:** Medical Diagnosis.

Total Hours: 45

Text Books:

1.	Frank Amthor, “Neuroscience For Dummies”,Wiley Publication,2023.
2.	Bob Garrett, Gerald Hough, “Brain and Behavior: An introduction to Behavioral Neuroscience”, Fifth Edition, 2017.

Reference Books:	
1.	Eric R Kandel, James H Schwartz, “Principles of Neural Science”, Stanford, UCSF, Columbia, 2018.
2.	Charles A Nelson, “Brain, Mind and Behavior”, Macmillan Learning, 2006.
Web References:	
1.	https://en.wikipedia.org/wiki/Neuroscience
2	https://en.wiktionary.org/wiki/neurosystem
3	https://psychology.fas.harvard.edu/cognition-brain-behavior
Online Resources:	
1	https://onlinelibrary.wiley.com/journal/21579032
2	https://open.bu.edu/handle/2144/27397

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms’ Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom’s Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C011.1	Understand	Quiz	20
C011.2	Analyze	Tutorial	20
C011.3& C011.4	Understand	Assignment	20
C011.5	Analyze		
C011.6	Apply	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyse	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination						
Continuous Assessment (40%) [200 Marks]						**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks			**CA 2 : 100 Marks**			
SA 1 (60 Marks)	**FA 1 (40 Marks)**		**SA 2 (60 Marks)**	**FA 2 (40 Marks)**		
	Component - I (20 Marks)	**Component - II (20 Marks)**		**Component - I (20 Marks)**	**Component - II (20 Marks)**	

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C011.1	3	3										2	2	2	2
C011.2	2	2	3									2	3	3	2
C011.3	2	3	2									2	3	3	3
C011.4	2	3	3									3	3	3	3
C011.5	3	2	3									3	3	3	3
C011.6	3	2										3	2	2	2

22AD012	DATA ENGINEERING	3/0/0/3
Nature of Course	F (Theory Programming)	

Prerequisites: Data Analytics and Machine Learning

Course Objectives:

1	To discuss the essence of front-end development skills.
2	To impart the knowledge of React components used in Big DataS development platforms.
3	Ability to understand and use Setup Cloud MySql
4	To deploy and test the React App used in Big Query.
5	To learn the Pipeline concepts using IOT

Course Outcomes:

Upon completion of the course, students shall have ability to:

C012.1	Identify the basic concepts and design issues of operating systems.	[R]
C012.2	Understand the principles of process and threads	[U]
C012.3	Illustrate the approaches in scheduling and Bigquery to apply in real world problems.	[AP]
C012.4	Apply concepts of Visualizing Data including Google Cloud Platform to the issues that occur in Real time applications	[AP]
C012.5	Identify issues related to Legal Compliance, Data Analytics,Data Warehouse	[AP]
C012.6	Examine common Google Cloud Platform, Availability and Scalability.	[A]

Course Contents:

MODULE I FUNDAMENTALS OF DATA ENGINEERING AND BATCH PROCESSING 15 Hours

Introduction-Data life Cycle- Roles of Data Engineer-Data Warehouse-BigData On GCP-GCP Components-Google Cloud Platform-Data Warehouse in BigQuery- Data Ingestion into Bigquery/GCS using Sqoop on Dataproc-Setup Cloud MySql Instance & Database.Orchestration for Batch Processing.Case Study : Credit Card Transaction Processing.

MODULE II GOOGLE CLOUD STORAGE AND BIG QUERY 15 Hours

Introduction-BigQuery Console- Pyspark on Dataproc-Automate Jobs using Apache Airflow-Google Workflow. -Sqoop Basic-Data orchestration Job Automation using Google Workflow-Data Lake-Dataproc-Replications-Designing pipeline- Bigquery as the DWH-Spark Dstreams API and Spark-Process Time Streaming .Data warehouse Component- Case Study - Analyzing Customer Behavior to Improve Marketing Strategies

MODULE III ML ON GOOGLE CLOUD PLATFORM 15 Hours

Basic Concepts-Visualizing Data-Data Driven Decision with Data Studio-BI Engine Works-MLops Landscape in GCP-GCP in AutoML-AI Pipeline-IAM –End to End Data Solutions-CI/CD and Components-IOT Sensor Data Energy Consumption- Managed Cluster-Data Staging-Data Residency Requirements-ACID-Dataprep-LegalCompliance(HIPAA,COPPA,FedRamp,GDPR)-Casestudy-Operationalizing Scalable Data Analytics System on GCP- Case study : Enhancing Fraud Detection Using Machine Learning on Google Cloud Platform

Total Hours:	**45**

Text Books:

1	Adi Wijaya, “Data Engineering with Google Cloud Platform” A practical guide to operationalizing scalable data analytics systems on GCP, -Import, January 2021.

Reference Books:

1	Manoj Kukreja, Danil Zburivsky, “Data Engineering with Apache Spark” Delta Lake, and Lakehouse,Packt Publishing,2021.
2	Rudy Lai, Bartłomiej Potaczek,”Hands-On Big Data Analytics with PySpark” ,Packt Publishing, 2019.

Web References:

1	https://www.data-engineering-with-google-cloud-platform/

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	Total	Total Continuous Assessment		
80	120	200	40	60	100

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative Assessment based on Capstone Model			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list - Quiz, Assignment, Case Study, Seminar, Group Assignment)**	**FA (16%) [80 Marks]**
C012.1	Remember	Quiz	20
C012.2	Understand	Tutorial	20
C012.3	Apply	Assignment	20
C012.4&C 012.5	Apply		
C012.6	Analyze	Presentation	20

Assessment based on Summative and End Semester Examination			
Bloom's Level	**Summative Assessment (24%) [120 Marks]**		**End Semester Examination (60%) [100 Marks]**
	CIA1 : [60 Marks]	**CIA2 : [60 Marks]**	
Remember	20	20	20
Understand	30	30	30
Apply	20	20	20
Analyze	30	30	30
Evaluate	-	-	-
Create	-	-	-

Assessment based on Continuous and End Semester Examination				
Continuous Assessment (40%) [200 Marks]				**End Semester Examination (60%) [100 Marks]**
CA 1 : 100 Marks		**CA 2 : 100 Marks**		
SA 1	**FA 1 (40 Marks)**	**SA 2**	**FA 2 (40 Marks)**	

(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	(60 Marks)	Component - I (20 Marks)	Component - II (20 Marks)	

Course Outcomes (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C012.1	2	2	2		2									2	
C012.2	2	3	2		2									2	
C012.3	2	2	2		2									2	
C012.4	2	3	2		3	2							3	2	3
C012.5	2	2	2		2	3								2	
C012.6	2	2	2		2								2	2	2

22MC101	INDUCTION PROGRAMME	1/0/0/0
Nature of Course	Induction Programme	
Pre requisites	Nil	
Course Objectives:		
1.	To have broad understanding of society and relationships	
2.	To nurture the character and fulfil one's responsibility as an engineer, a citizen and a human being	
3.	To incorporate meta skills and values	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C101.1	Explore academic interest and activities	[AP]
C101.2	Work for excellence	[AP]
C101.3	Promote bonding and give a broader view of life and character	[AP]

Course Contents:

PHYSICAL ACTIVITY: Research over the past years has shown Yoga to have stress-relieving powers on students, paving the way for improved academic performance with the practice of asanas, meditation and breathing exercises. To prove these words Yoga classes has been planned in this module.(CO mapping: C101.1, C101.2, C101.3)

CREATIVE ARTS (students can select any one of their choice): Cultural development supports students to understand, feel comfortable with, value and appreciate the potential enrichment of cultural diversity. They should challenge discrimination, whether based on cultural or racial difference. Students should experience cultural traditions embedded in arts, crafts, language, literature, theatre, song, music, dance, sport, Science, technology and travel. Students should develop an appreciation of beauty both in experiencing artistic expression and by exploring their own creative powers. To inculcate those skills they are given a chance to exhibit their talents through painting, sculpture, pottery, music, dance, craft making and so on. .(CO mapping: C101.1, C101.2, C101.3)

UNIVERSAL HUMAN VALUES: Moral development involves supporting students to make considered choices around their behaviour and the values that provide a framework for how they choose to live. Moral development is also learning about society's values, understanding the reasons for them, how they are derived and change; and how disagreements are resolved. Students must consider the consequences of personal and societal decisions on the wider community – local and global- and on the environment and future generations. To acquire this the students are exposed to training to enhance their soft skills. .(CO mapping: C101.1, C101.2, C101.3)

LITERARY AND PROFICIENCY MODULES: Social development helps students to work effectively together, developing the inter-personal skills required to relate positively with their peers and people of all ages. Students must also understand how to participate productively in a diverse and plural society and learn about, and how to effectively engage with societal institutions and processes. They should understand that a person may have different roles and responsibilities within society. To reach this the following aspects are given in the form of Reading, writing, speaking – debate, role play etc. Communication and computer skills. (CO mapping: C101.1, C101.2, C101.3)

LECTURES BY EMINENT PEOPLE: Teaching with Lectures. ... It is essential to see lectures as a means of helping students learn to think about the key concepts of a particular subject, rather than primarily as a means of transferring knowledge from instructor to

student. During the induction period students will attend to Guest lectures by subject experts.(CO mapping: C101.1, C101.2, C101.3)

VISIT TO LOCAL AREAS: Traveling is in fact a way of learning to learn. You are out of your comfort zone and so you must learn to be able to adapt to a new learning environment in a very short time. It also helps in your overall learning as well. In the induction period students will be taken to different places near college to learn new things. Eg.Meditation centre/orphanage/Hospital.(CO mapping: C101.1, C101.2, C101.3)

FAMILIARIZATION TO DEPARTMENT/BRANCH INNOVATION: Hod's of different branches will present about their department followed by department visit to view various facilities available at their department, new innovations from students and faculties etc. .(CO mapping: C101.1, C101.2, C101.3)

Course Articulation Matrix (Lab)

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						3	3	3	3	3	3	3			1
2						3	3	3	3	3	3	3			1
3						3	3	3	3	3	3	3			1
Avg						3.0	3.0	3.0	3.0	3.0	3.0	3.0			1.0

1	Reasonably agreed	2	Moderately agreed	3	Strongly agreed

22MC201	ENVIRONMENTAL SCIENCES	2 /0 /0 /0

Nature of Course	:C (Theory Concept)
Pre requisites	:Basics in Environmental Studies

Course Objectives:

1	To learn the integrated themes on various natural resources.
2	To gain knowledge on the type of pollution and its control methods.
3	To have an awareness about the current environmental issues and the social problems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C201.1	Recall and play an important role in transferring a healthy environment for future generation.	[R]
C201.2	Understand the importance of natural resources and conservation of biodiversity.	[U]
C201.3	Understand and analyze the impact of engineering solutions in a global and societal context.	[U]
C201.4	Apply the gained knowledge to overcome pollution problems.	[AP]
C201.5	Apply the gained knowledge in various environmental issues and sustainable development.	[AP]

Course Contents:

Natural Resources:
Introduction-Forest resources: Use and abuse, case study-Major activities in forest-Water resources-over utilization of water, dams-benefits and problems. Mineral resources-Use and exploitation, environmental effects of mining- case study–Food resources- World food problems, case study. Energy resources -Renewable and non-renewable energy sources Land resources- Soil erosion and desertification – Role of an individual in conservation of natural resources.

Environmental Pollutions:
Definition – causes, effects and control measures of: a. Air pollution-Acid rain - Green house effect-Global warming- Ozone layer depletion – case study- Bhopal gas tragedyb. Water pollution c. Soil pollution - Solid waste management-Recycling of plastics-Pyrolysis method-causes, effects and control measures of municipal solid wastes d. Noise pollution. e. Nuclear hazards-case study-Chernobyl nuclear disaster-Role of an individual in prevention of pollution.

Social issues and the Environment:
Sustainable development-water conservation, rain water harvesting, E-Waste Management – Environmental ethics: 12 Principles of green chemistry-Scheme of labelling of environmental friendly products (Eco mark) – Emission standards – ISO 14001 standard.

Total Hours:	**30**

Text Books:

1	AnubhaKaushik and C P Kaushik "Perspectives in Environmental Studies"4th Edition, Newage International (P) Limited, Publisher Reprint 2014. New Delhi
2	Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press 2015.

Reference Books:

1	Tyler Miller, Jr., "Environmental Science", Brooks/Cole a part of Cengage Learning, 2014.
2	William Cunningham and Mary Cunningham, "Environmental Science", 13th Edition, McGraw Hill,2015.
3	Gilbert M. Masters, "Introduction to Environmental Engineering and Science", Third Edition, Pearson Education, 2014.

Web References:

1	http://nptel.ac.in/courses/104103020/20

2	http://nptel.ac.in/courses/120108002
3	http://nptel.ac.in/courses/122106030
4	http://nptel.ac.in/courses/120108004/
5	http://nptel.ac.in/courses/122102006/20

Online Resources:

1	https://www.edx.org/course/subject/environmental-studies
2	www.environmentalscience.org

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:50)

Course Outcome	Bloom's Level	Assessment Component	Marks
C201.1	Remember	Quiz	**10**
C201.2	Understand	Mini project based on environmental aspect	**20**
C201.3	Understand	Class Presentation	**10**
C201.4	Apply	Assignment	**10**

Summative assessment based on Continuous Assessment

Bloom's Level	Continuous Assessment		
	CIA-I [0 marks]	CIA-II [0 marks]	Term End Assessment [50 marks]
Remember	-	-	30
Understand	-	-	40
Apply	-	-	30
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C102.1						2	2						2		
C102.2						2	2						2		
C102.3						2	2							2	
C102.4						3	3						2		
C102.5						3	3						2		

22MC103	SOFT SKILLS	2/0/0/0
Nature of Course:	Theory Concept	
Pre requisites:	Technical Communication Skills	
Course Objectives:		
1.	To develop the students competency level and their capabilities.	
2.	To teach the students to be effective in workplace and social environments.	
3.	To create self confidence among the students and to resolve stress and conflict within themselves.	
4.	To help the students to enhance their career skills by increasing their productivity and performances.	
5.	To concentrate more on conversation skills, presentation skills, verbal ability, critical and creative thinking.	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C103.1	Remember the principles of soft skills required for their profession.	[R]
C103.2	Understand the importance of Interpersonal communication Skills among individuals, groups and cultures.	[U]
C103.3	Apply verbal and non-verbal communication skills in corporate environment.	[AP]
C103.4	Analyse and apply creativity skills, critical thinking skills and problem solving skills.	[AN]
C103.5	Articulate oral and written messages in an appropriate and persuasive manner to suit specific purposes, audiences and contexts at work place.	[AP]
C103.6	Apply good teamwork skills and Leadership Skills	[AP]

Module 1: Professional Communication Skills **10 Hours**

Introduction to the Soft Skills, Performance Evaluation 1 –Significance of Soft Skills- Understanding the basic Communication Principles –Listening Skills- Listening Exercises- Speaking Skills- How to start and Sustain a Conversation- Speaking in Groups- Understanding self and Personal Branding, attitude, types of attitude, Positive Attitude, Self Confidence and Self-Motivation - Personal Application/Action Taken. Advanced Writing Skills-Principles of Business Writing- E mails- Writing Reports- Types of Reports- Strategies for Report Writing- Personal Application/Action Taken. Verbal Ability- Analogy- Classification- Odd One Out-

Idioms and Phrases- Sentence Correction- Empathy and its importance in career -Personal Application/Action Taken.

Module 2: Interpersonal Communication **10 Hours**

Nonverbal Communication- Individual, Groups and Cultures- Body Language- Attire and Etiquettes- Interpersonal Skills- dealing with diverse People- Networking- Emotional Intelligence and its importance. Personal Application/Action Taken. Developing Creativity- Critical Thinking and Problem Solving Skills- Making the Right Choice- Never Give Up- Begin to Grow- Personal Application/Action Taken. Interviews- Facing Job Interviews - Planning and Preparing- Effective Resume along with Covering Letter- Planning and Preparing- Personal Application/Action Taken. Self-Discipline - Self Presentation - Personal Application/Action Taken.

Module 3: Teamwork and Leadership Skills **10 Hours**

Industry Expectations- Universal Hiring Rule- Personal Application/Action Taken. Importance of Human Values-Importance of Team Work- Developing Key Traits in Motivation, Persuasion, Negotiation and Leadership Skills- Being an Effective Team Player- Personal Application/Action Taken. Planning- Prioritization - Delegation- Conflict Management- Decision and its necessity in crucial situations- Group Discussion- Personal Application/Action Taken. Essential Skills in working Strategies- Presentation and Interaction Skills- What to Present and How- Being Assertive- Multimedia Presentation-Making Effective Presentations. Interview Skills- Do's and Don'ts - Body Language – Answering the Common Questions of Interview- Performance Evaluation 2- Mock Interview

Total Hours:	**30**

Text Books:

1.	Penrose, "Business Communication for managers: An advanced approach", Cengage learning.
2.	H.E. Sales, "Professional Communication in Engineering", Palgrave Macmillan 2009.
3.	W. P. Scott, Bertil Billing, "Communication for Professional Engineers", Thomas Telford, 1998.

Reference Books:

1.	Peter Davson-Galle, "Reason and Professional Ethics", Ashgate Publishing, Ltd., 2009.

3.	Joep Cornelissen, "Corporate Communications: Theory and Practice", Sage Publications India Pvt Ltd, New Delhi, 2004.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc16_hs15/preview
2	https://www.getinternship.switchidea.com/NTAT/syllabus/Interpersonal-Communication.
3	https://smude.edu.in/smude/programs/bca/soft-skills.html
Online Resources:	
1	https://swayam.gov.in/course/4047-developing-soft-skills-and-personality
2	https://www.clearias.com/interpersonal-skills-including-communication-skills-for-csat/
3	https://www.bizlibrary.com/soft-skills-training/

Assessment Methods & Levels (based on Revised Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:40)			
Course Outcome	**Revised Bloom's Level**	**Assessment Component**	**Marks**
C103.1	Remember	Group Discussion	10
C103.2 & C103.3	Understand	Listening Skills	10
C103.4	Apply	Interview	10
C103.5 & C103.6	Apply	Formal Presentation	10

Revised Bloom's Level	**Tentative End Assessment Examination (Theory) [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C103.1						1	1	2	2	3	2	2			1
C103.2							1	1	3	3	2	2			1
C103.3									2	3	2	2			1
C103.4						1	1	1	2	3	3	2			1
C103.5						1	1		2	3	2	2			1
C103.6							1	2	3	3	2	2			1

22MC105	GENERAL APTITUDE	2/0/0/0

Nature of Course	Problem analytical
Pre requisites	Basic Mathematical calculations

Course Objectives:

1	To ensure that students learn to think critically about mathematical models for relationships between different quantities and use those models effectively to solve problems and reach conclusions about them.
2	To impart skills that enable students to effectively use and interpret data, formulas, and graphs in the workplace.
3	To instills confidence in facing technical aptitude questions interviewed by recruiters.

Course Outcomes:

Upon completion of the course, students shall have ability to

C105.1	To teach the basics of Quantitative Techniques in a graded manner.	[R]
C105.2	Understand the verbal and non-verbal nature of problems in reality and know the shortcut methods of solving it.	[U]
C105.3	Solve problems using their general mental ability.	[AP]
C105.4	To give intense focus on improving and increasing the ability of solving real problems.	[AP]
C105.5	Think critically about mathematical models for relating different quantities to reach conclusion.	[AP]
C105.6	Enable effective use of data interpretation, formulas, graphs and assumptions.	[AP]

Module 1: Number Theory and Statistics **14 Hours**

Number Systems– HCF and LCM of Numbers – Decimal Fractions – Simplification – Square Root and Cube Root of a number – Surds and Indices – Problems on numbers – Percentage – Ratio and Proportion – Divisibility – Mixtures – Averages- Polynomials – Solving Equations and Inequalities – Discard's rule of signs – Problems on ages – Chain rule – Time and Work – Time and Distance – Problems on Trains – Problems on Boats and Streams- Measures of central tendency – Mean, Median and Mode – Variance and Standard deviation Logarithms – Profit and Loss – Simple Interest – Compound Interest.

Module 2: Logic and Decision Making **8 Hours**Analogy – Classification – Series completion – Coding and Decoding – Blood Relations – Puzzle Test – Direction Sense test – Logical Venn Diagrams - Number Ranking and Time

Sequence Test – Decision Making – Assertion and Reason– Inserting the missing one – Logical Sequence of words – Syllogisms.

Module 3: Reasoning **8 Hours**

Logic – Statement and Arguments – Statements and Assumptions – Statements and Course of Action – Statements and Conclusions – Deriving conclusions from passages – Functions – Different kinds of functions – Miscellaneous sets- Series – Analogy – Classifications – Analytical Reasoning – Problems on Cubes and Dice – Mirror Images – Water Images – Rule Detection.

Total Hours:	**30**

Text Books:

1	Aggarwal R. S, "Quantitative Aptitude" Revised Edition, S. Chand Publication.
2	Abhijit Guha, "Quantitative Aptitude" 5th Edition, McGraw Hill Education.

Reference Books:

1	Edgar Thorpe "Mental Ability & Quantitative Aptitude" 3rd Edition, McGraw Hill Education.

Web References:

1	https://www.wiziq.com/tutorial/815468-quantitative-aptitude-reasoning-data-interpretation-video-lectures
2	https://learningpundits.com/contest?referrer=harsh.cse15@nituk.ac.in
3	https://nptel.ac.in/courses/114106041/8
4	https://nptel.ac.in/courses/111103020/2

Online Resources:

1	http://aptitudetraining.in/home/index.php
2	https://www.udemy.com/vedicmaths/
3	https://www.youtube.com/channel/UCtmn-DsF4BhPug-ff9LiDAA?disable_polymer=true

Tentative Assessment Methods & Levels (based on Revised Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Revised Bloom's Level	Assessment Component	Marks
C105.1	Remember	Classroom or Online Quiz	10
C105.2 & C105.3	Understand	Formal presentation	10
C105.4, C105.5 & C105.6	Apply	Formal interview tests	20

Summative assessment based on Continuous and End Semester Examination	
Bloom's Level	**Term End Assessment Examination (Theory) [60 marks]**
Remember	20
Understand	40
Apply	40
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes(PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C105.1	3	3	1												
C105.2	3	2	1												
C105.3	3	3	1												
C105.4	3	2	1										2		
C105.5	3	3	1										2		
C105.6	3	2	1										2		

22MC106	LIFE SKILLS AND ETHICS	2/0/0/0
Nature of Course	Theory Concept	
Pre requisites	Nil	

Course Objectives:

1	To develop communication competence in prospective engineers.
2	To enable them to convey thoughts and ideas with clarity and focus.
3	To develop report writing skills.
4	To equip them to face interview & Group Discussion.
5	To inculcate critical thinking process.
6	To prepare them on problem solving skills.
7	To provide symbolic, verbal, and graphical interpretations of statements in a problem description.

Course Outcomes:

Upon completion of the course, students shall have ability to

C106.1	Define and identify different life skills required in personal and professional life.	[U]
C106.2	Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.	[AP]
C106.3	Explain the basic mechanics of effective communication and demonstrate these through presentations.	[AN]
C106.4	Use appropriate thinking and problem-solving techniques to solve new problems.	[AP]
C106.5	Understand the basics of teamwork and leadership	[U]

Course Contents:

Communication Skill:

Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

Critical Thinking & Problem Solving:

Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats Mind Mapping & Analytical Thinking. Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Ethics, Moral & Professional Values:

Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE. **Leadership Skills:** Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation

Total Hours:	**30**

Reference Books:

1	Barun K. Mitra, "Personality Development & Soft Skills", First Edition, Oxford Publishers, 2011.
2	Kalyana, "Soft Skill for Managers", 1st Edition, Wiley Publishing Ltd, 2015.
3	Larry James, "The First Book of Life Skills", 1st Edition, Embassy Books, 2016
5	John C. Maxwell, "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc, 2014.

Web References:

1	https://www.coursera.org/courses?query=ethics

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Bloom's Level	Assessment Component	Marks
C106.1	Remember	Quiz	**5**
C106.2	Understand	Assignment	**15**
C106.3	Understand	Presentation	**10**
C106.4 C106.5	Apply	Group Discussion	**10**

Summative assessment based on Continuous Assessment

Revised Bloom's Level	Term End Assessment [60 marks]
Remember	30
Understand	40
Apply	30
Analyse	-

Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C106.1								1	2	1		2	1		
C106.2								1	2	1		2	1		
C106.3								2	2	3		1	1		
C106.4								1	1	1		1	3		
C106.5								1	3	2		2	1		

22MC107	STRESS MANAGEMENT	2/0/0/0

Nature of Course	Theory Concept
Pre requisites	Nil

Course Objectives:

1	Understand the basic principles of stress management
2	Recognize your stress triggers and how to manage them
3	Develop proactive responses to stressful situations
4	Use coping tips for managing stress both on and off the job
5	Learn to manage stress through diet, sleep and other lifestyle factors
6	Develop a long term action plan to minimize and better manage stress
7	Understand the basic principles of stress management

Course Outcomes:

Upon completion of the course, students shall have ability to

C107.1	Understand the basic principles of stress management	[U]
C107.2	Apply the concept of recognizing your stress triggers and find was to manage them.	[AP]
C107.3	Develop proactive responses to stressful situations	[AN]
C107.4	Develop a long term action plan to minimize and better manage stress	[AP]

Course Contents:

Scientific Foundations of Stress:

What is stress? – Sources of Stress – Types of Stress – Personality Factors and stress – Stress and the college student. Stress Psychophysiology: Stress and nervous system – Hypothalamic – Pituitary – Adrenal (HPA) Axis – Effect of Stress on Immune system – Health risk associated with chronic stress – Stress and Major Psychiatric disorders.

Developing Resilience to Stress:

Understanding you stress level – Role of personality pattern, Self-esteem, Locus of control – Role of Thoughts Beliefs and Emotions – I & II – Life situation Intrapersonal: (Assertiveness, Time Management).

Strategies for Relieving Stress:

Developing cognitive coping skills – Autogenic training, imagery and progressive relaxation – Other relaxation techniques – Exercise and Health – DIY strategies stress management.

Total Hours:	**30**

Reference Books:	
1	Jonathan C. Smith, "Stress Management: A Comprehensive Handbook of Techniques and Strategies", 1st Edition, Springer Publishing Company, 2011.
2	Bob Stahl, Elisha Goldstein, Jon Kabat-Zinn, "A Mindfulness–based Stress Reduction Workbook", 2nd Edition, New Harbinger Publications, 2019.
3	Ryan M. Niemiec, "The Strengths-based Workbook for Stress Relief", 1st Edition, New Harbinger Publications, 2019.
Web References:	
1	https://thiswayup.org.au/courses/coping-with-stress-course/
2	https://www.classcentral.com/course/swayam-stress-management-14309

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:40)

Course Outcome	Bloom's Level	Assessment Component	Marks
C107.1	Remember	Quiz	**10**
C107.2	Understand	Group Discussion	**10**
C107.3	Understand	Class Presentation	**10**
C107.4	Apply	Assignment	**10**

Summative assessment based on Continuous Assessment	
Revised Bloom's Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C107.1								1	3			1	1		
C107.2								1	2	1		1	1		
C107.3								1	3	1		2	2		
C107.4								1	3	1		3	2		

22MC108	CONSTITUTION OF INDIA	2/0/0/0

Nature of Course : Theory

Pre Requisites : Nil

Course Objectives:

1	To familiarize with basic information about Indian constitution
2	To understand the fundamental rights and duties as citizens of India

Course Outcomes:

Upon completion of the course, students shall have ability to

C108.1	Explain the objectives of the Constitution of India and its formation	[U]
C108.2	Recall state and central policies (Union and State Executive), fundamental Rights and their duties.	[R]
C108.3	Make use of legal directions in developing solutions to societal issues	[AP]
C108.4	Utilized for competitive exams that requires knowledge of Indian Constitution	[AP]

Course Contents:

Module 1 **10 Hours**

Historical perspective, The making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights, Directive Principles of State Policy, Fundamental Duties, Citizenship Article 5-11.

Module 2 **10 Hours**

Federal structure, Powers of the Union and the states, Centre-State Relations, Union Executive – President, Prime Minister, Union Cabinet, Parliament, Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Elections, Electoral Process, and Election Commission of India, Election Laws. Powers and Functions of Municipalities and Panchayat

Module 3 **10 Hours**

Amendments - Methods, Emergency Provisions, National Emergency, President Rule, Financial Emergency, Provisions for SC & ST, OBC, women, children and backward classes, Right to Property, Freedom of Trade and Commerce. Agricultural Law

Total Hours:	**30**

Text Books:

1	Dr. D. D. Basu, "Introduction to the Constitution of India", LexisNexis, New Delhi, 22nd Edition, 2016.
2	"Bare act-constitution of India", The universal Publications, LexisNexis 2020, New Delhi, India.

Reference Books:	
1	Subhash. C. Kashyap, "Our Constitution: An Introduction to India's Constitution and Constitutional Law", National Book Trust, India, 5th Edition, 2019.
2	M. Laxmikanth, "Constitution of India", Cengage Learning India, 1st Edition 2018.
Web References:	
1	https://unacademy.com/course/the-indian-constitution/NSKQ8XXQ
2	https://unacademy.com/goal/upsc-civil-services-examination-ias-preparation/KSCGY

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C108.1	Remember	Test	10
C108.4	Understand	Quiz	10
C108.3	Apply	Presentation	10
C108.2	Apply	Group Assignment	10

Summative assessment based on Continuous Assessment	
Revised Bloom's Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	Programme Outcomes (PO)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C108.1						3	1	1	1			1	1	1	
C108.2						3	1	1	1			1	1	2	
C108.3						3	2	2	1			1	1	2	
C108.4						3	1	1	1			2	1	1	

22MC109	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2/0/0/0
Nature of Course : Theory		
Pre Requisites : Nil		

Course Objectives:

1	To make understand the contribution of Indian mind in various fields.
2	To cultivate critical appreciation of the thought content and provide insights relevant for promoting cognitive ability, health, good governance, aesthetic appreciation and right values.

Course Outcomes:

Upon completion of the course, students shall have ability to

C109.1	Relate classical Indian traditions with contemporary traditions and culture.	[R]
C109.2	Outline the thoughts of Indians in different disciplines.	[U]
C109.3	Apply the knowledge to the present context.	[AP]
C109.4	Develop a better appreciation and understanding of Indian traditions.	[C]

Course Contents:

Indian Ethics: Individual and Social – Society state and Polity (Survey) - Education systems – Agriculture (Survey) – Early & Classical Architecture – Medieval & Colonial Architecture.

Astronomy in India – Martial Arts Traditions (Survey) - Indian Literatures - Indian Philosophical Systems - Indian Traditional Knowledge on Environmental Conservation

Ayurveda for Life, Health and Well-being - The Historical Evolution of Medical Tradition in Ancient India- Music in India - Classical & Folk

Total hours:	**30**

Text Books:

1	Kapil Kapoor and Michel Danino, "Knowledge Traditions and Practices of India", Central Board of Secondary Education, 2017.
2	Yogesh Atal, "Indian Society: Continuity and Change", Pearson Education India, 2016.

Reference Books:	
1	Douglas Osto, "An Indian Tantric Tradition and Its Modern Global Revival", Routledge publications, 2020.
2	Rao C.N. Shankar, "Sociology: Principles of Sociology with an Introduction to Social Thoughts", S Chand Publisher, 2019.
Web References:	
1	http://nopr.niscair.res.in/handle/123456789/43
2	https://nptel.ac.in/courses/109/104/109104102/

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:100)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C109.1	Remember	Quiz	10
C109.2	Understand	Group Assignment	10
C109.3	Apply	Presentation	10
C109.4	Create	Survey	10

Summative assessment based on Continuous Assessment	
Revised Bloom's Level	**Term End Assessment [60 marks]**
Remember	30
Understand	40
Apply	30
Analyse	-
Evaluate	-
Create	-

Course Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C109.1						2	1	1	1			2	3	1	
C109.2						2	1	1	2			1	2	1	
C109.3						1	1	1	1			1	1	1	
C109.4						2	1	1	2			2	1	1	

22VA701	DATA REPRESENTATION AND INTERPRETATION USING PYTHON	1/0/0/1

Nature of Course

Course Objectives:

1	To develop the student's competency level and their capabilities.
2	To help the students to enhance their career skills by increasing their productivity and performances.
3	To use latest python libraries for data science in real time paradigms.

Course Outcomes:
Upon completion of the course, students shall have the ability to:

C701.1	Understand the programming skill required for their profession.	[U]
C701.2	Read and write data from data sheets and Analyze data.	[AP]
C701.3	Review, collect, transform and organize data to make future predictions, and make informed data-driven decisions.	[AP]

COURSE Contents:

Analyzing Numerical Data with NumPy

Arrays in NumPy - Creating NumPy Array - NumPy Array Indexing - NumPy Array Slicing - NumPy Array Broadcasting.

Working with Dataset

Pandas series - Pandas DataFramesPandas Read CSVPandas Read JSONPandas Analyzing Data.

Data visualization

Seaborn – Pandas – Plotly - Python Matplotlib - Matplotlib Pyplot - Matplotlib Plotting - Matplotlib Markers - Matplotlib Line - Matplotlib Labels - Matplotlib Grid - Matplotlib Subplot - Matplotlib Scatter - Matplotlib Bars - Matplotlib Histograms - Matplotlib Pie Charts.

Total Hours:	**30 Hours**

Text Books:

1	Fabio Nelli, "Python Data Analytics: Data Analysis and science using pandas, matplotlib and python programming language", Apress.

Web References:

1	http://nptel.ac.in/courses/106106145/
2	https://www.codecademy.com/learn/learn-python

Course Outcome(s)	Programme Outcome(s)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C701.1		1	3	3	3							1	3	3	3
C701.2	1	2	3	3	3	1						1	3	3	3
C701.3	2	2	3	3	2							1	3	3	3

22VA702	ANDROID ENTERPRISE	1/0/0/1

Nature of Course

Course Objectives:

1	To provide in-depth knowledge and hands-on experience in android application development, the latest trends and features.
2	To explore the intent and various functions of intent.
3	To construct user interface, layout and constraints.
4	Creating intuitive, reliable mobile apps using the android services and components.
5	To demonstrate the application with SQL lite.

Course Outcomes:

Upon completion of the course, students shall have the ability to:

C702.1	Demonstrate and understanding of the fundamentals of Android operating systems.	[U]
C702.2	Interacting with the user, the user experience and debugging.	[AP]
C702.3	Design and develop user Interfaces for the Android platform.	[AP]
C702.4	Understand the basics of UI layout and UI control.	[U]
C702.5	Understand the purpose different development tools for Android.	[U]

COURSE Contents:

MODULE I: INTRODUCTION

Introduction to Android OS: Android Architecture.: Overview of the Stack, Linux Kernel, Native Libraries, Dalvik Virtual Machine, Android Virtual Machine (ADT), Dalvik Debug Monitor Server (DDMS), LogCat, Application Framework, Application Licensing, Gradle - Android Life cycle, working with App Inventor Designer and Blocks Editor.

MODULE II:ANDROID BASICS

Android Resources - Activities - Services - Broadcast Reviewers - Content Providers- Fragments - Intents/ Filters - UI Layout - UI Controls.

MODULE III: HANDLING DATA

Text controls, Button controls, Images Supporting Multiple Screen, Activities, application context, Web View File, shared Preferences, Database (SQLite database) Creation of .apk files.

Total Hours:	**30 Hours**

Text Books:

1	Google Developer Training, "Android Developer Fundamentals Course – Concept Reference", Google Developer Training Team, 2017.

Web References:

1	https://developer.android.com/index.html
2	https://in.udacity.com/course/new-android-fundamentals--ud851

Course Outcome(s)	Programme Outcome(s)												Programme Specific Outcomes (PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C702.1		1	3	3	3							1	3	3	3
C702.2	1	2	3	3	3	1						1	3	3	3
C702.3	2	2	3	3	2							1	3	3	3
C702.4	2	1	3	3	3							1	3	3	3
C702.5	2	1	2	3	2	1						1	3	3	3

22VA130	EFFECTIVE COMMUNICATION SKILLS	2/0/0/2
Nature of Course	E (Theory skill based)	
Pre-Requisites	Basics of English Language	

Course Objectives:

1	To become self-confident individuals by mastering interpersonal skills, team management skills, and leadership skills.
2	To develop effective communication skills.
3	To train students to use the language with confidence and without committing errors.
4	To improve the fluency of the students when speaking English.
5	To focus on pronunciation, dialect, intonation, interaction, practice and communication.

Course Outcomes:
Upon completion of the course, students shall have ability to

C130.1	Remember correct usage of English grammar in speaking.	[U]
C130.2	Apply and improve their speaking ability in English both in terms of fluency and comprehensibility	[AP]
C130.3	Understand and communicate effectively in personal and professional situations.	[U]
C130.4	Understand and analyze oral presentations and receive feedback on their performance.	[U]
C130.5	Apply reading fluency skills through extensive reading.	[AP]

Course Contents:

Module I **10 Hours**

Pre-Test - Vocabulary Building- Connecting Phrases- Exercises and **Activities- Conversation Practices-** Greetings-exchanging ideas - Asking for information - questioning techniques / answering techniques - Getting people to do things - requesting/agreeing/refusing **– Activity Common Expressions** (Individual)- Talking about Favorites - Talk Show **Activity** - **Impromptu Speaking-** Personal Interest - Talking about Past Events and Future/Talking about Everyday Life (Family, Hobbies, Work, Travel and Current Events) **– Activity.**

Module II **10 Hours**

Listening - Trials of a Good Listener- Listening to Texts, Listening for Specific Purpose- **Activity- 21st Century Skills –** Communication with Critical Thinking and Creativity-Role Play**-Activity- Personality Development-** Manners and Etiquettes. Building Confidence and Developing Presentation Skills**-Activity- Singing a Song (Group)- Activity.**

Module III **10 Hours**

Story Telling- Use of Charts and Graphs**-Activity -Persuasive Speech-** Handling Criticism-Justifying Opinions-Conflict-Resolution-Situational Role Play **Activity- - News reading and Pronunciation- Activity -Satori**- Intuitive Approach**-Activity- Post Test.**

30 Hours

Total Hours:	**30**

Text Books:

1	English and Soft skills Orient Black Swan Publishers (S. P. Dhanavel)2010.
2	Remedial English Grammar. F.T. Wood. Macmillan.2007
3	On Writing Well. William Zinsser. Harper Resource Book. 2001

4	Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited 2015.
Reference Books:	
1	Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.
2	Busch, B., & Oakley, B. (2017). Emotional intelligence: why it matters and how to teach it. Retrieved from https://www.theguardian.com/teacher-network/2017/nov/03/emotional-intelligence-why-it-matters-and-how-to-teach-it.
3	Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
Web References:	
1	https://www.udemy.com/course/english-speaking-complete/
2	https://www.cambridgeenglish.org/exams-and-tests/linguaskill/
Online Resources:	
1	https://www.lingoda.com/en/linguaskill-from-cambridge/
2	https://www.icd.org.pk/linguaskill/

Summative assessment based on Continuous and End Semester Examination

Internal Components - 10

S.No	Components	Marks
1.	Vocabulary Building	10 Marks
2.	Conversation Practices	10 Marks
3.	Common Expressions	10 Marks
4.	Impromptu Speaking	10 Marks
5.	Listening	10 Marks
6.	21st Century Skills	10 Marks
7.	Presentation Skills	10 Marks
8.	Singing a Song (Group)	10 Marks
9.	News Reading and Pronunciation	10 Marks
10.	Satori	10 Marks
Total		100 Marks

Course Outcome(CO)	Programme Outcomes (PO)												Programme Specific Outcomes(PSO)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C130.1									2	3		2			2
C130.2									3	3		1			1
C130.3								2	2	2		1			1
C130.4								1	1	2					1
C130.5								1	3	3		2			2