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

Curriculum & Syllabi

Regulation 2022

2022-2026 Batch

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

(Batch 2022-2026)

VISION OF THE INSTITUTION

- To Produce Globally Competitive Engineers with High Ethical Values and Social Responsibilities

MISSION OF THE INSTITUTION

- To impart the highest quality state-of-the-art technical education by providing impetus to innovation, research, and development and empowering students with entrepreneurship skills
- To instill ethical values, imbibe a sense of social responsibility, and strive for societal well-being
- To identify the needs of society and offer sustainable solutions through outreach programs

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

VISION OF THE DEPARTMENT

- To prepare professionals with high technical, research and entrepreneurial skills as well as ethical values who will contribute to the computational world

MISSION OF THE DEPARTMENT

- To develop human resources with the ability and attitude to adapt to emerging technological changes through academic and research-oriented events
- To identify current socio, economic problems of national and international significance and provide solutions through competency centers
- To impart ethics, social responsibilities and necessary professional, entrepreneurial and leadership skills through student lead activities

I.	PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)
To enable graduates to	
PEO 1	Be successful in their career in industries associated with Computer Science and Engineering
PEO 2	Comprehend, analyze, design, and create novel products and solutions for the real-life problems
PEO 3	Possess professional and ethical attitude, effective communication skills, team working skills, multi-disciplinary approach, and an ability to relate engineering issues to broader social context
PEO 4	Exhibit leadership qualities and progress through life-long learning

II.	PROGRAMME OUTCOMES (POs)
PO 1	**Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO 2	**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
PO 3	**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
PO 4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO 5	**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 the limitations
PO 6	**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
PO 7	**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
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**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 clear instructions.
PO 11	**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.
PO 12	**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.

III. PROGRAMME SPECIFIC OUTCOMES (PSOs)	
The Graduates of B.E – CSE programme will be able to:	
PSO 1	Apply the fundamental knowledge for problem solving and analysis as well as conduct investigations in computer science and engineering for sustainable development
PSO 2	Design and develop the solutions for real time problems and implement them by using modern software tools in lieu of deploying them in the society for its growth
PSO 3	Communicate effectively, adopt ethics and engage in life-long learning

IV. MAPPING OF PEOs WITH POs

PEO	**POs**											
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
1	3	3	3	2	2	3	-	1	1	1	2	1
2	3	3	3	3	3	2	1	1	1	2	2	2
3	-	-	-	-	-	3	3	3	2	2	2	2
4	-	-	-	-	-	-	-	-	3	3	3	3
	1- low, 2 - medium, 3 - high, '-' - no correlation											

V. MAPPING OF PEOs WITH PSOs

	PSO 1	**PSO 2**	**PSO 3**
PEO 1	2	2	2
PEO 2	3	1	-
PEO 3	1	3	2
PEO 4	-	-	3

AUTONOMOUS CURRICULUM AND SYLLABI

Regulations 2022

SEMESTER I							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MA102	Mathematics I	3/1/0	4	4	60/40	BSC
2	22EE111	Basics of Electrical and Electronics Engineering	2/1/0	3	3	60/40	ESC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
3	22IT101	Application Development Practices	3/0/2	5	4	50/50	PCC
4	22CS101	Problem Solving using C++	3/0/2	5	4	50/50	PCC
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
Practical (Internal 60 Marks & External 40 Marks)							
7	22EE114	Basics of Electrical and Electronics Engineering Laboratory	0/0/2	2	1	40/60	ESC
Mandatory Course (Internal 100 Marks)							
8	22MC101	Mandatory Course – I (Induction Programme)	3 Weeks				MC
TOTAL				**28**	**23**	**800**	

SEMESTER II							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22GE201	Universal Human Values	3/0/0	3	3	60/40	HSMC
2	22MA202	Mathematics II	3/1/0	4	4	60/40	BSC
3	22TA101	Heritage of Tamils	1/0/0	1	1	60/40	HSMC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
4	22CS201	Data Structures and Algorithms	3/0/2	5	4	50/50	PCC

5	22IT201	Database Management Systems	3/0/2	5	4	50/50	PCC
6	22AD201	Java Programming	3/0/2	5	4	50/50	PCC
7	22PH201	Physics	3/0/2	5	4	50/50	BSC
Mandatory Course (Internal 100 Marks)							
8	22MC102	Mandatory Course II (Environmental Sciences)	1/0/0	1	0	0/100	MC
TOTAL				**29**	**24**	**800**	

SEMESTER III							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22IT301	Computer Architecture	3/0/0	3	3	60/40	ESC
2	22EC111	Digital Logic and Design	3/0/0	3	3	60/40	ESC
3	22MA302	Random Variable and Statistics	3/1/0	4	4	60/40	BSC
4	22TA201	Tamils and Technology	1/0/0	1	1	60/40	HSMC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
5	22AD301	Design and analysis of algorithms	1/0/4	5	3	50/50	PCC
6	22IT302	Web Technology	1/0/4	5	3	50/50	PCC
7	22CS301	Advanced Java Programming	1/0/4	5	3	50/50	PCC
Mandatory Course (Internal 100 Marks)							
8	22MCXXX	Mandatory Course-III	1/0/0	1	0	0/100	MC
			TOTAL	**28**	**20**	**800**	

SEMESTER IV							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22MA401	Optimization and Project Management	3/1/0	4	4	60/40	BSC
2	22CS401	Theory of Computation	3/0/0	3	3	60/40	PCC
Theory with Practical (Internal 50 Marks & External 50 Marks)							

3	22IT402	Software Testing	1/0/4	5	3	50/50	PCC
4	22CS402	Web Frameworks	1/0/4	5	3	50/50	PCC
5	22AD401	Cloud Computing	1/0/4	5	3	50/50	PCC
6	22CS403	Operating Systems	3/0/2	5	4	50/50	PCC
Mandatory Course (Internal 100 Marks)							
7	23MCXXX	Mandatory Course -IV	1/0/0	1	0	0/100	MC
			TOTAL	**28**	**20**	**700**	

SEMESTER V							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22XXXXX	Open Elective – I	3/0/0	3	3	60/40	OEC
2	22XXXXX	Professional Elective – I	3/0/0	3	3	60/40	PEC
3	22XXXXX	Professional Elective - II	3/0/0	3	3	60/40	PEC
4	22CS501	Computer Networks	3/0/0	3	3	60/40	ESC
5	22EC512	Microcontrollers and Embedded Systems	3/0/0	3	3	60/40	PCC
Theory with Practical (Internal 50 Marks & External 50 Marks)							
6	22CS502	Principles of Compiler Design	3/0/2	5	4	50/50	PCC
Practical (Internal 60 Marks & External 40 Marks)							
7	22CS503	Computer Networks Laboratory	0/0/3	3	1.5	40/60	PCC
Mini Project (Internal 100 Marks)							
8	22CS504	Mini Project	0/0/2	2	1	40/60	PRJ
TOTAL				**28**	**21.5**	**800**	

SEMESTER VI							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22CSXXX	Emerging Elective – I	3/0/0	3	3	60/40	EEC
2	22XXXXX	Professional Elective - III	3/0/0	3	3	60/40	PEC
3	22XXXXX	Professional Elective - IV	3/0/0	3	3	60/40	PEC
4	22CS601	Object Oriented Analysis and Design	3/0/0	3	3	60/40	PCC
5	22CS602	Cryptography and Network Security	3/0/0	3	3	60/40	PCC
6	22CS603	Artificial Intelligence	3/0/0	3	3	60/40	PCC
Practical (Internal 60 Marks & External 40 Marks)							
7	22CS604	Object Oriented Analysis and Design Laboratory	0/0/3	3	1.5	40/60	PCC
8	22CS605	Artificial Intelligence Laboratory	0/0/3	3	1.5	40/60	PCC
TOTAL				**27**	**21**	**800**	

SEMESTER VII							
S.No	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22CS701	Internet of Everything	3/0/0	3	3	60/40	PCC
2		Open Elective - II	3/0/0	3	3	60/40	OEC
3		Emerging Elective - II	3/0/0	3	3	60/40	EEC
4		Professional Elective - V	3/0/0	3	3	60/40	PEC
5		Professional Elective - VI	3/0/0	3	3	60/40	PEC
Practical (Internal 60 Marks & External 40 Marks)							
6	22CS702	Internet of Everything Laboratory	0 / 0 / 3	3	1.5	40/60	PCC
Project (Internal 60 Marks & External 40 Marks)							
7	22CS703	Project - I	0/0/6	6	3	40/60	PRJ

Internship (Internal 100 Marks)						
8	22CS704	Employability Enhancement Skills (Internship)	28 Days	2	0/100	PRJ
TOTAL			**21**	**21.5**	**800**	

SEMESTER VIII							
S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Ext/Int**	**Cat.**
Theory (Internal 40 Marks & External 60 Marks)							
1	22CS801	Project - II	0 / 0 / 24	24	12	60/40	PRJ
TOTAL				**24**	**12**	**100**	

SCHEME OF CREDIT DISTRIBUTION – SUMMARY											
Sl. No.	Stream	Credits/Semester								C	%
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities & Social Sciences Including Management (HSMC)	3	4	1						8	4.9
2	Basic Sciences (BSC)	8	8	4	4					24	14.7
3	Engineering Sciences (ESC)	4		6		3				13	8.0
4	Professional Core (PCC)	8	12	9	16	8.5	12	4.5		70	42.9
5	Professional Electives (PEC)					6	6	6		18	11.0
6	Open/Emerging/Industry (OEC)					3	3	6		12	7.4
7	Project Work (PROJ)					1		5	12	18	11.0
8	Mandatory Course (MC) / Spoken Hindi									Non credit	
Total		23	24	23	23	21.5	21	21.5	12	163	100

STRUCTURE FOR UNDERGRADUATE ENGINEERING PROGRAM

S. No.	Course Work - Subject Area	AICTE Suggested Credits	SKCET Credits (163)
1	Humanities and Social Sciences (HS), including Management;	**16**	**8**
2	Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology;	**23**	**24**
3	Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation;	**29**	**13**
4	Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required	**59**	**70**
5	Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch;	**12**	**18**
6	Open Subjects- Electives (OE), from other technical and/or emerging subject areas;	**9**	**12**
7	Project Work, Seminar and/or Internship in Industry or elsewhere.	**15**	**18**
8	Mandatory Courses (MC)	Non-credit	
Total		**163**	**163**
**Minor Variations is allowed as per need of the respective disciplines*			

HUMANITIES & SOCIAL SCIENCES INCLUDING MANAGEMENT (8 Credits)							
SL. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
1	22EN101	Technical Communication Skills	2/0/2	4	3	50/50	HSMC
2	22GE201	Universal Human Values	3/0/0	3	3	60/40	HSMC
3	22TA101	Heritage of Tamils	1/0/0	1	1	60/40	HSMC
4	22TA201	Tamils and Technology	1/0/0	1	1	60/40	HSMC

BASIC SCIENCE COURSES (21 Credits)

SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1	22MA102	Mathematics I	3/1/0	4	4	60/40	BSC
2	22CH101	Engineering Chemistry	3/0/2	5	4	50/50	BSC
3	22MA202	Mathematics II	3/1/0	4	4	60/40	BSC
4	22PH201	Physics	3/0/2	5	4	50/50	BSC
5	22MA302	Random variable & Statistics	3/1/0	4	4	60/40	BSC
6	22MA401	Optimization and Project Management	3/1/0	4	4	60/40	BSC

ENGINEERING SCIENCE COURSES (16 Credits)							
SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1	22EE111	Basics of Electrical and Electronics Engineering	2/1/0	3	3	60/40	ESC
2	22IT301	Computer Architecture	3/0/0	3	3	60/40	ESC
3	22EC111	Digital Logic and Design	3/0/0	3	3	60/40	ESC
4	22EC512	Microcontrollers and Embedded Systems	3/0/0	3	3	60/40	ESC
5	22IT702	Computational Biology	3/0/0	3	3	60/40	ESC
6	22EE114	Basics of Electrical and Electronics Engineering Laboratory	0/0/2	2	1	40/60	ESC

PROFESSIONAL CORE COURSES (70 Credits)							
SL. No.	Course Code	Course Title	L/T/P	Contact hrs./Wk.	C	Ext/ Int	Cat.
1	22IT101	Application Development Practices	3/0/2	5	4	50/50	PCC
2	22CS101	Problem Solving using C++	3/0/2	5	4	50/50	PCC
3	22CS201	Data Structures and Algorithms	3/0/2	5	4	50/50	PCC

4	22IT201	Database Management Systems	3/0/2	5	4	50/50	PCC
5	22AD201	Java Programming	3/0/2	5	4	50/50	PCC
6	22AD301	Design and analysis of algorithms	1/0/4	5	3	50/50	PCC
7	22IT302	Web Technology	1/0/4	5	3	50/50	PCC
8	22CS301	Advanced Java Programming	1/0/4	5	3	50/50	PCC
9	22CS401	Theory of Computation	3/1/0	4	3	60/40	PCC
10	22AD401	Cloud Computing	1/0/4	5	3	50/50	PCC
11	22IT402	Software Testing	1/0/4	5	3	50/50	PCC
12	22CS402	Web Frameworks	1/0/4	5	3	50/50	PCC
13	22CS403	Operating Systems	3/0/2	5	4	50/50	PCC
14	22CS501	Computer Networks	3/0/0	3	3	60/40	PCC
15	22CS502	Principles of Compiler Design	3/0/2	5	4	50/50	PCC
16	22CS503	Computer Networks Laboratory	0/0/3	3	1.5	40/60	PCC
17	22CS601	Object Oriented Analysis and Design	3/0/0	3	3	60/40	PCC
18	22CS604	Object Oriented Analysis and Design Laboratory	0/0/3	3	1.5	40/60	PCC
19	22CS602	Cryptography and Network Security	3/0/0	3	3	60/40	PCC
20	22CS603	Artificial Intelligence	3/0/0	3	3	60/40	PCC

21	22CS605	Artificial Intelligence Laboratory	0/0/3	3	1.5	40/60	PCC
22	22CS701	Internet of Everything	3/0/0	3	3	60/40	PCC
23	22CS702	Internet of Everything Laboratory	0/0/3	3	1.5	40/60	PCC

PROFESSIONAL ELECTIVE COURSES (18 Credits)							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
ELECTIVE STREAM I – CLOUD COMPUTING & DATA STORAGE TECHNOLOGIES							
1	22CD901	Data Virtualization	3/0/0	3	3	60/40	PEC
2	22IT901	Cloud Services and Integration	3/0/0	3	3	60/40	PEC
3	22CY901	Security and Privacy in Cloud	3/0/0	3	3	60/40	PEC
4	22AD902	Storage Technologies	3/0/0	3	3	60/40	PEC
5	22CS901	Software Defined Networks	3/0/0	3	3	60/40	PEC
6	22CB901	Stream Processing	3/0/0	3	3	60/40	PEC
7	22CD903	Multimedia and Animation	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM II - APPLIED ARTIFICIAL INTELLIGENCE							
1	22IT911	Intelligent Multiagent and Expert Systems	3/0/0	3	3	60/40	PEC
2	22AD901	App Development	0/0/6	6	3	40/60	PEC
3	22CY911	ETL Tools	3/0/0	3	3	60/40	PEC
4	22CS911	Statistical Pattern Recognition	3/0/0	3	3	60/40	PEC
5	22CD911	Stochastic and Network Control	3/0/0	3	3	60/40	PEC
6	22AD911	Bayesian Data Analysis	3/0/0	3	3	60/40	PEC

7	22AD917	Virtual Reality and Augmented Reality	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM III - INFORMATION SECURITY							
1	22IT921	Cyber Threats and Vulnerabilities	3/0/0	3	3	60/40	PEC
2	22IT923	Cyber Physical Systems	3/0/0	3	3	60/40	PEC
3	22IT924	Ethical Hacking and Auditing Frameworks	3/0/0	3	3	60/40	PEC
4	22CY921	Data Privacy and Security	3/0/0	3	3	60/40	PEC
5	22CY944	Cyber Crime and Forensics	3/0/0	3	3	60/40	PEC
6	22CY922	Digital and Mobile Forensics	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM IV – DATA ANALYTICS							
1	22IT931	NLP in Analytics	3/0/0	3	3	60/40	PEC
2	22IT903	Deep Learning Techniques	3/0/0	3	3	60/40	PEC
3	22IT932	Cognitive Systems and Analytics	3/0/0	3	3	60/40	PEC
4	22CS931	Big Data Analytics	3/0/0	3	3	60/40	PEC
5	22CD931	Social Network Analysis	3/0/0	3	3	60/40	PEC
6	22CY931	Exploratory Data analytics	3/0/0	3	3	60/40	PEC
7	22CS902	Data Science with Python	3/0/0	3	3	60/40	PEC
8	22IT922	Data Mining	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM V – IOT AND SMART CITIES							
1	22CS941	IOT Architecture and Framework	3/0/0	3	3	60/40	PEC
2	22CS942	Communication Protocols for IOT	3/0/0	3	3	60/40	PEC
3	22CS943	Cloud Services for IOT	3/0/0	3	3	60/40	PEC
4	22CS944	IoT for Healthcare	3/0/0	3	3	60/40	PEC
5	22CS945	Intelligent Transport Systems	3/0/0	3	3	60/40	PEC

6	22CS946	IOT for Smart Cities and Buildings	3/0/0	3	3	60/40	PEC
7	22CS947	Industrial IOT	3/0/0	3	3	60/40	PEC
8	22CS948	IOT for Smart Grids	3/0/0	3	3	60/40	PEC
9	22CS949	Big Data Analytics for IOT	3/0/0	3	3	60/40	PEC
ELECTIVE STREAM VI – MACHINE LEARNING							
1	22CS951	Computer Vision	3/0/0	3	3	60/40	PEC
2	22CS952	Feature Engineering	3/0/0	3	3	60/40	PEC
3	22CS953	Deep Neural Networks	3/0/0	3	3	60/40	PEC
4	22CS954	Optimization Techniques	3/0/0	3	3	60/40	PEC
5	22CS955	Advanced Learning Algorithm	3/0/0	3	3	60/40	PEC
6	22CS956	Scalable Machine Learning	3/0/0	3	3	60/40	PEC
7	22CS957	Mathematics for Machine Learning	3/0/0	3	3	60/40	PEC
8	22CS958	Generative Adversarial network	3/0/0	3	3	60/40	PEC
9	22CS959	Deep Learning Frameworks	3/0/0	3	3	60/40	PEC

OPEN/ EMERGING/ INDUSTRY (9 Credits)							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
1	22CS001	Analysis of Algorithms	1/0/4	5	3	50/50	OEC
2	22CS002	Front End Engineering - REACT	0/0/6	6	3	40/60	OEC
3	22CS003	Fundamentals of Java Programming	1/0/4	5	3	50/50	OEC

4	22CS004	Mern Stack Development	0/0/6	6	3	40/60	OEC
5	22CS005	Networks and Security	3/0/0	3	3	60/40	OEC

PROJECT WORK (18 Credits)							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
1	22CS504	Mini Project	0/0/2	2	1	40/60	PRJ
2	22CS703	Project - I	0/0/6	6	3	40/60	PRJ
3	22CS704	Employability Enhancement Skills (Internship)	28 Days		2	0/100	PRJ
4	22CS801	Project - II	0 /0/24	24	12	60/40	PRJ

PROFESSIONAL ELECTIVE COURSES: VERTICALS					
Vertical I - CLOUD COMPUTING & DATA STORAGE TECHNOLOGIES	**Vertical II - APPLIED AI**	**Vertical III - INFORMATION SECURITY**	**Vertical IV - DATA ANALYTICS**	**Vertical V – IOT AND SMART CITY**	**Vertical VI – MACHINE LEARNING**
Data Virtualization	Intelligent Multiagent and Expert Systems	Cyber Threats and Vulnerabilities	NLP in Analytics	IOT Architecture and Framework	Computer Vision
Cloud Services and Integration	App Development	Cyber Physical Systems	Deep Learning Techniques	Communication Protocols for IOT	Feature Engineering
Security and Privacy in Cloud	ETL Tools	Ethical Hacking and Auditing Frameworks	Cognitive Systems and Analytics	Cloud Services for IOT	Deep Neural Networks
Storage Technologies	Statistical Pattern Recognition	Data Privacy and Security	Big Data Analytics	IoT for Healthcare	Optimization Techniques
Software Defined Networks	Stochastic and Network Control	Cyber Crime and Forensics	Social Network Analysis	Intelligent Transport Systems	Advanced Learning Algorithm
Stream Processing	Bayesian Data Analysis	Digital and Mobile Forensics	Exploratory Data analytics	IOT for Smart Cities and Buildings	Scalable Machine Learning
Multimedia and Animation	Virtual Reality and Augmented Reality		Data Science with Python	Industrial IOT	Mathematics for Machine Learning
			Data Mining	IOT for Smart Grids	Generative Adversarial network
				Big Data Analytics for IOT	Deep Learning Frameworks

INTERN (2 Credits)							
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**	**Ext/ Int**	**Cat.**
1.	22CS704	Employability Enhancement Skills (Internship)	28 Days		2	0/100	PRJ

VALUE ADDED COURSES (Based on student's interest)			
S. No.	**Course Code**	**Course Title**	**Sem**
1.	22VA200	Cassandra	III
2.	22VA201	MongoDB	IV
3.	22VA202	Edge Computing	V
4.	22VA203	PyCharm	VI
5.	22VA204	Generative AI	VII

MANDATORY COURSES (01) (Courses conducted either by internal faculty or through MOOCs)					
S. No.	**Course Code**	**Course Title**	**L/T/P**	**Contact hrs./Wk.**	**C**
1.	22MC101	Induction Programme			0
2.	22MC102	Environmental Sciences	1 / 0 / 0	1	0
3.	22MC103	Soft Skills	1 / 0 / 0	1	0
4.	22MC104	Stress Management	1 / 0 / 0	1	0

L: Lecture **T:** Tutorial **P:** Practical **C:** Credit **O:** Outside Class hours **Cat.:** Category

HSMC : Humanities and Social Sciences including Management
BSC : Basic Science Courses
ESC : Engineering Science Courses
PCC : Professional Core Courses
PEC : Professional Elective Courses
OEC : Open and Emerging Elective Courses
PRJ : Project Work
INT : Internship
MC : Mandatory Course

Definition of Credit:

L – Lecture	1 Hr. Lecture (L) per week	1 credit
T – Tutorial	1 Hr. Tutorial (T) per week	1 credit
P - Practical/Practice (Project and Industry based Courses)	1 Hr. Practical (P) per week	0.5 credit

SEMESTER I

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 development methods.
2. Ability to understand and apply Scrum framework.
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	Identify the driving forces and adopt Agile approaches to software development practices.	[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 web pages.	[R]
C101.4	Utilize the knowledge of HTML and CSS code to create personal and/or business websites following current professional and/or industry standards.	[AP]
C101.5	Develop dynamic web page with validation and event handlingmechanisms.	[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 Hours

Lab Component:

S. No	List of Experiments
1	Draw basic UML diagrams (use case, Activity, class, interaction, State charts, Component and Deployment diagram)
2	Develop DFD model (level-0, level-1)
3	Design a web page using HTML basic tags.
4	Develop web site with suitable contents and links.
5	Design web pages using lists and tables.
6	Build a web client-side Login, Registration form and Dashboard with drop down menus.
7	Develop a HTML form and validation using HTML5 features.
8	Create a website using HTML: To embed an image map in a web page. To fix the hot spots. Show all the related information when the hot spots are clicked.

9	Apply style specification in HTML page using CSS.
10	Develop dynamic web application using HTML, CSS and JavaScript.
	Total Hours **30 Hours**

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 Examin	Total
Theory	**Practical**	**Total (A+B)**	**Total Continuous**		

Formative Assessment	Summative Assessment	Total	Total (A)	Formative Assessment	Summative Assessment	Total (B)		Assessment	ation	
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]**
C101.1	Apply	Assignment - 1	20
C101.2&C101.3	Understand Remember	Quiz	20
C101.4	Apply	Case Study	20
C101.5	Apply	Assignment - 2	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	40	20	20
Understand	30	30	20
Apply	30	50	60
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	30	20	20
Understand	20	30	30
Apply	50	50	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 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	3	2	2
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
C101	**3**	**2**	**3**	**3**	**3**	**2**						**2**	**3**	**3**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

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 cin and 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 Deep Copying. **Overloading:** this' Pointer, structs vs Classes, Friends of a class, Operator Overloading, Inheritance, Overloading vs Overriding, Polymorphism, Virtual Functions, Pure Virtual Functions and 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 (Theory) 45 Hours

Lab Component

S.No.	**Lab Exercise**
1.	Practice of C Programming using Branching and Iterative constructs.
2.	Programs using arrays and strings
3.	Programs using Functions
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 exception handling concept
12. Programs using Files.
13. Mini project

Total Hours (Lab) 30 Hours
Total Hours(45+30) 75 Hours

Text Books:

1. E Balagurusamy,"Object Oriented Programming With C++", 4th Edition, Tata McGraw-Hill Education, 2008.
2. YashavantP. Kanetkar, "Let us C++", BPB Publications, 2020.
3. 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	20
C101.2 & C101.3	Apply	Assignment	20
C101.4	Analyze	Group Assignment	20
C101.5	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	30
Apply	40	50	50
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	10	20	20
Understand	30	20	20
Apply	50	60	60
Analyse	10	-	-
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		
C101.2	3	3	3	2	2				2	1		3	3	2	1
C101.3	3	3	3	2	3				2	1		3	3	2	1
C101.4	3	3	3	3	3				3	2		3	3	2	2
C101.5	3	3	3	3	3				2	2		2	3	2	1
C101	**3**	**3**	**3**	**3**	**3**				**3**	**2**		**2**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22EN101 **TECHNICAL COMMUNICATION SKILLS** **2/0/2/3**
(MCT/CIVIL/IT/EEE/ECE/AI&DS/CYBER/CSE/CSD)
(SEMESTER I)
(MECH- SEMESTER II)

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.

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.

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.

Total 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 – Form an NGO	[AP]

Total Hours: 30 Hours

Total Hours:30+30=60 Hours

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/

ContinuousAssessment									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 mapcomponents 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				2	
C101.2								2		3					
C101.3								2		3	2			2	2
C101.4										3					
C101.5										3		3		2	3
C101								**2**		**3**	**2**	**3**		**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CH101 **ENGINEERING CHEMISTRY** **3/0/2/4**

Common for all B.E/ B.Tech Engineering Courses
(Except CSBS &M.Tech CSE)

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 and energy sources.
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

Module I Electrochemistry and Corrosion **15 Hours**

Electrochemistry-Introduction*,* Oxidation and reduction potentials-Free energy and emf, cell potentials, Nernst equation and applications. Reference electrodes-standard hydrogen electrode, saturated calomel electrode, glass electrode-pH measurement. Electrochemical cells-electrolytic cell-reversible and irreversible cells. Water treatment-characteristics of water-hardness-types and estimation of hardness by EDTA method with numerical problems. Importance of corrosion-types–mechanism of dry and wet corrosion-galvanic corrosion-differential aeration corrosion. Corrosion protection-electroplating of Chromium-electroless plating of Nickel.

Module II Nano-Chemistry and Energy sources **15 Hours**

Nano Chemistry-Basics-Comparison of molecules, nanomaterials and bulk materials; Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: Electrochemical deposition and electro spinning. Applications of nanomaterials in medicine. Energy Sources-Fuel Cells-Solid oxide and polymer electrolytes in H_2-O_2 fuel cell. Storage Devices-Batteries- Alkaline-Lead acid, Nickel cadmium and Lithium-ion batteries.

Module III Polymer chemistry and Spectroscopic techniques **15 Hours**

Introduction-monomers and polymers-classification of polymers-Degree of Polymerization (Simple problems). Mechanism of addition polymerization (free radical mechanism). Plastics-classification-preparation, properties and uses of Nylon 6,6, Nylon 6, PVC, Bakelite and PET. Moulding methods- moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays (Compression moulding) and PET bottles (Blow moulding). Spectroscopy-Beer Lambert's law, principle, instrumentation, and applications of Electronic spectroscopy (UV-visible), Vibrational and rotational spectroscopy (IR) and Flame emission spectroscopy (FES).

Field work:

Industrial visit- Moulding and spectroscopic techniques

Theory:45 hours

Lab Components: 30 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.	[E]
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]

Total Hours: 75 Hours

Understanding the concepts by simple Demonstrations/Experiments:

11	To detect the chlorine content in tap water using simple chemical method.
12	To know the presence of dissolved oxygen in given water sample using glucose by redox principle.
13	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. https://ocw.mit.edu/courses/chemistry
2. nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com -
3. Spectroscopic technique, Colorimetry
4. https://ocw.mit.edu/courses/chemistry
5. nptel.ac.in/courses/113108051

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	Remember	Online Quiz-I	20
C101.2	Apply	Assignment-I	20
C101.3	Understand	Online Quiz-II	20
C101.4	Apply	Assignment-II	20
C101.5	Understand		

Assessment based on Summative and End Semester Examination - Theory			
Bloom's Level	**Summative Assessment (15%) [120 Marks]**		**End Semester Examination (35%) [100 Marks]**
	CIA 1: [60 Marks]	**CIA 2: [60 Marks]**	
Remember	20	20	20
Understand	35	35	35
Apply	45	45	45
Analyze	-	-	-
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
Analyze	25	25	25
Evaluate	25	25	25
Create	-	-	-

Assessment based on Continuous and End Semester Examination									
Continuous Assessment (50%)									End Semester Examination (50%)
CIA 1 (100 Marks)			CIA 2 (100 Marks)			Practical Exam (100 Marks)		Theory Examination (35%) Practical Examination (15%)	
SA 1 (60 M)	FA 1		SA 2 (60 M)	FA 2		FA (75 M)	SA (25 M)		
	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		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
C101.1	3	2	2		1							1	3		1
C101.2	3	2	2	1	1							1	2		1
C101.3	3	3	2		1							1	2		1
C101.4	3	2	2		1							1	2		1
C101.5	3	2	2	1	1							1	3		1
C101	**3**	**3**	**2**	**1**	**1**							**1**	**3**		**1**
	3 Strongly agreed			2 Moderately agreed						1 Reasonably agreed					

22MA102 **MATHEMATICS I** **3/1/0/4**

(COMMON TO CSE,IT, AI&DS,CSD)

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 Hours**

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 Hours**

DIFFERENTIAL CALCULUS: Solution of First order ordinary differential equations: Taylor's series method – Runge kutta 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 – LaplaceTransform **20 Hours**

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 Hours

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	Seminar	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**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**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													
C102	**3**	**3**											**1**		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22EE111 **Basics of Electrical and Electronics Engineering** **2/1/0/3**
(Common to CSE, IT, AIDS, CSD, CS and M.TECH)

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	Analyze the concepts in AC circuit and DC circuits.	[A]
C111.2	Examine the working principle of singlephase 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:

Module I DC Circuits and AC Circuits **15 Hours**

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.

Module II Magnetic Circuits and Electrical Machines **15 Hours**

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.

Module III Basics of Electronics and Applications **15 Hours**

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.

Total Hours 45 Hours

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)**	

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

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C111.1	3												1		
C111.2	3												1		
C111.3	3		1										1		
C111.4	3		1										1		
C111.5	3		1										1		
C111	**3**		**1**										**1**		

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22EE114 **Basics of Electrical and Electronics Engineering Laboratory** **0/0/2/1**
(Common to CSE, IT, AIDS, CSD, CS and M.TECH)

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 elementsunder 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 Hours**

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

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**
C114.1	3	1											3		
C114.2	3	1													
C114.3	3	1													
C114.4	3	2													
C114.5	3	1													
C114	**3**	**2**											**3**		
	3	Strongly agreed		2	Moderately agreed			1	Reasonably agreed						

SEMESTER II

22CS201 **Data Structures and Algorithms** **3/0/2/4**

Nature of Course: F (Theory Programming)

Prerequisites: Problem Solving using C++

Course Objectives:

1. To introduce list data structure 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 Linked List & 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 Anany Levitin, 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 SeymourLipschutz,“DataStructuresbySchaumSeries”,2nd edition,TataMcGrawHill, 2013.

2 NarasimhaKarumanchi,”DataStructuresandAlgorithmsMadeEasy:DataStructuresandAlgorithmic Puzzles”,5th Edition,CareerMonk,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	Understand	Quiz	20
C201.2	Apply	Case Study	20
C201.3, C201.5	Analyse	Group Assignment	20
C201.4	Apply	Assignment	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	30
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)	**ProgrammeOutcomes(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 Application)

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	Conceptualize data using the relational model.	[U]
C201.2	Improve the database design through normalization.	[U]
C201.3	Manipulate a database using SQL.	[AP]
C201.4	Implement advanced SQL concepts on database.	[AP]
C201.5	Infer the transactions management 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 III Queries 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. Document Database creation using MongoDB
9. Study of Cloud Storage

10.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 Hours

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								
Continuous Assessment (50%)								**End Semest Examina (50%)**
CA 1 (100 Marks)			**CA 2 (100 Marks)**			**Practical Exam (100 Marks)**		**Theor Examina (35%) Practic Examina (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)**			

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	-	-	-

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
C201	**3**	**3**	**3**	**3**	**2**				**2**	**2**	**2**	**3**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

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 and Control 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 basic concepts of java programming.	[U]
C201.2	Illustrate the usage of different aspects of Controls statements in real world scenarios.	[AP]
C201.3	Apply Array and strings in real time environment.	[AP]
C201.4	Analyse and Interpret StringBuffer 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 and Assignment 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**

(CSE, IT, AI&DS, CYBER & CDS)

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:

Module I 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 – 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 - Optical fibers for computing applications – PC to PC communication and fiber optics in computer networking.

Module II 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 – 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.

Module III 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.

45 Hours

Lab Component **30 Hours**

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

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 Rleffel 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. https://www.sciencedirect.com/science/article/pii/S2211379718314268
6. https://lecturenotes.in/notes/13602-note-for-optical-fibre-communication-ofc-by-sunil-s-harakannanavar
7. https://ocw.mit.edu/courses/materials-science-and-engineering/3-46-photonic-materials-and-devices-spring-2006/lecture-notes/
8. http://wcchew.ece.illinois.edu/chew/course/QMALL20121005.pdf
9. https://www.technologyreview.com/2019/01/29/66141/what-is-quantum-computing/
10. https://www.quantum-inspire.com/kbase/what-is-a-qubit/
11. https://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	2		1
C201.2	3	2	1	1								1	2		1
C201.3	3	2	1	1								1	2		1
C201.4	3	2		1								1	2		1
C201.5	3	2	1	1								1	2		1
C201	**3**	**2**	**1**	**1**								**1**	**2**		**1**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

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

(Common to all branches)

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, atleast 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]

Course Contents:

Module I 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 theharmonyof'I' with the Body- Social activities – Waste Management - Water Conservation-Soil Pollution - Physical Health and related activities - Lectures by eminent persons- Literary activities.

Module II 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)- Physical activities(games).

Module III 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.

Total Hours: 45 Hours

Text Books:

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.

Reference Books:

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-Maulana Abdul Kalam Azad.

Web References:

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

Online Resources:

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									
C201.2						3			3					3	
C201.3						3		3							
C201.4						3	3	3			2			3	2
C201.5						3	3								
C201						**3**	**3**	**3**	**3**		**2**			**3**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22MA202 **MATHEMATICS II** **3/1/0/4**
CSE/ IT/ AI&DS / CSD

Nature of Course C (20% Descriptive & 80% Analytical)
Prerequisites -
Course Objectives:

1 To use logical notation to define and reason mathematically about the fundamental data types and structures used in computer algorithms and systems.
2 To study the concepts needed to test the logic of a program.
3 To learn the working 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, divisionalgorithm.	[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 3Number 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 Hours

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 https://www.maa.org/press/ebooks/resources-for-teaching-discrete-mathematics
4 https://youtu.be/qvw1GX93JSY

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]**
C202.1	Remember	Quiz	20
C202.2	Understand	Seminar	20
C202.3 – C202.5	Apply	Tutorial	20
C202.3 – C202.5	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 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		
C202	**3**	**3**	**2**										**2**		

3	Strongly agreed	2	Moderately agreed	1	Reasonably 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. **Folk And Martial Arts:** Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

Thinai Concept Of Tamils - 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. Contribution of Tamils to Indian national movement and indian culture: 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 தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2 கணினித் தமிழ் – முனைவர் இல. சுந்தரம் . (விகடன் பிரசுரம்).

3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
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	-	-	-	-	-	-

SEMESTER III

22IT301	COMPUTER ARCHITECTURE	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	To study the concepts of the basic structure and operation of a digital computer.
2.	To learn the working of different types of arithmetic operations.
3.	To understand the different types of control and the concept of pipelining.
4.	To learn the working of different types of memories.
5.	To understand the different types of communication with I/O devices and standard I/O interfaces

Course Outcomescs

Upon completion of the course, students shall have ability to

C301.1	Recall the design of the various units and functionality of digital computers that store and process information via instruction sets and addressing modes.	[R]
C301.2	Interpret the logic design of fixed-point add, subtract, multiply and divide hardware and instantiating the concepts of fast adders, high speed multiplier, booth multiplier and carry save addition techniques.	[U]
C301.3	Classify the hazards of pipelining technique and use in high performance processors.	[U]
C301.4	Make use of various memory components and memory mapping techniques including Cache and virtual memory for increasing the memory bandwidth and high performance.	[AP]
C301.5	Categorize different ways of communication with I/O devices using various interconnection networks including bus structures	[A]

Course Contents:

Module I Architecture Fundamentals and Memory Organization **15 Hours**

Organization of the Von Neumann Machine - Basic Operational Concepts of a Machine – Memory Locations and Addresses – Instruction Format - Instruction Sets, Addressing Modes and Assembly Language. Memory Organization**:** Basic Concepts, Semiconductor RAMs, ROMs, Cache memories, Performance Consideration, Virtual Memory and Memory Management requirements – Secondary storages. Case Study: Raptor Cove CPU Micro architecture by intel.

Module II Processor Design **15 Hours**

Arithmetic Unit: Addition and Subtraction of Signed Numbers – Design of Fast Adders – Multiplication of Signed Numbers, Fast Multiplication, Integer Division, Floating Point Numbers and Operations**.** Control Unit: Execution of a Complete Instruction - Hardwired Control and Micro Programmed Control. Pipelining: Basic Concepts, Data Hazards, Instruction Hazards, Influence on Instruction Sets, Data Path and Control Consideration and Superscalar Operation. Case study: Intel's x86 Core2 and i7 microarchitectures

Module III Interfacing and Communication: **15 Hours**

I/O fundamentals: Handshaking, Buffering; I/O techniques: Programmed I/O, Interrupt-Driven I/O, DMA, Buses, Bus Protocols, Local and Geographic Arbitration. Interrupt Structures, Vectored and Prioritized, Interrupt Overhead, Interrupts and Reentrant Code. Multicore Architecture: Multicore Processors, Centralized and Distributed Shared Memory Architecture, Parallel Computers.

Total Hours	**45 hours**

Text Books:	
1.	Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Naraig Manjikian, “Computer Organization”, McGraw- Hill, 6th Edition 2017.
2.	John P. Hayes, “Computer Architecture and Organization”, McGraw-Hill, 3rd Edition, 2017.
3.	William Stallings, “Computer Organization and Architecture Designing for Performance”, 10th Edition, Pearson Education, 2016.
Reference Books:	
1.	David A. Patterson and John L. Hennessy, “Computer Organization and Design: The Hardware/Software Interface”, Elsevier, 5th Edition, 2013.
2.	John L. Hennessy and David A. Patterson, “Computer Architecture: A Quantitative Approach”, Morgan Kaufmann, 5th Edition, 2011.
3.	M. J. Flynn, “Computer Architecture: Pipelined and Parallel Processor Design”, Narosa Publishing House, 2013.
Web References:	
1.	https://www.cs.cmu.edu/~fp/courses/15213-s07/lectures/27-multicore.pdf
2.	https://fdocuments.in/document/intel-core-i7-processor.html
3.	https://www.intel.com/content/dam/www/public/us/en/documents/manuals/64-ia-32-architectures-software-developer-instruction-set-reference-manual-325383.pdf
Online Resources:	
1.	https://www.coursera.org/learn/comparch
2.	https://www.eguardian.co.in/computer-architecture-mcqs/
3.	http://nptel.ac.in/courses/106102062/

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]
C301.1	Remember	Assignment	20
C301.2, C301.3	Understand	Group Assignment	20
C301.4	Apply	Online Quiz	20
C301.5	Analyse	Seminar	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	10	20
Understand	60	30	30
Apply	10	30	30

Analyse	-	30	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**
C301.1	2	3	1		1								1	2	2
C301.2	1	2	2		2								2	1	1
C301.3	3	3	3	3	3								3	3	1
C301.4	1	1	2		1								1	1	1
C301.5	2	1	2	2	1								2	1	2
C301	**3**	**3**	**3**	**3**	**3**								**3**	**3**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed	

22EC111	DIGITAL LOGIC AND DESIGN	3/0/0/3
Nature of Course	G (Theory analytical)	
Course Objectives:		
1.	To understand how computers operate at the most basic level.	
2.	To gain familiarity to the principles of combinational logic and the design of combinational circuits.	
3.	To understand the basics of sequential logic devices and the design of sequential circuits.	
4.	To learn the process of modeling the combinational and sequential logic circuits using Verilog.	
5.	To understand the concepts of Programmable logic devices.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C111.1	Identify and encode information in binary and to manipulate Boolean functions using Boolean algebra.	[U]
C111.2	Interpret and minimize Boolean functions and implement them using digital logic gates.	[U]
C111.3	Illustrate and design different combinational logic circuits.	[A]
C111.4	Analyze and design various sequential circuits.	[A]
C111.5	Construct Verilog models for digital logic circuits.	[AP]
C111.6	Implement digital logic circuits using programmable logic devices.	[AP]

Course Contents:

Module I Introduction **15 Hours**

Number Systems- Binary codes – Binary Arithmetic - Boolean algebra - Boolean functions –Minimization of Boolean Functions using Karnaugh Maps - Implementation of Logic Circuits using Gates(Two Level/Multi level Implementation).

Module II Combinational Logic: **15 Hours**

Analysis and Design Procedures-Circuits for Arithmetic Operations- Multiplexer-Demultiplexer - Decoder-Encoders- and their use in Logic Synthesis-Verilog Modelling for Combinational Circuits.

Module III Synchronous Sequential Logic & Programmable Logic devices **15 Hours**

Latches-Flipflops-Analysis and Synthesis of Clocked Sequential Circuits – Registers- Shift Registers-Ripple Counters-Synchronous Counters-Special Counters-Verilog Modelling for Sequential circuits-Finite State Machines, PROM,PLA,PAL,FPGA .

Total Hours	**45 hours**

Reference Books:

1. John F. Wakerly, “Digital Design: Principles and Practices”, 5thEdition, Pearson,2018.

2.Donald P Leach, Albert Paul Malvino, Goutam Saha, “Digital Principles and Application”,

8th Edition, McGraw Hill education (India) Private Limited,2015.

3. Clive Woods, Brian Holdsworth, “Digital Logic Design”, 4th Edition, O’Reilly Media,2002.

4. Donald D.Givone, “Digital Principles and Design”, 7th Edition, McGraw-Hill,2010.

Web References:

1. https://www.xilinx.com/support/documentation/university/Vivado-eaching/HDLDesign/2013x/Nexys4/Verilog/docs-pdf/Vivado_tutorial.pdf.

Continuous Assessment				End Semester Examination	Total
Formative Assessment	Summative Assessment	tTotal	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	Remember	Quiz	20
C111.2	Apply	Assignment	20
C111.4	Understand	Quiz	20
C111.6	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**
C111.1	3	3	3	3								2	3	2	1
C111.2	2	3	3	2	2							2	3	1	1
C111.3	3	3	3	2	3							2	3	3	1
C111.4	2	3	3	3	2								2	2	2
C111.5	2	2	3	1	2								3	3	2
C111.6	2	2	2	2	2								2	2	2
C111	**3**	**3**	**3**	**3**	**3**							**2**	**3**	**3**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22MA302	RANDOM VARIABLE & STATISTICS CSE / IT / AI & DS / CYBER	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/

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	**20**
C302.2	Understand	Group Assignment	**20**
C302.3	Apply	Presentation	**20**
C302.4 & C302.5	Apply	Group Activities / Tutorial	**20**

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	-	-	-

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)**	

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) - Thirumalai Nayakar Mahal - 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 Kumizhi Thoompu 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	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2	கணினித் தமிழ் – முனைவர் இல. சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
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
5 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
5 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
5 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	**15**

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

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 **5 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 **5 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 **5 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	**15 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 &	Apply	Quiz	20

C301.3			
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
C302.5	3	3	3	2	3				2	2		2	3	3	3
C301	**3**	**3**	**3**	**3**	**3**				**3**	**2**		**2**	**3**	**3**	**3**

SEMESTER IV

22MA401	OPTIMIZATION AND PROJECT MANAGEMENT (COMMON TO CSE /IT/AI&DS)	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

C404.1	Recall the basic concepts of optimization, Queueing and simulation.	[R]
C404.2	Understand the concepts of linear programming problems.	[U]
C404.3	Apply operations research techniques for LPP in industrial optimization problems.	[AP]
C404.4	Apply the concepts of discrete time Markov chains to model computer systems.	[AP]
C404.5	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 Hrs**

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	http://nptel.ac.in/courses/111104079/
2	http://nptel.ac.in/video.php/subjectId=117105085
3	http://nptel.ac.in/syllabus/111105041/
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

<table>
<tr><td colspan="6">Summative assessment based on Continuous and End Semester Examination</td></tr>
<tr><td colspan="5">Continuous Assessment (40%)</td><td rowspan="2">End Semester Examination (60 %)</td></tr>
<tr><td colspan="2">CA 1

(20 Marks)</td><td colspan="3">CA 2

(20 Marks)</td></tr>
<tr><td rowspan="2">SA 1

(12 Marks)</td><td colspan="2">FA 1</td><td rowspan="2">SA 2

(12 marks)</td><td colspan="2">FA 2</td><td rowspan="2">Theory Examination

(60 Marks)</td></tr>
<tr><td>Component -I

(4 marks)</td><td>Component –II

(4 marks)</td><td>Component -I

(4 marks)</td><td>Component -II

(4 marks)</td></tr>
</table>

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (16%)			
Course Outcome	**Bloom's Level**	**Assessment Component (Choose and map components from the list – Quiz, Assignment, Case study, Seminar, Group Assignment)**	**Marks**
C401.1	Remember	Quiz	20
C401.2	Understand	Assignment	20
C401.3 & C401.4	Apply	Tutorial	20
C401.5	Apply	Presentation	20

Summative assessment based on Continuous and End Semester Examination			
Bloom's Level	**Continuous Assessment (24%)**		**End Semester Examination (60%)**
	CIA1	**CIA2**	
Remember	20	20	20
Understand	30	30	30
Apply	50	50	50
Analyse	-	-	-
Evaluate	-	-	-
Create	-	-	-

Course Outcomes (CO)	**Programme Outcomes (PO)**												**Programme**		
	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		

22CS401	THEORY OF COMPUTATION	3/1/0/4
Nature of Course	J (Problem Analytical)	
Pre requisites	Mathematical Structures	

Course Objectives:

1	To describe various Computing models like Finite Automata, Regular Expression, Grammars, Pushdown Automata, and Turing Machines.
2	To practice formal languages such as Regular languages, Context free languages and Recursive languages and their properties
3	To employ knowledge of pumping lemma in formal language applications

Course Outcomes:

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

C401.1	Construct a Finite Automata and Regular expression for a Regular language	[AP]
C401.2	Construct a Grammar and Push Down Automata for a Context Free language.	[AP]
C401.3	Apply pumping lemma to Regular Languages and Context Free Languages	[AP]
C401.4	Interpret the properties of Regular, Context Free and recursive Languages	[U]
C401.5	Differentiate decidable and undecidable problems about Turing Machine	[A]

Course Contents:

Module I Finite Automata and Regular Languages **20 Hours**

Mathematical preliminaries and notations, Central concepts of automata theory: Finite Automata -Deterministic Finite Automata - Nondeterministic Finite Automata, Equivalence of DFA and NFA, Finite Automata with Epsilon transitions - Applications of FA. Regular Expressions: Finite Automata and Regular Expressions, Applications of Regular Expressions - Regular Grammars. Properties of regular languages: Pumping lemma for regular languages, Closure properties of regular languages, Equivalence and Minimization of Finite Automata.
Case Study on Finite Automata: Online Shopping flow diagram, A Pilot Study on Natural Language Processing.

Module II Context Free Languages **25 Hours**

Context Free Grammars (CFG)- Parse Trees - Ambiguity in Grammars and languages, Applications of Context Free Grammars, Pushdown automata (PDA) : Languages of a PDA - Properties of Context Free Languages: Normal Forms (CNF, GNF) for Context Free Grammars - Closure properties of CFL, Membership algorithm for CFG (CYK algorithm)

Module III Turing Machines **15 Hours**

Introduction Formal Definition - Design of TM - Computable Functions, Variants of TM, Recursive and Recursively Enumerable languages, Undecidable Problems. Case Study: Explain the concepts Quantum computing and Quantum operations.

Total Hours:	**60**

Text Books:

1.	Hopcroft J.E, Motwani R, and Ullman J D,"Introduction to Automata Theory, Language and Computations", 3rd Edition, Pearson Education (ISBN 1292039051), 2014.
2.	Martin J,"Introduction to Languages and the Theory of Computation", 3rd Edition, TMH, 2007.

Reference Books:

1.	Kamala Krithivasan and Rama R,"Introduction to Formal Languages, Automata Theory amd Computation", Pearson Education 2009.
2.	Lewis H. and Papadimitriou C.H , "Elements of the Theory of Computation",

	2ndEdition,Pearson Education/PHI, 2003.
3.	Greenlaw,"Fundamentals of Theory of Computation, Principles and Practice", Elsevier, 2008.
4.	Peter Linz, "An Introduction to Formal Language and Automata", Narosa Publishers, New Delhi, 2011.
5	Janet J, Sujaritha M, Kousika N, "Theory of Computation" Sri Krishna Hitech Publishing Company Pvt. Ltd.
Web References:	
1.	www.jflap.org/
2.	automatonsimulator.com/
3.	http://www.jflap.org/tutorial/grammar/bruteforceCFG/index.html
4.	https://turingmachinesimulator.com/
5.	http://weitz.de/pump/
Online Resources:	
1.	https://swayam.gov.in/nd1_noc19_cs79/
2.	https://nptel.ac.in/courses/106104028/
3.	https://online.stanford.edu/courses/soe-ycsautomata-automata-theory

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 & C401.2	Apply	Quiz	20
C401.3	Apply	Case study	20
C401.4	Understand	Assignment	20
C401.5	Analyze	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	10	10	10
Understand	30	20	20
Apply	60	60	60
Analyse	-	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**
C401.1	3	3	3	1	2	2	-	-	-	-	-	2	3	2	2
C401.2	3	3	3	1	2	2	-	-	-	-	-	2	3	2	2
C401.3	3	3	3	-	-	-	-	-	-	-	-	2	3	-	2
C401.4	3	3	3	1	2	2	-	-	-	-	-	3	3	2	2
C401.5	3	3	3	1	2	2	-	-	-	-	-	3	3	2	3
C401	**3**	**3**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**
	3	Strongly agreed				2	Moderately agreed				1	Reasonably agreed			

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-endtesting.
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	Apply testing models, processes and practices appropriate for the software development lifecycle model of a project	[AP]
C402.4	Apply principles and practices of test-driven development to improve testing quality and reduce delivery times	[AP]
C402.5	Inspect the various testing processes towards the continuous delivery of a software product.	[A]

Course Contents:

Introduction to Automation Testing with Selenium: 5 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: 5 Hours

Selenium webdriver - Maven Configuration, WebDriver Commands, Navigation Command, Selenium locators - Selenium Locators Basics (id, name),Xpath and css locators, Selenium Web Element - 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 5 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	**15**

Lab Component:

Lab Experiments

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.

Total Hours:	**30**

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”, 1st Edition, 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**
C402.1 C402.4	Apply	Quiz	**20**
	Apply	Assignment	**20**
C402.2, C402.5	Analyse	Case Study	**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 (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	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

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 **5 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 **5 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 **5 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: 15

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: 30

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**

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 **5 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 **5 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 **5 Hours**

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

Total Hours:	**15**

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

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

SEMESTER V

22CS501	Computer Networks	3/0/0/0
Nature of Course:	F (Theory Programming)	
Pre requisites:	Basics of Electrical and Electronics Engineering	

Course Objectives:

1	To express the concepts of data communications and functionalities of different layers of ISO/OSI reference architecture.
2	To illustrate the channelization, flow and error control methods.
3	To practice the concepts of addressing, subnetting and routing mechanisms.
4	To describe the process to process delivery and protocols used for it.
5	To identify the suitable protocols for different applications.

Course Outcomes

Upon completion of the course, students shall have ability to

C501.1	Indicate the fundamentals of data communications, topologies and functions of physical layer.	[U]
C501.2	Describe data link layer functionalities and discuss the flow control and error control mechanisms.	[U]
C501.3	Categorize the logical addressing schemes and routing protocols.	[A]
C501.4	Illustrate the process-to-process delivery models, protocols and congestion control principles.	[AP]
C501.5	Articulate the services of application layer protocols and emerging networking technologies	[AP]

Course Contents:

MODULE I Data Communication and Physical Layer **15 Hours**

Components of data communication - Data Representation – Data flow – Analog and Digital Signals - Categories of Networks – Network Topology - Protocols and Standards - Layers in OSI Model - TCP / IP protocol suite – Addressing - Performance Metrics. Transmission media – Transmission Impairment. Encoding: NRZ – NRZI –Manchester - 4B/5B. Network Hardware: Repeaters - Hubs – Bridges – Switches - Routers and Gateways.

MODULE II Data Link and Network Layer **15 Hours**

Data Link Layer: Block Coding - Cyclic Codes – Checksum. Stop-and-Wait ARQ - Go-Back-N ARQ - Selective Repeat ARQ- ~~Piggybacking~~. Ethernet – IEEE 802.11 – Bluetooth. Network Layer: IP semantics and syntax - IPv4: Addresses, Datagram. IPv6: Addresses - Advantages, Packet Format – Subnetting. Routing: Distance Vector Routing – Link State Routing. ARP – RARP – DHCP - ICMP. Internet – Voice and video over IP.

MODULE III Transport and Application Layer **15 Hours**

Transport Layer: Process to Process delivery- UDP - TCP - Congestion - Congestion control in TCP. QoS. Marking, Shaping, Policing. Application Layer: Domain Name System – Electronic Mail – FTP – WWW - HTTP - SNMP - DDoS Attacks and Application layer Attacks - Firewalls. Case Study: Software Defined Networking for IoT, Network Troubleshooting with Wireshark.

Total : 45 Hours

Text Books:	
1.	Behrouz A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, 6th Edition, TataMcGraw- Hill, 2022.
2.	**Andrew S. Tanenbaum, Nick Feamster, David J. Wetherall,** Computer Networks, 6th Edition, Pearson, 2021.
Reference Books:	
1.	Peterson & Davie, Computer Networks, A Systems Approach, 3rd Edition, Harcourt, 2013.
2.	William Stallings, Data and Computer Communications, 9th Edition, ~~PHI, 2006,~~ Pearson, 2013
3.	Bertsekas and Gallagher, Data Networks, PHI, 2011.
Web References:	
1.	https://www.nesoacademy.org/cs/06-computer-networks
2.	https://www.geeksforgeeks.org/last-minute-notes-computer-network/
3.	https://www.gatevidyalay.com/computer-networks/
4.	https://www.netacad.com/courses/networking/ccna-introduction-networks
Online Resources:	
1.	https://www.coursera.org/learn/computer-networking
2.	https://archive.nptel.ac.in/courses/106/105/106105183/

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**
C502.1	3	3	3									3	3		2
C502.2	3	3	3	2								3	3		2
C502.3	3	3	3	2	2				1	1		3	3	3	2
C502.4	3	3	3	2	2				1	1		3	3	3	2
C502.5	3	3	3	3	3				1	1		3	3	3	2
C502	**3**	**3**	**3**	**3**	**3**				**1**	**1**		**3**	**3**	**3**	**2**

	3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed	

22EC512	MICROCONTROLLERS AND EMBEDDED SYSTEMS	3/0/0/3
Nature of Course	D (Theory Application)	
Pre requisites	Digital Organization	

Course Objectives:

1.	To provide the insight on the 8051 architecture and its Instruction set
2.	To know about different peripheral devices and their interfacing to 8051
3.	To understand the architecture and programming of ARM Processor
4.	To learn the architecture and process of embedded systems

Course Outcomes

Upon completion of the course, students shall have ability to

C512.1	Explain the concepts of 8051 and apply the programming concepts in 8051.	[AP]
C512.2	Design 8051 microcontroller and to interface the controller with the external circuits.	[AP]
C512.3	Illustrate concepts of a RISC Machine & ARM architecture.	[U]
C512.4	Analyze the peripheral interfacing with ARM.	[A]
C512.5	Discuss the overall landscape and characteristics of Embedded systems.	[U]

Course Contents:

MODULE I MICROCONTROLLER 15 Hours

Introduction to 8051 Microcontroller – Architecture - Special Function Registers (SFRs) - 1/0 Pins Ports Circuits - Addressing Modes - Instruction set – Interrupts - Assembly language programming - Timer/Counter - 8051 Interfacing - LCD, Keyboard, External Memory, ADC, DAC & Sensor Interfacing: Temperature, Gas sensor.

MODULE II ARM ARCHITECTURE 15 Hours

RISC Vs CISC - RISC Properties and Evolution - Introduction to Von Neumann architecture - Harvard architecture and Modified Harvard architecture - ARM Architecture - ARM Bus Architecture - ARM7TDMI - ARM Programming model - ARM Instruction Set - Thumb Instruction Set - Memory Mapping – Pipelining - Interfacing - LED, Seven segment display - Stepper Motor.

MODULE III EMBEDDED SYSTEMS 15 Hours

Characteristics - Challenges of Embedded Systems - Design process - Categories of Embedded systems - Introduction to Embedded Systems protocols- SPI,I2C,UART/USART,CAN - Overview of embedded architecture - specialties of embedded systems - recent trends in embedded systems - Hardware & Software architecture - application software - communication software - process of generating executable image - development/ testing tools, Application of Embedded Systems: Chocolate Vending Machine.

Total Hours	**45**

Text Books:

1.	Mohamed Ali Mazidi, Janice GillispieMazidi, "The 8051 microcontroller and embedded systems", Pearson Education, 2006.

2.	Andrew N.Sloss, Dominic Symes and Chris Wright" ARM System Developer's Guide: Designing and Optimizing System Software", First edition, Morgan Kaufmann Publishers, 2004.
3	Rajkamal, "Embedded Systems: Architecture, Programming and Design", TMH Publications, Third Edition, 2014.
4	Dr KVKK Prasad," Embedded/Real time systems: Concepts, design and programming", 25th Edition, Pearson education, Dreamtech press, 2014
Reference Books:	
1.	Steve Furber, "ARM System -On -Chip architecture", Addision Wesley, 2000.
2.	Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition, Morgan Kaufmann Publisher, 2012.
Web References:	
1.	https://www.elprocus.com/peripherals-interfacing-to-the-microcontroller-8051-in-electronics
2.	https://developer.arm.com/products/architecture/cpu-architecture
3.	https://exploreembedded.com
4.	www.ee.ic.ac.uk/pcheung/teaching/ee2_computing/ARMbasics4
Online Resources:	
1.	https://freevideolectures.com/course/3018/microprocessors-and-microcontrollers/22
2.	www.infocobuild.com/education/audio-video-courses/electronics/.../lecture-05.html
3	https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-03x

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**
C512.1	2	2	1		1			2	2	1		2	2	3	2
C512.2	3	3	2		2			3	3	2		3	3	3	3
C512.3	3	3	2		2			3	3	2		2	3	3	3
C512.4	2	2	1		1			2	2	1		3	2	2	2
C512.5	2	2	1		1			2	2	1		2	2	3	2
C512	**3**	**3**	**2**		**2**			**3**	**3**	**2**		**3**	**3**	**3**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS502	PRINCIPLES OF COMPILER DESIGN	3/0/2/4
Nature of Course:	D (Theory Design)	
Pre requisites	Theory of Computation	

Course Objectives:

1.	To introduce the major concept areas of language translation and compiler design
2.	To understand, design and construct a lexical analyzer and parser.
3.	To employ code generation schemes
4.	To perform optimization of codes and gain knowledge about runtime environments
5.	To provide practical programming skills necessary for constructing a compiler using LEX and YACC tools

Course Outcomes:

Upon completion of the course, students shall have ability to

C502.1	Construct a lexical analyzer to identify the tokens in a program	[AP]
C502.2	Construct a parser through the application of grammar.	[AP]
C502.3	Discuss the intermediate code generation and symbol table organization techniques	[U]
C502.4	Implement Frontend and Backend of a compiler for simple C statements.	[AP]
C502.5	Analyze the code optimization strategies of a compiler.	[A]

Course Contents:

MODULE I Lexical Analysis and Syntax analysis **15 Hours**

Introduction to Phases of a compiler - **Lexical Analysis:** Role of Lexical Analyzer - Input Buffering - Specification of Tokens - Recognition of Tokens. Finite Automata - From a regular expression to an NFA and DFA. **Syntax Analysis:** Role of the parser -Context-Free Grammars - **Top-Down parsing**: Recursive Descent Parsing - Predictive Parsing. **Bottom-up parsing**: Shift Reduce Parsing - LR Parsers - LEX and YACC tools.

MODULE II Semantics analysis and Intermediate Code Generation **15 Hours**

Introduction to Semantics Analysis - Type Checking. **Intermediate Code Generation**: Intermediate Languages- Declarations - Assignment Statements - Boolean Expressions - Case Statements - Back patching - Procedure Calls. **Run Time Environments**: Source Language Issues - Storage Organization - Storage Allocation strategies.

MODULE III Code Generation and Code Optimization **15 Hours**

Issues in the design of code generator - The Target Machine - Basic Blocks and Flow Graphs - A simple Code generator - DAG representation of Basic Blocks - Peephole Optimization. **Code Optimization:** Principal Sources of Optimization - Optimization of Basic Blocks - Introduction to Global Data Flow Analysis. **Case Study**: Just-in-time Compilation with adaptive optimization - Compiler for Data science.

Total Hours: 45 Hours

Laboratory Experiments:

1. Implementation of lexical analyzer using C and LEX TOOL.
2. Implementation of a calculator that takes an expression (with digits, + and *), computes and prints its value, using YACC.
3. Implementation of a parser using LEX and YACC.
4. Implementation of symbol table
5. Implementation of Predictive parsing.
6. Implementation of Shift Reduce Parsing Algorithm.
7. Implementation of LR parsing.

8. Implementation of front end of a compiler that generates the three address code for a simple language with One data type integer, arithmetic operators, relational operators, variable declaration statement, one conditional construct, one iterative construct and assignment statement. 9. Implementation of back end of the compiler which takes the three address code as input and produces assembly language instructions that can be assembled and run using an 8086 assembler. The target assembly instructions can be simple move, add, sub, and jump. **10.** Implementation of the code optimizer phase of a compiler that eliminates dead code and common sub-expressions.	
Text Books:	
1.	Alfred Aho, Ravi Sethi, Jeffrey D Ullman, Monica S. Lam, "Compilers Principles, Techniques and Tools" , 2nd Edition, Pearson Education Asia, 2013
2.	T.G Manikumar ,M Ganga Durga , "Principles of Compiler Design" , First Edition, MJP Publisher , 2021
Reference Books:	
1.	C.N.Fischer and R.J.LeBlanc, "Crafting a compiler with C", Benjamin Cummings, 2010
2.	HenkAlblas and Albert Nymeyer, "Practice and Principles of Compiler Building with C", PHI, 2001
Web References:	
1.	gatecse.in/category/compiler-design/
2.	www.tutorialspoint.com/compiler_design
Online Resources:	
1.	http://nptel.ac.in/syllabus/syllabus.php?subjectId=106108113
2.	nptel.ac.in/courses/106104123/

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**
C502.1	3	3	3	3	3				2	1	2	2	3	3	2
C502.2	3	3	3	3	3				2	1	2	2	3	3	2
C502.3	3	3	3	3	3				2	1	2	2	3	3	2
C502.4	3	3	3	2	2				2	1	2	2	3	3	2
C502.5	3	3	3	3	3				2	1	2	2	3	3	2
C502	**3**	**3**	**3**	**3**	**3**				**2**	**1**	**2**	**2**	**3**	**3**	**2**
	3 Strongly agreed			2 Moderately agreed					1 Reasonably agreed						

22CS503	**Computer Networks Laboratory**	**0/0/3/1.5**
Nature of Course:	L (Programming)	
Pre requisites:	Basics of Electrical and Electronics Engineering	
Course Objectives:		
1	To practice a simple network design and Implementation in real time.	
2	To familiarize packet tracer tool to simulate the network for different applications.	

3	To describe the working principle of various communication protocols.	
4	To introduce network simulators NS2 and NS3.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C503.1	Infer the fundamental concepts in networking and system administration.	[AP]
C503.2	Test the different networking protocols and their flow.	[AP]
C503.3	Design a wireless network for real time applications.	[AP]
C503.4	Construct the network with cloud connectivity.	[AP]
C503.5	Analyze the various simulators used for network design.	[A]

List of experiments:	
1	Implement and study the performance of CDMA on NS2/NS3 (Using stack called Call net) or equivalent environment.
2	Implement Dynamic routing with RIP and OSPF.
3	Build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes.
4	Setup an network with IP address.
5	Write a program on a datagram socket for the client/server to display the messages on the client side typed at the server-side
6	Implement transmission of ping messages/trace route over a network topology consisting of 6 nodes and find the number of packets dropped due to congestion using packet tracer tool.
7	Configure routers, switches and end devices to provide access to local and remote network resources and to enable end-to-end connectivity between remote devices.
8	Build two virtual local area networks (VLAN) and communicate them.
9	Configuration of DHCP, DNS and Web Server.
10	Implement a home or small business network using wireless technology, then connect it to the Internet.
Total Hours:	**30**

Text Books:	
1.	Behrouz A. Forouzan, Data communication and Networking, 5th Edition, Tata McGraw- Hill, 2017.
2.	A S Tanenbaum, DJ Wetherall, Computer Networks, 5th Edition, Prentice-Hall, 2022.
Reference Books:	
1.	Peterson & Davie, Computer Networks, A Systems Approach, 3rd Edition, Harcourt, 2013.
2.	William Stallings, Data and Computer Communications, 9th Edition, PHI, 2006, Bertsekas and Gallagher Data Networks, PHI, 2011.
Web References:	
1.	https://www.nesoacademy.org/cs/06-computer-networks
2.	https://www.geeksforgeeks.org/last-minute-notes-computer-network/
3.	https://www.gatevidyalay.com/computer-networks/
Online Resources:	
1.	https://www.coursera.org/learn/computer-networking
2.	https://archive.nptel.ac.in/courses/106/105/106105183/

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**
C503.1	3	3	3	3	3				2	1	2	2	3	3	2
C503.2	3	3	3	3	3				2	1	2	2	3	3	2
C503.3	3	3	3	3	3				2	1	2	2	3	3	2
C503.4	3	3	3	2	2				2	1	2	2	3	3	2
C503.5	3	3	3	3	3				2	1	2	2	3	3	2
C503	**3**	**3**	**3**	**3**	**3**				**2**	**1**	**2**	**2**	**3**	**3**	**2**
	3 Strongly agreed				2 Moderately agreed				1 Reasonably agreed						

22CS504	**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**		
C504.1	Identify a problem and carry out a thorough study on the chosen problem	[AP]
C504.2	Analyze ongoing developments in the chosen domain and demonstrate technical knowledge pertaining to the same.	[A]
C504.3	Apply suitable tools, techniques, Algorithms, frameworks to solve the practical problems.	[AP]
C504.4	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.

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	3	3	2	2	1			3	3	3		3	2	3	3
C504.2	3	3	3	3	3			3	2	3	2	3	2	3	3
C504.3	3	3	3	3		3	3	3	3	3	3	3	2	3	3
C504.4	3	3	3	3				3	3	3	3	3	2	3	3

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS601	OBJECT ORIENTED ANALYSIS AND DESIGN	3/0/0/3

Nature of Course:	G (Theory Analytical)
Prerequisites:	Object Oriented Programming using Java

Course Objectives:

1.	To provide the fundamentals of object oriented concepts and object modeling.
2.	To illustrate the UML diagrams and behavioral modeling.
3.	To evaluate the software design with appropriate design patterns.
4.	To construct structural diagrams for real time applications.

Course Outcomes:

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

C601.1	Describe the structure and attributes for designing complex systems.	[U]
C601.2	Illustrate the use of CASE tools.	[AP]
C601.3	Identify the object and class relationships for building UML diagrams.	[AP]
C601.4	Develop appropriate use case, activity, state and sequence processes in real-time Application.	[AP]
C601.5	Interpret the Design patterns for real time applications.	[A]

Course Contents:

Module 1 Object Modules 15 Hours

Introduction to OOAD with Object Oriented Basics – Unified Process. Classes and Objects: Object and Class Relationships. Building Quality Classes and Objects: Measuring Quality - Choosing Operations. Classification: Importance and Challenges - Incremental and Iterative Classification. Approaches for Identifying Classes and Objects: Classical and Modern - Key Abstractions and Mechanisms. Complexity - Structure and Attributes of Complex Systems - Designing Complex Systems. Introduction to CASE tools. **Case Study**- Liskov Substitution Principle

Module 2 Static Use Case Modeling 15 Hours

Use Case Modeling: Modeling Requirements - Components – Use Case Identification and Description – Use Case Relationships - Use Case Modeling - Relating Use cases – include - extend - generalization. Class Diagram – Elaboration – Domain Model – Finding conceptual classes and description classes – Associations – Attributes - Domain Modeling using class diagrams - Domain Model Refinement - Finding conceptual class hierarchies – Aggregation and Composition. **Case Study**-Use case Modeling for Walmart Supply Chain Management.

Module 3 Dynamic UML and Implementation 15 Hours

UML Diagrams: UML Views - Classification of UML Diagrams - Extended UML – Interaction Diagram - System Sequence Diagram – Collaboration Diagram - Communication Diagram - State machine diagram and Modeling - Activity Diagram - Timing Diagram - Object Diagram- Implementation Diagram – Package Diagram - Composite Structure Diagram – Component Diagram - Deployment Diagram. GRASP: Designing objects with responsibilities – Design Patterns – Applying Gang of Four design patterns – Mapping design to code. **Case Study**:Next Gen Point of Sale(POS) system, Monopoly game system, Implementation of Chat Bot System.

Total Hours:	**45 Hours**

Text Books:

1.	Booch G, Rumbaugh J and Jacobson I, “The Unified Modeling Language User Guide”, Second Edition, Addison Wesley Professional, 2017.
2.	Craig Larman, “Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development”, Third Edition, Pearson Education,2016.

3.	Edwin Mach, “Object Oriented Analysis and Design Cookbook: Introduction to Practical System Modeling”, Independently Published, 2019.
Reference Books:	
1.	Ali Bahrami, Object Oriented System Development, McGraw Hill International Edition, 2008.
2.	Pressman RS, Software Engineering - A Practitioner’s Approach, 9th Edition,McGraw Hill, 2019.
3.	Erich Gamma “Design Patterns: Elements of Reusable OO Software”, Addison- Wesley,2015.
Web References:	
1.	https://www.tutorialspoint.com/object_oriented_analysis_design/index.htm
2.	https://www.codeproject.com/Articles/1137299/Object-Oriented-Analysis-and-Design
3.	https://www.bu.edu/csmet/files/2018/05/CS682_O2_Spring-2018.pdf
Online Resources:	
1.	https://swayam.gov.in/nd1_noc19_cs48
2.	https://www.coursera.org/learn/object-oriented-design
3.	https://nptel.ac.in/courses/106105153/
4.	https://www.coursehero.com/search/results/656274807/ac230e95b69ffbb097/

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	2								2	2	3	2	2
C601.2	3	3	2								2	2	3	2	2
C601.3	3	3	2								2	2	3	2	2
C601.4	3	3	2								2	2	3	2	2
C601.5	3	3	2								2	2	3	2	2

22CS602	CRYPTOGRAPHY AND NETWORK SECURITY	3/0/0/3
Nature of Course:	G (Theory Analytical)	
Pre requisites:	Data Communications and Computer Networks	

Course Objectives:

1.	To interpret the security goals of cryptography.
2.	To identify the different types of modern cryptographic techniques.
3.	To illustrate public key encryption and hash functions.
4.	To analyze email security, IP security and web security.

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

C602.1	Discuss OSI security architecture and classical encryption techniques.	[U]
C602.2	Apply the Symmetric and Asymmetric Cryptographic algorithms in real-time examples	[AP]
C602.3	Examine the applications of Cryptographic Hash Functions and Message Authentication Codes	[AP]
C602.4	Develop a model for Digital signature system and authentication system	[AP]
C602.5	Apply techniques to enhance the security in different applications and networks	[AP]

Course Contents:

MODULE I Introduction **15 Hours**

Concepts of Cyber security– CIA Triad – OSI Security Architecture (attacks, services, mechanisms)- Cryptography - Network Security– Classical Encryption techniques - Symmetric ciphers - Substitution Techniques - Transposition Techniques- Data Encryption Standard – DES example - The Strength of DES - Block Cipher Design Principles -Advanced Encryption Standard, AES Structure- AES Transformation Functions- AES Key Expansion – AESExample- Multiple Encryption and Triple DES

MODULE II Public-Key Encryption and Hash Functions **15 Hours**

Fermat's and Euler'stheorem - Testing of primality -The Chinese remainder theorem - Public Key Cryptography: RSA- The RSA Algorithm- Diffie-Hellman (ElGamal) - Cryptographic Hash Functions - Applications of Cryptographic Hash Functions -Two Simple Hash Functions - Secure Hash Algorithm (SHA)- SHA 3 - Message Authentication Codes – Requirements – Functions - MACs Based on Hash Functions: HMAC.

MODULE III Network Security Applications **15 Hours**

Digital Signatures: Introduction **-**ElGamal/Schnorr Digital Signature Scheme
Authentication Applications: Remote User-Authentication Principles - Kerberos - **Transport-Level Security:** Web Security Considerations **-** Transport Layer Security – HTTPS - Secure Shell (SSH)- **Wireless Network Security**: Wireless Security - Mobile Device Security- **Network Endpoint Security**: Firewalls - Intrusion Detection Systems - Malicious Software - Distributed Denial of Service Attacks
Case Study: Hardening CISCO Devices based on Cryptography and Security Protocols.

Total Hours:	**45 Hours**

Text Books:	
1.	William Stallings, “Cryptography and Network Security - Principles and Practice”,8th edition, Pearson, 2020.
Reference Books:	
1.	Behrouz A. Forouzon, “Cryptography and network security”, 3rd edition, Tata Mc Graw Hill, 2015.
2.	Atul Kahate, “Cryptography and Network Security”, 3rd edition, Tata Mc Graw-Hill, 2013.
Web References:	
1.	https://crypto.stanford.edu/~dabo/cs255/syllabus.html
2.	http://www.iitg.ac.in/icdcn2006/isg.pdf
3.	http://www.tutorialspoint.com/cryptography/
4.	https://blockgeeks.com/guides/what-is-blockchain-technology/
5.	https://www.kaspersky.com/resource-center/definitions/what-is-cryptocurrency
6.	https://ieeexplore.ieee.org/document/6527783 - Lightweight cipher implementations on embedded processors.
7.	https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3523710
Online Resources:	
1.	https://onlinecourses.nptel.ac.in/noc18_cs07/preview
2.	http://www.nptelvideos.in/2012/11/cryptography-and-network-security.html
3.	http://freevideolectures.com/Course/3027/Cryptography-and-Network-Security
4.	https://www.coursera.org/learn/crypto
5.	https://www.youtube.com/playlist?list=PL96A74njP_C8arW6NeU1o0e1NKjAWj0HA

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	3	1										2			1
C602.2	3	2	1	2								2	2	2	1
C602.3	3	3	1	3	2							2	2	2	1
C602.4	3	3	1	3	2							2	3	2	1
C602.5	3	3	1	3	1							2	3	2	1
C602	**3**	**3**	**1**	**3**	**2**							**2**	**3**	**3**	**1**

22CS603	ARTIFICIAL INTELLIGENCE	3/0/0/3

Nature of Course:	G (Theory analytical)
Pre requisites:	Mathematical Structures, Data Structures

Course Objectives:

1.	To learn the fundamental concepts in Artificial Intelligence.
2.	To provide knowledge of AI systems and its variants.
3.	To learn the various knowledge representation schemes.
4.	To learn the advanced concepts of machine learning and planning Technique.

Course Outcomes :

Upon completion of the course, students shall have ability to

C603.1	Summarize the structure of an Intelligent Agent.	[U]
C603.2	Examine the problem solving and searching techniques in a simple and complex environment.	[AP]
C603.3	Apply adversarial search techniques and make optimal decisions on a multi-agent environment.	[AP]
C603.4	Develop knowledge representation sentences with propositional and first order logic and inferring new sentences to the knowledge base.	[AP]
C603.5	Analyze complex problems for decision making using machine learning and planning techniques.	[A]

Course Contents:

MODULE I Agents & Its Techniques **15 Hours**

Intelligent Agents - Agents and environments - Nature of environments - structure of agents. **Problem Solving by searching:** Problem solving agents - example problems - Search Algorithms - Uninformed search strategies - Informed search strategies - heuristic functions. **Search in Complex Environments:** Local search and optimization problems - Local Search in Continuous Spaces - Defining Constraint Satisfaction Problems, Constraint Propagation: Inference in CSPs Backtracking Search for CSPs.

MODULE II Adversarial Search and Logical Agents **15 Hours**

Game theory - Optimal decisions in games - Alpha Beta pruning – Stochastic games. **Logical Agents:** Knowledge-Based Agents - The Wumpus World - Logic. **Propositional Logic:** A Very Simple Logic - **First order logic**: Syntax and semantics for first order logic - Knowledge engineering in first order logic - Inference in First order logic - propositional versus first order Inference - unification and lifting - forward chaining - backward chaining.

MODULE III Learning and Planning **15 Hours**

Forms of Learning - Supervised Learning - Learning decision trees - Ensemble learning - Unsupervised learning - K-Means Clustering algorithm - Steps for Designing Learning System. **Planning:** Definition, Algorithms, Heuristics for Planning, Hierarchical Planning, Planning and Acting in Nondeterministic Domains **Case Study:** Chatbot for healthcare professionals, Schneider Electric – AI for industry applications

Total :	**45 Hours**

Text Books:

1.	Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 4th Edition, Pearson Education, 2021.
2.	Kevin Night and Elaine Rich, Nair B., “Artificial Intelligence”, 3rd Edition McGraw Hill- 2011.

Reference Books:	
1.	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education (India) 2013.
2.	E. Alpaydin, Introduction to Machine Learning. MIT Press, 2nd edition, 2010.
3.	N.P.Padhy: Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.
Web References:	
1.	http://aima.cs.berkeley.edu/ai.html
2.	http://www.stanford.edu/class/cs221
Online Resources:	
1.	http://nptel.ac.in/video.php?subjectId=106105079
2.	http://nptel.ac.in/courses/106106126
3.	https://www.youtube.com/watch?v=AZuTTODTtvo/stanford university
4.	https://youtu.be/EwLrzlfi0oo/university of oxford

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**
C603.1	-	1	-	1	-				1	-	-	1	1	-	1
C603.2	3	3	-	2	-				1	2	-	3	2	-	3
C603.3	3	3	-	2	-				1	2	-	3	2	-	3
C603.4	3	3	-	2	-				1	2	-	3	2	-	3
C603.5	3	3	-	2	3				1	2	-	3	2	3	3
C603	**3**	**2**	**-**	**2**	**3**				**1**	**2**	**-**	**3**	**2**	**3**	**3**

22CS604	OBJECT ORIENTED ANALYSIS AND DESIGN LABORATORY	0/0/3/1.5
Nature of Course:	M (Practical Applications)	
Prerequisites:	Object Oriented Programming using Java	

Course Objectives:

1.	To capture the requirements specification for an intended software system
2.	To draw the UML diagrams for the given specification
3.	To improve the design by applying appropriate design patterns.
4.	To construct structural diagrams for real time applications.

Course Outcomes:

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

C604.1	Describe the Test compliance of the software with the SRS	[U]
C604.2	Illustrate the OO analysis and design for a given problem specification	[AP]
C604.3	Identify the basic software requirements in UML mapping.	[AP]
C604.4	Develop appropriate Sequence, Component, package and deployment diagrams	[A]
C604.5	Categorize the software quality using design patterns	[A]

Laboratory Component:

List of Experiments

1.	Identify a Software System and document the Software Requirement Specification for the identified system.
2.	Sketch the class diagrams to identify and describe key concepts and their relationships.
3.	Identify Use Cases and develop the Use Case model.
4.	Identify the conceptual classes and develop a Domain Model with Class Diagrams.
5.	Using the identified scenarios, find the interaction between objects and represent them using UML Sequence and Collaboration Diagrams.
6.	Sketch the Activity and State Diagrams for an identified application.
7.	Sketch the UML package diagram to show the User Interface, Domain objects and Technical services.
8.	Sketch the component diagram assuming that you will build your system by reusing existing components along with few new components.
9.	Sketch the deployment diagrams to model the runtime architecture of your application.
10.	Apply appropriate design patterns to improve the reusability and maintainability of the software system.

Total Hours:	**30 Hours**

Text Books:	
1.	Craig Larman, “Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development”, Third Edition, Pearson Education,2016.
2.	Booch G, Rumbaugh J and Jacobson I, “The Unified Modeling Language User Guide”, Second Edition, Addison Wesley Professional, 2017.
3.	Edwin Mach , “Object Oriented Analysis and Design Cookbook: Introduction to Practical System Modeling”, Independently Published, 2019.
Reference Books:	
1.	Ali Bahrami, “Object Oriented System Development”, McGraw Hill International Edition, 2008.
2.	Pressman RS, “Software Engineering - A Practitioner’s Approach”, 9th Edition,McGraw Hill, 2019.
3.	Erich Gamma, “Design Patterns: Elements of Reusable OO Software”, Addison-Wesley,2015.
Web References:	
1.	https://www.tutorialspoint.com/object_oriented_analysis_design/index.htm
2.	https://www.codeproject.com/Articles/1137299/Object-Oriented-Analysis-and-Design
Online Resources:	
1.	https://swayam.gov.in/nd1_noc19_cs48
2.	https://www.coursera.org/learn/object-oriented-design

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**
C604.1	3	3	3	3	3	2			2	2	2	2	3	3	2
C604.2	3	3	3	3	3	2			2	2	2	2	3	3	2
C604.3	3	3	3	3	3	2			2	2	2	2	3	3	2
C604.4	3	3	3	2	2	2	2	2	2	2	2	2	3	3	2
C604.5	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2
C604	3	3	3	3	3	2	2	2	2	2	2	2	3	3	2

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS605	ARTIFICIAL INTELLIGENCE LABORATORY	0/0/3/1.5
Nature of Course:	L (Programming)	
Pre requisites:	Python Programming	

Course Objectives:	
1.	To practice the fundamental concepts in Artificial Intelligence.
2.	To provide information of AI systems and its applications.
3.	To learn the various real word problem and its schemes.
4.	To familiarize the advanced concepts of machine learning and expert systems.

Course Outcomes : **Upon completion of the course, students shall have ability to**		
C605.1	Generalize the search strategies to solve informed and uninformed problem and identify its types.	[U]
C605.2	Identify and Apply Artificial Intelligence concepts to solve real world problems.	[AP]
C605.3	Interpret fundamental concepts of Genetic Algorithm and analyze and design the genetic algorithms for optimization engineering problems	[AP]
C605.4	Apply various pre-processing techniques on different datasets.	[AP]
C605.5	Predict the valid solutions for problems involving uncertain inputs by using decision making techniques.	[AP]

List of Experiments :	
1.	Uninformed Search
2.	8-puzzle problem using best first search
3.	A* search algorithm
4.	Mini-Max algorithm for game playing (Alpha-Beta pruning)
5.	Genetic Algorithm
6.	Map Coloring Problem using CSP
7.	Adversarial Search for Tic-tac-toe problem
8.	Kinship Domain using Prolog
9.	K-Means Clustering algorithm
10.	Decision tree for restaurant waiting problem
	Total Hours: 30 Hours

Text Books:	
1.	Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, 4th Edition, Pearson Education, 2021.
2.	Kevin Night and Elaine Rich, Nair B., “Artificial Intelligence”, 3rd Edition McGraw Hill- 2011.

Reference Books:	
1.	Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Education (India) 2013.
2.	E. Alpaydin, Introduction to Machine Learning. MIT Press, 2nd edition, 2010.
3.	N.P.Padhy: Artificial Intelligence and Intelligent Systems, Oxford University Press, 2009.

Web References:	
1.	http://aima.cs.berkeley.edu/ai.html
2.	http://www.stanford.edu/class/cs221

Online Resources:	
1.	http://nptel.ac.in/video.php?subjectId=106105079
2.	http://nptel.ac.in/courses/106106126
3.	https://www.youtube.com/watch?v=AZuTTODTtvo/stanford university

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**
C605.1	-	1	-	1	-				1	-	-	1	1	-	1
C605.2	3	3	-	2	-				1	2	-	3	2	-	3
C605.3	3	3	-	2	-				1	2	-	3	2	-	3
C605.4	3	3	-	2	-				1	2	-	3	2	-	3
C605.5	3	3	-	2	3				1	2	-	3	2	3	3
C605	**3**	**2**	**-**	**2**	**3**				**1**	**2**	**-**	**3**	**2**	**3**	**3**

22CS009	SERVERLESS COMPUTING	3/0/0/3

Nature of Course:	D (Theory Applications)
Prerequisites:	Web Technology, Cloud Computing

Course Objectives:

1.	To comprehend the working of serverless computing and ways it can be used in cloud applications.
2.	To create and manage serverless functions using the Cloud Functions platform.
3.	To organize functions and create reusable building blocks using packages.
4.	To navigate the web user interface to perform the tasks.

Course Outcomes:

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

C009.1	Design and develop serverless computing solutions by leveraging its fundamental concepts for diverse applications.	[AP]
C009.2	Critically evaluate the functionality and interactions of Handlers, Callback Functions, Events, and Context objects in serverless architectures.	[E]
C009.3	Devise and execute operations on storage and database services to optimize serverless application performance.	[AP]
C009.4	Construct and deploy serverless solutions using various functions and frameworks, addressing real-world challenges.	[AP]
C009.5	Analyze and optimize web services by utilizing advanced features of different serverless computing platforms.	[A]

Course Contents:

MODULE I Serverless Essentials **15 Hours**

Serverless Computing - Benefits and use cases- Limitations - Provider offers - Explore Triggers and Events - Development Options, Toolkits, SDKs - Developing Locally vs Using the Console- The Tools - Environment Setup.

MODULE II Computing Services **15 Hours**

Serverless Security: Comparing FaaS to IaaS - Serverless Framework – Serverless Functions – Understanding lambda functions - Command line interface - Integrating Lambda Layers with the Serverless Framework – Serverless storage services and Database services. **Case Study:** Amazon DynamoDB and AWS Lambda Functions.

MODULE III Web Services **15 Hours**

Explore the UI - Security - Code - Environment Variable - HTTP Event - Storage Event using Amazon Web Services - Azure and Google Cloud - An Agnostic Approach- Reference architecture for a web App - Reference architecture for a real-time file processing. **Case Study:** Build AWS serverless web applications - Create a CRUD HTTP API with Lambda and DynamoDB.

Total Hours:	**45 Hours**

Text Books:

1.	Maddie Stigler , “Beginning Serverless Computing: Developing with Amazon Web Services, Microsoft Azure, and Google Cloud”, A Press, 2018.
2.	Kuldeep Chowhan," Hands-On Serverless Computing”, Packt Publishing, July 2018.
3.	Sheen Brisals & Luke Hedger, “Serverless Development on AWS – Building Enterprise - scale Serverless solutions”, O’Reilly Publications Inc., 2024.

Reference Books:

1.	Praveen Kumar Sreeram, “Azure Serverless Computing Cookbook", Third Edition, Packt Publishing, 2021.
2.	Scott Patterson, "Learn AWS Serverless Computing", Packt Publishing, December 2019.
Web References:	
1.	https://www.tutorialspoint.com/serverless/serverless_introduction.htm
2.	https://bytescout.com/blog/serverless-computing-tutorial.html
3.	https://www.naukri.com/learning/articles/a-guide-to-serverless-computing/
Online Resources:	
1.	https://cognitiveclass.ai/courses/serverless-computing-using-cloud-functions-developer-1
2.	https://www.coursera.org/learn/aws-fundamentals-building-serverless-applications
3.	https://www.udemy.com/course/serverless-computing-with-aws-lambda-faas/

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	3	2	2										3	2	
C009.2	3	2	2										3	2	1
C009.3	3	3	3	2	1								3	2	1
C009.4	3	3	3	2	1							1	3	2	1
C009.5	3	3	3	2	1							1	3	2	1
C009	**3**	**3**	**3**	**2**	**1**							**1**	**3**	**2**	**1**

SEMESTER – VII

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

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	Develop an application using IoT to solve the real-time problem	[AP]
C701.3	Interpret services, privacy and security in the 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:

INTRODUCTION TO IOT AND IOE **15**

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

CHALLENGES OF IOE **15**

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- Case Study: MQTT

DESIGN WITH IOE AND USE CASES **15**

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. Case Study: Handling Data acquisition with devices

TOTAL PERIODS: 45

Text Books:

1.	Gunneswara Rao VSSS Kalaga, “Design of Internet of Things”, CRC Press, 2022.
2.	Aarti Jain, Rubén González Crespo and Manju Khari, “Smart Innovation of Web of Things” , CRC Press, 2020
3.	Hazim Dahir, 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 Mongay Batalla, George Mastorakis, “Beyond the Internet of Things -Everything Interconnected”, Springer Nature, 2017
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

22ME003	TOTAL QUALITY MANAGEMENT	3/0/0/3
Nature of Course	D (Theory Application)	
Pre Requisites	-	

Course Objectives:

1	To understand the engineering and management aspects of quality planning and control
2	Study the methodology of improving quality in manufacturing process / products
3	To understand the concepts of quality management system

Course Outcomes:

Upon completion of the course, students shall have ability to

C003.1	Define the basic concepts of quality management	[U]
C003.2	Recall the fundamentals of Total Quality Management and its tools.	[U]
C003.3	Examine the role of TQM tools and techniques in elimination of wastages and reduction of defects.	[AN]
C003.4	Inculcate the concepts of quality and continuous improvement as a passion and habit.	[AP]
C003.5	Analyze and understand the industrial problem and provide the optimal solution	[AN]

Course Contents:

QUALITY CONCEPTS **9**

Definition of quality, dimensions of quality, quality planning, quality costs. Cost estimation and principles, leadership, quality council, quality statements, strategic, Quality Guru's and their techniques: Walter Shewhart, W.Edward Deming, Kaoro Ishikawa, Joseph.M. Juran,Philip Crosby. PRODUCT DESIGN AND ANALYSIS: Basic Design Concepts and TQM Principles, Failure Mode Effect Analysis, Fault Tree Analysis, Value Analysis.

PROCESS IMPROVEMENT AND MODERN PRODUCTION MANAGEMENT TOOLS **9**

Six Sigma Approach, Total Productive Maintenance, Just-In-Time, Lean Manufacturing, Quality Improvement Tools and Continuous Improvement. Q-7Tools, New Q-7 Tools, Quality Function Deployment, Kaizen, 5S, Poka- Yoke, SMED.

QUALITY MANAGEMENT SYSTEMS **9**

Quality Management Systems, Introduction to ISO9000, TS16949: 2002 and EMS 14001certifications. OHSAS 18001 Occupational Health & Safety Assessment Series, Functional safety.

Total Hours: 45

Text Books:

1	DaleH. Besterfield "Total Engineering Quality Management", 6thEdition, Pearson Education, 2019
2	Sunil Sharma, "Total Engineering Quality Management", 6thEdition, Mac Millan India Limited, 2019

Reference Books:

1	PoornimaM. Charantimath, “Total Quality Management”, 5thEdition, Pearson Education, 2019
2	James R Evans, “Quality and Performance Excellence”, 8thEdition, Cengage Learning, 2019
Web Resources:	
1.	https://onlinecourses.nptel.ac.in/noc17_mg18/preview

22CS005	NETWORKS AND SECURITY	2/0/2/3
Nature of Course	D (Theory Application)	
Pre requisites	-	
Course Objectives:		
1	To analyze the differences between IPv4 and IPv6 protocols in various networking scenarios.	
2	To evaluate the effectiveness of VLAN configurations in optimizing network performance.	
3	To design secure WLANs using 802.1X authentication and AAA protocols to enhance network security.	
4	To critically assess the role of SD-WAN in modern network architectures, focusing on scalability and flexibility.	
5	To develop strategies for implementing network redundancy using Spanning Tree Protocol and VRRP for high availability.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C005.1	To describe the fundamentals of networking protocols such as TCP/IP, OSI model, and encapsulation.	[U]
C005.2	To explain the configuration and management of networking devices, including switches and routers.	[U]
C005.3	To apply VLAN configurations and IP addressing to create efficient network segmentation.	[AP]
C005.4	To analyze the performance of various routing protocols like OSPF and static routing in different network setups.	[AN]
C005.5	To compare the benefits and limitations of different types of physical media in LAN and WAN environments.	[AN]

FOUNDATIONS OF NETWORKING AND PROTOCOLS **10**

Introduction to Networking- LAN, WAN and components- OSI model & encapsulation- Different types of physical media Compare unicast, multicast, and broadcast, TCP/IP stack, IPv4 & IPv6- Different types of networking devices. Switching Fundamentals Connecting and accessing switch - Initial switch setup-Configuring VLANs, tagging, and IP addressing- Usage of LLDP and ICMP for network discovery and diagnosis-Configure link aggregation. Basic IP Setup: Inter-VLAN routing IPv4 & IPv6- DHCP relay-Static IP routing and configuration, single area OSPF- Basics of VoIP and its Advantages-Types of VoIP.

NETWORK SWITCHING TECHNOLOGIES **10**

Network Redundancy: Spanning Tree- VRRP and VSX - VSF configuration - Auto VSF - VSF MAD. Device Profiling: Use of device profiling - LLDP and MAC profiling - Establishing connections between APs and HPE- Setting up AP's. WLAN Fundamentals: Fundamentals of 802.11, RF

frequencies and channels- RF Patterns and coverage including SNR - Roaming standards and QOS requirements - RF design - Configuring WLANs. SD-WAN Fundamentals of SD-WAN - Future of SD-WAN - SD-WAN edge devices - SD-WAN gateway controllers - Configuring SD-WANs - Benefits of SD-WAN - Understanding WLC.

IMPLEMENTING SECURE WLANS **10**

AAA Security Frameworks - 802.1X authentication - Configuring secure WLANs - Roles and Access rules - Guest Access: setting up captive portal authentication- Configuration of guest WLANs- WLAN Security: WLAN security certificates- Cloud authentication. Network Security: Security devices (Firewalls, Routers and Wireless API's)-Principles of Network Security-Types of Security-Pillars of Network Security-Types of Network security Protections.

TOTAL PERIODS (Theory)	**30**

S. No	**List of Experiments**
1.	Configuring and accessing a Switch in Packet Tracer
2.	Configure and analyze IPv4 and IPv6 addressing schemes and subnetting
3.	Design and simulate VLAN configuration with inter-VLAN routing and static IP routing
4.	Simulate DHCP relay and basic VoIP setup
5.	Configure STP (Spanning Tree Protocol) and analyze redundancy in network switches
6.	Setup and test VRRP (Virtual Router Redundancy Protocol)
7.	Implement secure WLAN setup using 802.1X authentication with RADIUS
8.	Create and analyze WLANs with guest access via captive portals
9.	Analyze OSPF routing protocol performance through simulation
10.	Emulate SD-WAN-like behavior using static routes and redundancy simulation

TOTAL PERIODS (Lab)	**30**
TOTAL PERIODS	**60**

Text Books:

1.	Charlie Kaufman, Radia Perlman, and Mike Speicher, "Network Security, Private Communication in a Public World", 3rd Edition, Prentice Hall, 2022.
2.	Andrew S. Tanenbaum and David J. Wetherall, "Computer Networks ", 6th Edition, Pearson, 2021.
3.	Vijay K. Garg, "Wireless Communications and Networking", 2nd Edition, Morgan Kaufmann, 2018.

Reference Books:	
1.	William Stallings, “Network Security Essentials: Applications and Standards”, 7th Edition, Pearson Education, 2022.
2.	Behrouz A. Forouzan, “Data Communications and Networking”, 6th Edition, McGraw Hill, 2021.
3.	James F. Kurose and Keith W. Ross, “Computer Networking: A Top-Down Approach”, 8th Edition, Pearson, 2020.
Web References:	
1.	https://learn.microsoft.com/en-us/training/modules/network-fundamentals/
2.	https://learn.microsoft.com/en-us/azure/networking/fundamentals/
3.	https://www.juniper.net/documentation/

22CS012	DevOps	3/0/0/3
Nature of Course	D (Theory Applications)	
Prerequisites	Software Testing	

Course Objectives:

1	To understand the essential characteristics of DevOps for rapid and reliable application development.
2	To learn container management platform to manage application infrastructure.
3	To configure and manage Kubernetes for automatic application deployment.
4	To prepare the Jenkins environment for continuous integration and deployment.
5	To test the software applications using Jenkins.

Course Outcomes:

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

C012.1	Implement continuous integration and reduce software time to market and use GIT.	[AP]
C012.2	Demonstrate the container creation and running for application deployment using Docker.	[AP]
C012.3	Use the Kubernetes cluster to run the applications across multiple Environments.	[AP]
C012.4	Apply the continuous integration with Jenkins.	[AP]
C012.5	Implement the automation testing using the Jenkins platform.	[AP]

INTRODUCTION TO DEVOPS **15**

Introduction – Understanding DevOps – DevOps Benefits – DevOps Lifecycle – Defining the development pipeline – Devops Technical Challenges – Continuous integration and delivery: Definition, continuous Delivery, Benefits, designing continuous integration and delivery, Preparing the build for release – GIT – A Version Controlling Tool – GIT – A CLI - Essentials of GIT in industry – Branching and Merging in GIT.

CONTAINERIZATION WITH DOCKER AND KUBERNETES **15**

Introduction to Docker – Docker Essentials – Working with containers: Container Life Cycle – Docker Essentials – Creation of Docker File – Docker Swarm – Kubernetes: Introduction to Kubernetes, Kubernetes Cluster Architecture – Understanding the concepts of services and networking – Common kubectl Commands – Pods: Pods in Kubernetes, the pod manifest, running pods, Accessing pods, resource management- Using Kubernetes engine to deploy an application – Understanding labels, selectors, jobs and schedulers.

CONTINUOUS INTEGRATION WITH JENKINS **15**

Introducing Jenkins – Essentials of Continuous Integration – Jenkins Architecture – Preparing the environment – Configuring the tools – Configuring the Jenkins Server: Configuring dashboard, System environment, Global properties, Version control – Authentication – Authorization – Automated Testing – Securing Jenkins: Security realms, Auditing. **Case Study:** Configuration management using Chef and Puppet.

TOTAL PERIODS: 45

Text Books:	
1	Rafal Leszko, “Continuous Delivery with Docker and Jenkins” Packt publisher, Third Edition, 2022.
2	Brendan Burns, Joe Beda, and Kelsey Hightower “Kubernetes: Up and Running – Dive into the future infrastructure”, O’Reilly Publication, Second Edition, 2019.
3	John Ferguson Smart,” Jenkins - The Definitive Guide”, O'Reilly Publication, 2011.
Reference Books:	
1	Nigel Poulton and Pushkar Joglekar, “The kubernetes book” Packt publisher, 2019.
2	Pierluigi Riti, “Pro DevOps with Google Cloud Platform – with Docker, Jenkins and Kubernetes”, APress, 2018.
Web References:	
1	https://www.atlassian.com/devops
2	https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/
3	https://kubernetes.io/docs/concepts/cluster-administration/manage-deployment/
4	https://www.jenkins.io/
5	https://www.jenkins.io/doc/developer/views/exposing-bundled-resources/

22CS931	BIG DATA ANALYTICS	3/0/0/3
Nature of Course	H (Theory Technology)	
Prerequisites	-	

Course Objectives:

1	Introduce the fundamental concepts of Big Data and its importance in modern data-driven decision making.
2	Familiarize students with Big Data frameworks and tools such as Hadoop, Spark, and NoSQL databases.
3	Impart knowledge on data preprocessing techniques and distributed computing.
4	Enable students to apply machine learning and data mining techniques to large datasets.
5	Teach the evaluation and implementation of big data analytics solutions for real-world problems.

Course Outcomes:

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

C931.1	Explain the concepts, characteristics, and significance of Big Data and its role in solving contemporary data challenges.	[U]
C931.2	Utilize and assess data using Association Rule Mining, Classification, and Clustering algorithms to support data-driven decision-making	[AP]
C931.3	Implement data preprocessing techniques such as cleaning, transformation, and integration to prepare datasets for comprehensive analysis.	[AN]
C931.4	Demonstrate the principles of NoSQL databases, their types, and their relevance in managing Big Data effectively	[AN]
C931.5	Explore and apply visualization tools such as Tableau and Power BI to represent and communicate insights derived from Big Data.	[AP]

INTRODUCTION TO BIG DATA **15**

Introduction to Big Data: Definition, Characteristics of Big Data (Volume, Variety, Velocity, Veracity, Value), Big Data vs Traditional Data, Importance of Big Data. -Big Data Challenges: Data storage, processing, and management - Hadoop Ecosystem: Hadoop Architecture, HDFS, MapReduce, YARN, and Hadoop components like Hive, Pig, and HBase.

DATA ANALYTICS ALGORITHMS **15**

Association Rules: Introduction and Overview. Apriori Algorithm: Concepts, Process, and Applications. Frequent Pattern Tree: Construction, Advantages, and Use Cases. Classification Algorithms: 1R Algorithm: Rule-based Classification, Working Principle, and Example. Decision Trees: Structure, Construction, and Applications. Naïve Bayes Classification. Clustering Algorithms: K-Means Clustering: Algorithm, Steps, and Optimization Techniques. Hierarchical Clustering.

BIG DATA AND VISUALIZATION **15**

Introduction to NoSQL, Types of NoSQL Databases (Document, Column, Graph, Key-Value), and popular NoSQL databases. Analyzing big data with twitter — Big data for E-Commerce Big data for

blogs — Data Preprocessing: Data cleaning, transformation, and integration techniques in Big Data. Spark Framework: Introduction to Apache Spark. Understanding Data Visualization. Importance of Data Visualization in Big Data Analytics. Common types of visualizations: Bar charts, line graphs, pie charts, heatmaps, scatter plots. Tools for Visualization: Tableau and Power BI.	
TOTAL PERIODS	**45**
Text Books:	
1	Nathan Marz and James Warren, *Big Data: Principles and Best Practices of Scalable Real-Time Data Systems*, 1st Edition, Manning Publications, 2023.
2	Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media, 2023.
3	Jiawei Han, Micheline Kamber and Jian Pei, “Data Mining Concepts and Techniques”, 3rd Edition, Elsevier, 2023.
Reference Books:	
1	Nathan Marz and James Warren, “Big Data: Principles and Best Practices of Scalable Real-Time Data Systems”, 1st Edition, Manning Publications, 2022.
2	Pramod J. Sadalage and Martin Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*, 1st Edition, Addison-Wesley, 2023.
3	Pramod J. Sadalage and Martin Fowler, “NoSQL Distilled”, 1st Edition, Addison-Wesley 2012.
Web References:	
1	https://citationsy.com/styles/big-data-analytics
2	https://link.springer.com/chapter/10.1007/978-3-030-68176-0_6
Online Resources:	
1	https://www.niit.com/india/working-professionals/data-analytics
2	https://www.udemy.com/topic/big-data/

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]

INTRODUCTION TO CLOUD AND APPLICATION DEPLOYMENT **15**

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.

CORE CLOUD SERVICE **15**

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.

LINUX BASICS AND NETWORK SECURITY **15**

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 PERIODS	**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

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]

MULTIMEDIA FILE FORMATS AND STANDARDS **15**

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.

MULTIMEDIA AUTHORING AND APPLICATIONS **15**

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.

ANIMATION **15**

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 PERIODS: 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//

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 the 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 an IoT based real-time system.	[AP]
C702.5	Analysis and report the sensitive application using IoE.	[A]

List of Experiments:

1. Introduction to Arduino platform and programming
2. Interfacing sensors and actuators to Arduino
3. Introduction to Raspberry PI platform and python programming
4. Interfacing sensors and actuators to Raspberry
5. Setup a cloud platform to log the data
6. Log Data using Raspberry PI and upload to the cloud platform
7. Design an IOT based system
8. Develop the Vehicle Parking System in Smart Cities using IoE.
9. Develop an IoE-Enabled Healthcare System for Remote and Near Patient Monitoring.
10. Develop an IOE application to handle data acquisition with integration of the output devices.

TOTAL PERIODS:	**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	Marco Schwartz, “Internet of Things with Arduino Cookbook”, Packt Publishing, 2019.

22CS703	PROJECT - I	0/0/6/3
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**		
C703.1	Identify a problem and carry out a thorough study on the chosen problem	[AP]
C703.2	Analyze ongoing developments in the chosen domain and demonstrate technical knowledge pertaining to the same.	[A]
C703.3	Apply suitable tools, techniques, Algorithms, frameworks to solve the practical problems.	[AP]
C703.4	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.

SEMESTER – VIII

22CS801	PROJECT - II	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

OPEN ELECTIVE

22CS001	ANALYSIS OF ALGORITHMS	1/0/4/3
Nature of Course:	I (Problem Concepts)	
Pre requisites:	Data Structures	

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

C001.1	Understand basics of Algorithm analysis, Complexity Analysis and Apply Mathematical concepts and notations to define a problem	[U]
C001.2	Illustrate the searching and sorting algorithms.	[AP]
C001.3	Interpret the design principles of Divide and Conquer, greedy algorithm and Dynamic Programming	[AP]
C001.4	Apply the problem-solving methodology used in Backtracking.	[AP]
C001.5	Employ graph algorithms in real world problems.	[AP]

Course Contents:

Module I Introduction **15 hours**

Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency- Analysis Framework, Asymptotic Notations and their properties. - Time Complexity Analysis - Space Complexity – Mathematical analysis for Recursive and Non-recursive algorithms. Recurrence Relation: Substitution methods & Master Theorem. **Searching:** Linear, Binary search. **Sorting:** Bubble sort, Insertion sort & Selection sort.

Module II Divide and Conquer, Greedy Algorithms & Dynamic Programming **15hours**

Divide and Conquer: quick sort, mergesort and Strassens Matrix Multiplication **Heaps**: Binaryheap, heapsort - **Greedy Algorithms**: Activity selection problem, Fractional knapsack, Huffmancoding - String algorithms - Naive algorithm. **Dynamic Programming:** Travelling Sales man Problem, 0-1 Knapsack, Coin change problem, Longest common Subsequence, Longest Increasing Subsequences.

Module III Backtracking and Graph Algorithm **15 hours**

Backtracking - Rat in a maze, Permutation and Combination, N Queen problem, Subset Sum, M-Coloring Problem, Hamiltonian Cycle Problem, Sudoku Solver, Sieve of Sundaram, PrimeNumbers after P with Sum S. **Graph Algorithms**–Single source shortest path algorithm: Dijkstra Algorithm, All pair Shortest Path: Floyd Warshall Algorithm - Minimum Spanning Tree: Prims and Kruskal Algorithm.

	Total Hours:	**45 Hours**
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]**
C001.1	Understand	Quiz	**20**
C001.2	Apply	Quiz	**20**
C001.3	Apply	Mini Project	**20**
C001.4	Apply		
C001.5	Apply	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**
C001.1	3	3	3	2	2				2	2	2	2	3	3	2
C001.2	3	3	3	2	2				2	2	2	2	3	2	3
C001.3	3	3	3	3	2				3	2	2	2	3	2	2
C001.4	3	3	3	2	3				2	2	2	2	3	3	3
C001.5	3	3	3	2	3				2	2	2	2	3	2	2

22CS002	FRONT END ENGINEERING - REACT	0/0/6/3
Nature of Course	M (Practical Application)	
Pre requisites	Programming Languages	
Course Objectives:		
1.	To discuss the essence of front-end development skills.	
2.	Ability to understand and use JavaScript in client-side web applications.	
3.	To impart the knowledge of React components used in web application development platforms.	
4.	To deploy and test the React App used in Web Applications.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C002.1	Utilize the knowledge of HTML, CSS & Java script to create personal and business websites	[U]
C002.2	Illustrate the single page applications in React.	[U]
C002.3	Utilize the various React features including components and forms.	[AP]
C002.4	Show the functionality of front-end UI applications using React.	[U]
C002.5	Apply CSS for designing responsive React applications and understanding Axios package	[AP]

Course Contents:

Introduction to HTML: HTML Basics, Semantic Elements, Tables, List, Frames and Form elements, CSS, Types of CSS, CSS selectors, Bootstrap, Introduction: JavaScript Essentials, Node.js Fundamentals, React Introduction, Overview of frameworks, libraries for client-side Web applications, React Components basics, Understanding NPM commands, React: formatting and check styles, Overview of Webpack, Babel, Understanding JSX, Limitations of JSX, Working with Components and Reusing Components.

React Components - Props and State, Handling Events with methods, Manipulating the State, Two way data-binding, Functional (Stateless) VS Class (Stateful) Components, Parent – Child Communication, Showing Lists, List and keys, Styling Components, CSS Styling, Scoping Styles using Inline Styles, Inline Styles with Radium, Google Material UI, UI Templates for Business, Typography Usage, Debugging React Apps, 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, Fragments, Higher Order Components, Passing unknown Props, Validating Props, Using References, React Context API.

React Projects, HTTP Requests/Ajax Calls, HTTP Requests in React, Introduction of Axios package, HTTP GET Request, fetching & transforming data, HTTP POST, DELETE, UPDATE, react-router vs react-router-dom, Switching Between Pages. 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 Deploying React App to the Web.

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 Practical Hours	**60**

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.
3.	Adam Bouch, "React and React Native",Packt Publishing,3rd Edition, 2020.
4.	KirupaChinnathambi , "Learning React : A Hands-On Guide to Building Web Applications Using React and Redux",Pearson Education, Second Edition,2018.

Reference Books:

1.	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.
2.	Carlos Santana Roldan, "React Cookbook",Packt Publishing,2018.

3.	Lionel Lopez, “React: Quickstart Step-by-step Guide to Learning React Javascript Library (React.js, Reactjs, Learning React Js, React Javascript, React Programming)”,CreateSpace Independent Publishing Platform,2017.
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

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	60	60	60
Analyse	20	20	20
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**
C002.1	3	3	3	2	2				2	2	2	2	3	3	2
C002.2	3	3	3	2	2				2	2	2	2	3	2	3
C002.3	3	3	3	3	2				3	2	2	2	3	2	2
C002.4	3	3	3	2	3				2	2	2	2	3	3	3
C002.5	3	3	3	2	3				2	2	2	2	3	3	3
C002	**3**	**3**	**3**	**2**	**3**				**3**	**2**	**3**	**2**	**2**	**2**	**2**

22CS003	FUNDAMENTALS OF JAVA PROGRAMMING	1/0/4/3
Nature of Course:	G (Theory Programming)	
Prerequisites	Nil	

Course Objectives:

1.	To gain insight knowledge of OOP concepts.
2.	To analyze different types of constructor, Inheritance and polymorphism.
3.	To understand and apply package, Interface concepts and java frameworks
4.	To know the fundamental concepts of exceptions, threads with real world examples

Course Outcomes:

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

C003.1	Infer the basic concepts of java programming.	[U]
C003.2	Analyze, and interpret Inheritance and polymorphism in real world projects.	[A]
C003.3	Apply the basis of Packages and interfaces.	[AP]
C003.4	Apply the concepts of Exceptions handling in real world projects.	[AP]
C003.5	Develop Java frameworks like spring, spring MVC and Springboot.	[AP]

Course Contents:

MODULE I JAVA Basics **5+10 hours**

Review of Object-oriented concepts – History of Java – Java buzzwords – JVM architecture– Data types – Variables – Scope and life time of variables –Arrays – Operators – Control Statements – Type conversion and casting –Classes and objects – Methods –Strings– Static block – Access specifier – Command line arguments.

MODULE II Inheritance, Polymorphism & Packages **5+10 hours**

Basic concepts – Constructor - Types of inheritance – Member access rules – Usage of this and Super keyword – Method Overloading – Method overriding – Abstract classes –Usage of final keyword – Defining package – Access protection –Importing packages.

MODULE III Interfaces, Exception handling & Frameworks **5+10 hours**

Defining and Implementing interfaces, and Extending interfaces – Exception handling fundamentals– Exception Types – Usage of Try, Catch, Throw, Throws and Finally keywords – Built-in Exceptions – Creating own Exception classes - Introduction to threads - Multithreading - Templates - Introduction to Java frameworks –Spring - Spring MVC & Spring Boot.

Total Hours:45

Text Books:

1.	Herbert Schildt, “Java: The Complete Reference”, 11th edition, Mc craw Hill, 2020.

Reference Books:

1.	Y. Daniel Liang, “Introduction to Java Programming”, 9th Edition, Prentice Hall Publications, 2015.
2.	Paul Deitel, Harvey Deitel, “Java How To Program”, 10th Edition, Prentice Hall Publications, 2014.
3.	T. Budd, An Introduction to Object Oriented Programming, 3rd edition, Pearson Education, India, 2009.
4.	ShagunBakliwal, Hands-on Application Development using Spring Boot, bpb publisher, 2021.

Web References:	
1.	https://onlinecourses.nptel.ac.in/noc19_cs84/preview
2.	https://www.scientecheasy.com/2018/07/core-java-tutorial.html/
Online Resources:	
1.	https://www.edx.org/course/java-programming-fundamentals

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]**
C003.1	Understand	Quiz	**20**
C003.2	Apply	Quiz	**20**
C003.3	Apply	Mini Project	**20**
C003.4	Apply		
C003.5	Apply	Mini Project	**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	30	30
Apply	40	40
Analyse	20	20
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 Outcome (CO)	**Programme Outcomes (PO)**												**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C003.1	3	2	3									2	2	2	3
C003.2	3	2	2	2	2							2	3	3	3
C003.3	3	3	3	3	3							3	3	2	2
C003.4	3	3	3	3	2							3	2	3	3
C003.5	3	3	3	3	2							3	2	3	3
	3	Strongly agreed		2	Moderately agreed					1	Reasonably agreed				

22CS004	MERN STACK DEVELOPMENT	0/0/6/3
Nature of Course:	M (Practical Application)	
Prerequisites	Programming Languages	

Course Objectives:

1.	To understand the fundamentals of the MERN stack and its components
2.	To design and implement a database using MongoDB
3.	To build a RESTful API using Node.js and Express and understand how to handle requests and responses in Node.js and Express
4.	To learn about state management, props, and component lifecycle in React
5.	To deploy the application to a production environment

Course Outcomes:

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

C004.1	Describe the basics concepts of MERN stack and its components	[U]
C004.2	Create a frontend application using React	[AP]
C004.3	Integrate the frontend and backend to create a full-stack application	[AP]
C004.4	Implement authentication and authorization in the application	[AP]
C004.5	Apply best practices and design patterns in MERN stack development	[A]

Course Contents:

Introduction to MERN Stack: Overview of the MERN stack (MongoDB, Express.js, ReactJS, Node.js), Installation of necessary software and tools (MongoDB, Node.js, etc.), Introduction to JavaScript, HTML, CSS, MongoDB and NoSQL databases, CRUD operations using MongoDB. **Frontend development with ReactJS:** Introduction to ReactJS and its architecture, Introduction to ES6 Coding standards, JSX, Components and its types. Props, state, and lifecycle, Event Handling, Implementation of forms, Rendering and its types, Using third-party libraries and plugins, Debugging and testing ReactJS applications.

Building the backend with Node.js and Express.js: Introduction to Node.js and its ecosystem, Building a RESTful API using Express.js, Connecting to MongoDB with Mongoose, Handling HTTP requests and responses, Implementing authentication and authorization, Deploying the backend to a server. Using the MERN stack to build an application. Implementing client-side routing with React Router, Handling user input and form submissions, Connecting Express.js with React.js. Setting up navigation using React Router, Creating multiple pages in a React app, State Management in React, Understanding state management.

Defining and Implementing interfaces, and Extending interfaces – Exception handling fundamentals– Exception Types – Usage of Try, Catch, Throw, Throws and Finally keywords – Built-in Exceptions – Creating own Exception classes - Introduction to threads - Multithreading - Templates - Introduction to Java frameworks –Spring - Spring MVC & Spring Boot.

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 Practical Hours:	**60**

Text Books:	
1.	Vasan Subramanian , "Pro MERN Stack: Full Stack Web App Development with Mongo, Express, React, and Node", Apress Publication, 2019
2.	Nabendu Biswas , "Ultimate Full-Stack Web Development with MERN: Design, Build, Test and Deploy Production-Grade Web Applications with MongoDB, Express, React and NodeJS", Orange Education Pvt Ltd, 2023
Reference Books:	
1.	Greg Lim, "Beginning MERN Stack: Build and Deploy a Full Stack MongoDB, Express, React, and Node.js" Amazon Digital Services LLC, 2021
2.	Shama Hoque, "Full-Stack React Projects: Learn MERN stack development by building modern web apps using MongoDB, Express, React, and Node.js", 2nd Edition, Packt Publishing, 2020.
Web References:	
1.	https://www.freecodecamp.org/news/mern-stack-roadmap-what-you-need-to-know-to-build-full-stack-apps/
2.	https://medium.com/backenders-club/the-mern-stack-developers-guide-to-success-a-step-by-step-roadmap-1dc9956f6645
Online Resources:	
1.	https://www.udemy.com/course/mastering-mern-stack/
2.	https://www.coursera.org/articles/mern-stack

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	60	60	60
Analyse	20	20	20
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
C004.1	3	2	3						2	2	1	2	2	2	3
C004.2	3	2	2	2	2				2	2	1	2	3	3	3
C004.3	3	3	3	3	3				2	2	1	3	3	2	2
C004.4	3	3	3	3	2				2	2	1	3	2	3	3
C004.5	3	3	3	3	2				2	2	1	3	2	3	3
			3	Strongly agreed		2	Moderately agreed				1	Reasonably agreed			

Vertical 1-
Cloud Computing & Data Storage Technologies

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

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

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

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

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.	[AN]

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

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

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

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

Vertical 2-
Applied Artificial Intelligence

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

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

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/

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

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/

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

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/

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

Vertical 3-

Information Security

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

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

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/

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

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

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

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

Vertical 4-

Data Analytics

22IT931	NLP IN ANALYTICS	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Nil	

Course Objectives:

1.	To recognize and define core computer vision problems.
2.	To understand the principles behind the creation of the convolution neural network.
3.	To familiarize formal models to express natural language phenomenon
4.	To implement and debug large NLP systems in a clean and structured manner

Course Outcomes

Upon completion of the course, students shall have ability to

C931.1	Infer the different architectures of AI Computer Vision.	[U]
C931.2	Examine different methodologies to create application using LeNet-5, AlexNet, VGG, ResNet.	[A]
C931.3	Interpret state-of-the-art works of literature on Object detection and localization algorithms.	[U]
C931.4	Identify the appropriate deep learning models for analyzing the data for a variety of real world problems.	[AP]
C931.5	Develop computer vision applications.	[AP]
C931.6	Inspect the Transformer idea related to language modeling, sequence-to-sequence modeling, and googles's BERT model.	[A]

Course Contents:

Natural Language Processing (NLP) **15 Hours**

NLP overview - NLP - RNN - NLP - LSTM - GRU - NLP Attention based models: Encoder - Decoder - attention mechanism - NLP Transfer learning: GPT and BERT.

Architectures of Computer Vision: **15 Hours**

Background - Requirements of Computer vision- Architectures: LeNet-5 and implementation-AlexNet and implementation-VGG and implementation-Inception and practical-ResNet and implementation.

Advance Computer Vision: **15 Hours**

Data Augmentation and its benefits - object detections: bounding boxes - bounding box regression - IoU - Precision and recall - Transfer Learning - Average precision - CNN: Architecture - implementations - Cons - FAST RCNN - FAST RCNN Architecture - FASTER RCNN - and its architecture - YOLO: Architecture and implementation Detectron and its implementation.

Total Hours	**45**

Text Books:

1.	Lewis Tunstall, Leandro von Werra, Thomas Wolf, "Natural Language Processing with Transformers: Building Language Applications with Hugging Face", 1st Edition, O'Reilly 2022.
2.	I. Goodfellow, Y. Bengio and A. Courville, "Deep Learning: Algorithms and Applications", MIT Press Cambridge, 2017.
3.	S. Khan, H. Rahmani, S. Shah and M. Bennamoun, "A Guide to Convolutional Neural Networks for Computer Vision", Morgan & Claypool Publishers, 2018.
4.	Mohammed Elgendy, "Deep Learning for Vision Systems", Manning Publications Co., 2018.

Reference Books:	
1.	Seth Weidman , “Deep Learning from Scratch: Building with Python from First Principles” , O'Reilly, 2019.
2.	Denis Rothman, “Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more”, Packt, 2021.
Web References:	
1.	https://github.com/brianspiering/awesome-dl4nlp
2.	https://www.tutorialspoint.com/natural_language_processing/index.htm
Online Resources:	
1.	http://cs231n.stanford.edu/slides/2017/cs231n_2017_lecture11.pdf
2.	https://towardsdatascience.com/what-is-average-precision-in-object-detection-localization-algorithms-and-how-to-calculate-it-3f330efe697b
3.	https://www.kaggle.com/code/colearninglounge/nlp-model-building-transformers-attention-more

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
C931.1	2	2	2	2	2						2	2	2	2	2
C931.2	2	2		1	2						2	2	2	2	2
C931.3	2		1	1	3						2	2	2	2	2
C931.4	2	2	1	2	1						3	3	2	3	2
C931.5	1	2	2	1	2						2	3	3	2	2
C931.6	1	3	2	1	2						2	2	2	3	2

22IT903	DEEP LEARNING TECHNIQUES	3/0/0/3
Nature of Course	C (Theory Concept)	
Pre requisites	Artificial Intelligence and Machine Learning	

Course Objectives:

1.	To understand the fundamentals of neural networks and deep networks.
2.	To learn the different architectures of deep networks.
3.	To examine the core concepts in deep learning.
4.	To learn the applications of deep learning.
5.	To understand the underlying implementations of deep learning models, and techniques for optimization

Course Outcomes

Upon completion of the course, students shall have ability to

C903.1	Define the basics of Neural and Deep Networks.	[R]
C903.2	Summarize the CNN and RNN architectures that helps resolve complex problems.	[U]
C903.3	Experiment with the performance of a Deep Learning Network.	[AP]
C903.4	Apply Deep Learning for solving Real world problems.	[AP]
C903.5	Analyze appropriate neural network architectures and techniques for specific applications	[A]

Course Contents:

Foundations of Neural Networks **15 Hours**

Neural Networks – Training Neural Networks – Activation Functions – Loss Functions – Hyper parameters. Fundamentals of Deep Networks-Introduction to Deep Learning-Generative Adversarial Networks- Image Segmentation -–Reinforcement Learning and Deep Q-Networks (DQN)-Attention Mechanisms and Transformer Networks-Transfer Learning-Synthetic Data Creation.

CNN and RNN **15 Hours**

CNN: Introduction-Convolution and Pooling Layers-CNN Architectures (LeNet, AlexNet, VGG, ResNet)- Object Detection and Localization with CNNs-Image Classification and Transfer Learning-Case Studies: Image Recognition and Analysis. RNN: Introduction- Vanishing and Exploding Gradients - LSTM (Long Short-Term Memory) NetworksGRU (Gated Recurrent Unit) Networks-Applications of RNNs: Sequence Prediction, Language Modeling-Time Series Analysis and Forecasting.

Applications **15 Hours**

Autoencoders and Dimensionality Reduction**-**Implementing Neural Networks and Deep Learning Models using Frameworks like TensorFlow / PyTorch, Case Studies: Large-Scale deep learning-Computer Vision- Text Classification - Named Entity Recognition (using NLTK Library).

Total Hours	**45**

Text Books:

1.	Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning”, MIT Press, 2017.
2.	Rajalingappaa Shanmugamani, “Deep Learning for Computer Vision, Expert Techniques to Train Advanced Neural Networks using TensorFlow and Keras”, Packt Publishing, 2018.
3.	Adam Gibson, Josh Patterson, “Deep Learning, A practitioner’s approach”, O’Reilly, 1st Edition, 2017.
4.	Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.

Reference Books:	
1.	Aurelien Geron, “Hands-On Learning with Scikit-Learn and Tensorflow”, O’Reilly, 1st Edition, 2017.
2.	Ragav Venkatesan, Baoxin Li, “Convolutional Neural Networks in Visual Computing”, CRC Press, 2018.
3.	Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018
Web References:	
1.	https://home.cs.colorado.edu/~mozer/Teaching/syllabi/DeepLearningFall2017/
2.	http://www.cs.iit.edu/~agam/cs577/index.html
3.	https://online.stanford.edu/courses/cs230-deep-learning
Online Resources:	
1.	https://www.edx.org/course/deep-learning-with-tensorflow
2.	https://datascience.uci.edu/education/data-science-short-courses/
3.	https://onlinecourses.nptel.ac.in/noc19_cs81/preview

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
C903.1	2	3	3	2	2			2	2	2	2	2	3	2	2
C903.2	2	2	2	3	2			2	2	2	2	2	2	3	3
C903.3	3	3	3	3	3			3		3	3	3	3	3	3
C903.4	2	2	2	3	2			2		2	2	2	3	2	3
C903.5	2	2	2	3	3			3		3	3	3	2	3	2

22IT932	COGNITIVE SYSTEMS AND ANALYTICS	3/0/0/3
Nature of Course	H (Theory Technology)	
Pre requisites	Nil	

Course Objectives:

1.	To learn the history and fundamentals of cognitive science.
2.	To demonstrate learning, reasoning and design principles in cognitive systems.
3.	To illustrate the various analytics techniques in cognitive computing.
4.	To develop skills in analyzing, interpreting and assessing the empirical data and research techniques that contributes to cognitive science.

Course Outcomes:

Upon completion of the course, students shall have ability to

C932.1	Recall the basic concepts of cognitive science and its algorithms	[R]
C932.2	Understand the complexities of cognition using neural, social and technological approaches	[U]
C932.3	Practice the Learning, reasoning and designing methodologies in cognitive systems	[AP]
C932.4	Use various Analytics techniques in cognitive systems	[AP]
C932.5	Apply cognitive science theories, concepts to individual, social and cultural issues	[AP]
C932.6	Examine various cognitive applications for social issues	[A]

Course Contents:

Introduction to Cognitive Science **15 Hours**

Introduction: Foundation of Cognitive Science and design principles - Natural language processing in support of a cognitive system - Role of cloud and distributed computing in cognitive computing - Relationship between big data and Cognitive computing - The Business Implications of Cognitive Computing – Case based Reasoning.

Cognitive Systems and Learning **15 Hours**

Concept Learning-Classification Logic-Planning-Understanding Common Sense Reasoning-Scripts. Cognitive Systems and Reasoning- Explanation Based Learning -Analogical Reasoning-Version Spaces-Constraint Propagation Diagnosis-Meta Reasoning

Cognitive System Design Principles & Applications **15 Hours**

Machine Learning Hypothesis -Generation and Scoring-Representing Knowledge taxonomies and Ontologies -Advanced Analytics- Predictive Analytics-Text Analytics - Image Analytics-Speech Analytics Case study- Sensitivity Analysis using AWS services. Applications of cognitive computing - Building a Cognitive Healthcare Application, Smarter cities in Government & Emerging cognitive computing areas.

Total Hours	**45**

Text Books:	
1.	S.Hurwitz, M.Kaufman and A.Bowles, "Cognitive Computing and Big Data Analytics", Wiley Publishers, 2015.
2.	Herre van Oostendorp, "Cognition in a Digital World", Publishers: Lawrence Erlbaum Associates, 2003
Reference Books:	
1.	Felix Goodson “The Evolution and Function of Cognition” Publishers: Lawrence Erlbaum Associates, 2003
2.	Paul Thaugard, BradFord Book " Mind- Introduction to Cognitive Science", 2nd Edition, MIT Press, 2005.
Web References:	
1.	www.cognitivesciencesociety.org
2.	https://www.shortcoursesportal.conn/search/#q=di-2751lv-short
3.	https://cognitiveclass.ai/learn/cognitive-analytics-ibm
Online Resources:	
1.	https://www.edx.org/learn/cognitive-science
2.	https://ocw.mit.edu/courses/brain-and-cognitive-sciences/
3.	https://swayam.gov.in/course/267-cognitive-science
4.	https://www.coursera.org/courses?query=cognitive%20science
5.	https://www.coursera.org/learn/philosophy-cognitive-sciences

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
C932.1	3		3		3		2					2	3		
C932.2	2			2			3				2	2		2	
C932.3		3			2				2			2	3		
C932.4	3		2			2	3			2		3			3
C932.5	3		2			2	3			2		3			3
C932.6	3		2			2	3			2		3			3

22CS931	BIG DATA ANALYTICS	3/0/0/3
Nature of Course	H (Theory Technology)	
Prerequisites	**-**	

Course Objectives:

1	Introduce the fundamental concepts of Big Data and its importance in modern data-driven decision making.
2	Familiarize students with Big Data frameworks and tools such as Hadoop, Spark, and NoSQL databases.
3	Impart knowledge on data preprocessing techniques and distributed computing.
4	Enable students to apply machine learning and data mining techniques to large datasets.
5	Teach the evaluation and implementation of big data analytics solutions for real-world problems.

Course Outcomes:

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

C931.1	Explain the concepts, characteristics, and significance of Big Data and its role in solving contemporary data challenges.	[U]
C931.2	Utilize and assess data using Association Rule Mining, Classification, and Clustering algorithms to support data-driven decision-making	[AP]
C931.3	Implement data preprocessing techniques such as cleaning, transformation, and integration to prepare datasets for comprehensive analysis.	[AN]
C931.4	Demonstrate the principles of NoSQL databases, their types, and their relevance in managing Big Data effectively	[AN]
C931.5	Explore and apply visualization tools such as Tableau and Power BI to represent and communicate insights derived from Big Data.	[AP]

Course Contents:

MODULE I INTRODUCTION TO BIG DATA **15 Hours**

Introduction to Big Data: Definition, Characteristics of Big Data (Volume, Variety, Velocity, Veracity, Value), Big Data vs Traditional Data, Importance of Big Data. -Big Data Challenges: Data storage, processing, and management - Hadoop Ecosystem: Hadoop Architecture, HDFS, MapReduce, YARN, and Hadoop components like Hive, Pig, and HBase.

Module II: DATA ANALYTICS ALGORITHMS **15 Hours**

Association Rules: Introduction and Overview. Apriori Algorithm: Concepts, Process, and Applications. Frequent Pattern Tree: Construction, Advantages, and Use Cases. Classification Algorithms: 1R Algorithm: Rule-based Classification, Working Principle, and Example. Decision Trees: Structure, Construction, and Applications. Naïve Bayes Classification. Clustering Algorithms: K-Means Clustering: Algorithm, Steps, and Optimization Techniques. Hierarchical Clustering.

MODULE III BIG DATA AND VISUALIZATION **15 Hours**

Introduction to NoSQL, Types of NoSQL Databases (Document, Column, Graph, Key-Value), and popular NoSQL databases. Analyzing big data with twitter — Big data for E-Commerce Big data for blogs — Data Preprocessing: Data cleaning, transformation, and integration techniques in Big Data. Spark Framework: Introduction to Apache Spark. Understanding Data Visualization. Importance of Data Visualization in Big Data Analytics. Common types of visualizations: Bar charts, line graphs, pie charts, heatmaps, scatter plots. Tools for Visualization: Tableau and Power BI.

Total Hours:	**45**

Text Books:

1	Nathan Marz and James Warren, *Big Data: Principles and Best Practices of Scalable Real-Time Data Systems*, 1st Edition, Manning Publications, 2023.

2	Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media, 2023.
3	Jiawei Han, Micheline Kamber and Jian Pei, “Data Mining Concepts and Techniques”, 3rd Edition, Elsevier, 2023.
Reference Books:	
1	Nathan Marz and James Warren, “Big Data: Principles and Best Practices of Scalable Real-Time Data Systems”, 1st Edition, Manning Publications, 2022.
2	Pramod J. Sadalage and Martin Fowler, *NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence*, 1st Edition, Addison-Wesley, 2023.
3	Pramod J. Sadalage and Martin Fowler, “NoSQL Distilled”, 1st Edition, Addison-Wesley 2012.
Web References:	
1	https://citationsy.com/styles/big-data-analytics
2	https://link.springer.com/chapter/10.1007/978-3-030-68176-0_6
Online Resources:	
1	https://www.niit.com/india/working-professionals/data-analytics
2	https://www.udemy.com/topic/big-data/

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	2	1		2							2	2	2	1
C931.2	3	3	2	3	3				2			1	2	2	2
C931.3	3	3	2	3	3							1	3	3	2
C931.4	3	3	2	3	3							1	3	3	2
C931.5	3	3	3	3	3				2	2	2	2	3	3	3
C931	**3**	**3**	**3**	**3**	**3**				**2**	**2**	**2**	**2**	**3**	**3**	**3**

22CD931	SOCIAL NETWORK ANALYSIS	3/0/0/3

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

Course Objectives:

1.	To explore the concept of semantic web technologies.
2.	To illustrate the knowledge representation using ontology.
3.	To examine human behaviour in social web and related communities.
4.	To discuss visualization of social networks.

Course Outcomes:

Upon completion of the course, students shall have ability to

C931.1	Describe the concepts in semantic web and social network.	[U]
C931.2	Understand semantic web related applications.	[U]
C931.3	Discuss visualization of social networks.	[AP]
C931.4	Examine the methods used in community detection and mining	[AP]
C931.5	Extract human behaviour in social web and related communities.	[AN]
C931.6	Analyse different social network representations.	[AN]

Course Contents:

MODULE I Semantic Technology for Social Network Analysis **15 Hours**

Introduction to Social Network Analysis: Limitations of current Web – Development of Semantic Web – Emergence of the Social Web. **Social Network Analysis**: Key concepts and measures in network analysis –Electronic sources. **Ontology and their role in the Semantic Web:** Ontology-based knowledge Representation – Modelling and aggregating social network data – Ontological representation of social individuals and relationships – Aggregating and reasoning with social network data.

MODULE II Social Network Infrastructures and Communities **15 Hours**

Extracting Evolution of Web Community from a Series of Web Archive- Detecting communities in social networks –Applications of community mining algorithms – Tools for detecting communities –Understanding and predicting human behavior for social communities– User data management – Inference and Distribution – Enabling new human experiences – Reality mining – Context – Awareness. **Privacy in online social networks**: Trust in online environment – Trust models based on subjective logic – Trust network analysis – Trust transitivity analysis – Combining trust and reputation – Trust derivation based on trust comparisons.

MODULE III Visualization and Applications of Social Networks **15 Hours**

Graph theory – Centrality – Clustering – Node-Edge Diagrams- Matrix representation. **Visualizing online social networks**: Matrix-based representations– Matrix and Node-Link Diagrams – Hybrid representations. **Applications**: Covert networks – Community welfare – Collaboration networks – Co-Citation networks.

Total Hours:	**45**

Text Books:

1.	Peter Mika, “Social Networks and the Semantic Web”, First Edition, Springer 2007.
2.	Borko Furht, “Handbook of Social Network Technologies and Applications”, 1st Edition, Springer, 2010.

3.	Newman, M.E.J, “Networks: An Introduction”, First Edition, Oxford University Press. 2010.
Reference Books:	
1.	Guandong Xu, Yanchun Zhang and Lin Li, “Web Mining and Social Networking – Techniques and applications”, First Edition Springer, 2012.
2.	Dion Goh and Schubert Foo, “Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively”, IGI Global Snippet, 2008.
3.	Max Chevalier, Christine Julien and Chantal Soulé-Dupuy, “Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling”, IGI Global Snippet, 2009.
4.	John G. Breslin, Alexandre Passant and Stefan Decker, “The Social Semantic Web”, Springer, 2009.
Web References:	
1.	https://www.cl.cam.ac.uk/teaching/1415/L109/materials.html
2.	Types of Social Networks Analysis - GeeksforGeeks
Online Resources:	
1.	https://nptel.ac.in/courses/106106169
2.	https://www.coursera.org/learn/social-network-analysis

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	2	1		1							1	2	2	2
C931.2	3	2	1		1							1	2	2	2
C931.3	3	2	1		1							1	2	2	2
C931.4	3	2	1		1							1	2	2	2
C931.5	3	2	1		1							1	2	2	2
C931.6	3	2	1		1							1	2	2	2

22CY931	EXPLORATORY DATA ANALYTICS	3/0/0/3
Nature of Course:	D (Theory Application)	
Pre requisites:	Basic knowledge of programming, statistics, and data science concepts	

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.
4.	To outline an overview of exploratory data analysis.
5.	To implement data visualization using Matplotlib.

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

C931.1	Understand the fundamentals of exploratory data analysis.	[U]
C931.2	Implement the data Visualization using Matplotlib.	[AP]
C931.3	Perform univariate data exploration and analysis.	[AP]
C931.4	Perform bivariate data exploration and analysis.	[AP]
C931.5	Use Data exploration and visualization techniques for multivariate and time series data.	[A]

Course Contents:

Module 1 **15 Hours**

EDA fundamentals – Understanding data science - Significance of EDA – Making sense of data – Comparing EDA with classical and Bayesian analysis – Software tools for EDA – Visual Aids for EDA – Data transformation techniques-merging database, reshaping, data cleaning, handling outliers, normalization, and encoding categorical data, Transformation techniques.

Module 2 **15 Hours**

Data Manipulation using Pandas – Pandas Objects – Data Indexing and Selection – Operating on Data – Handling Missing Data – Hierarchical Indexing – Combining datasets – Concat, Append, Merge and Join – Aggregation and grouping – Pivot Tables – Vectorized String Operations. UNIVARIATE ANALYSIS-Introduction to Single Variable: Distribution Variables – Numerical Summaries of Level and Spread – Scaling and Standardizing – Inequality.

Module 3 **15 Hours**

BIVARIATE ANALYSIS-Relationships between Two Variables – Percentage Tables – Analysis Contingency Tables – Handling Several Batches – Scatterplots and Resistant Lines. MULTIVARIATE AND TIME SERIES ANALYSIS - Introducing a Third Variable – Causal Explanations – Three-Variable Contingency Tables and Beyond – Fundamentals of TSA – Characteristics of time series data – Data Cleaning – Time-based indexing – Visualizing – Grouping – Resampling.

Total Hours	**45**

Text Books:

1	Suresh Kumar Mukhiya, Usman Ahmed, “Hands-On Exploratory Data Analysis with Python”, Packt Publishing, 2020.
2	Jake Vander Plas, “Python Data Science Handbook: Essential Tools for Working with Data”. First Edition, O Reilly, 2017.
3	Catherine Mars, Jane Elliott, “Exploring Data: An Introduction to Data Analysis for Social Scientists”, Wiley Publications, 2nd Edition, 2008.

Reference Books:

1	Eric Pimpler, Data Visualization and Exploration with R, GeoSpatial Training service, 2017.
2	Claus O. Wilke, “Fundamentals of Data Visualization”, O’reilly Publications, 2019.
3	Matthew O. Ward, Georges Grinstein, Daniel Keim, “Interactive Data Visualization: Foundations, Techniques, and Applications”, 2nd Edition, CRC press, 2015

Web References:

1	https://en.wikipedia.org/wiki/Exploratory_data_analysis
2	https://www.kaggle.com/code/ekami66/detailed-exploratory-data-analysis-with-python

3	https://www.manning.com/books/exploring-data-science

Online Resources:	
1	https://www.coursera.org/learn/python-for-data-visualization
2	https://www.udemy.com/course/exploratory-data-analysis-in-python/?couponCode=24T4MT90924A
3	https://onlinecourses.nptel.ac.in/noc21_cs69/preview

Course Outcomes (CO)	**Programme Outcomes (PO)**											**Programme Specific Outcomes (PSO)**		
	1	**2**	**3**	**4**	**5**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
C931.1	2	3	1	-	1	-	-	-	-	-	-	1	2	2
C931.2	1	2	2	-	2	-	-	-	-	-	-	2	1	1
C931.3	3	3	3	3	3	-	-	-	-	-	-	3	3	1
C931.4	1	1	2	-	1	-	-	-	-	-	-	1	1	1
C931.5	2	1	2	2	1	-	-	-	-	-	-	2	1	2

22CS902	DATA SCIENCE WITH PYTHON	3/0/0/3
Nature of Course	D (Programming)	
Prerequisites	Problem Solving using C++	
Course Objectives:		
1.	To understand the basics of Data science using python programming and OOPS functions	
2.	To have a basic understanding of the Numpy and Pandas tools for data manipulation process.	
3.	To develop a solution for real-time datasets using tools.	
4.	To gain knowledge on data analytics and data visualization.	
Course Outcomes		
Upon completion of the course, students shall have ability to		
C902.1	Describe the fundamental programming concepts such as variables, data types, and basic operations.	[U]
C902.2	Articulate the usage of fundamental data structures like lists, tuples, dictionaries, strings, and sets for efficient data manipulation.	[AP]
C902.3	Explain the concept of Data Manipulation using Numpy and Pandas by examples.	[AP]
C902.4	Apply data wrangling skills to real-world datasets.	[AP]
C902.5	Illustrate effective and aesthetically pleasing visualizations for the datasets.	[AP]

Course Contents:

Module I Introduction **15 Hours**

Introduction to Data Science- Problem solving using Python
, Data Types, Looping and conditional statements, Data structures of List-Tuple-Dictionary-String and Sets, OOPS-functions-class and objects-modules-inheritance-encapsulation-exception handling.

Module II Data Manipulation Using NumPy and Pandas **15 Hours**

Basics of NumPy Arrays: Introduction to numpy, creating numpy array, numpy manipulation, matrix in numpy, operations in numpy array, reshaping numpy array, indexing numpy array, arithmetic operations on numpy array, numpy and random data, sorting and searching in array, universal functions. Introducing Pandas Objects: pandas series, data frame, panel, basic functionalities, reading data from different files.

Module III Data Wrangling and Data Visualization **15 Hours**

Data Wrangling**:** Combining and Merging Datasets, Reshaping and Pivoting, Data Transformation, String Manipulation, Regular Expressions- Data Aggregation and Group Operations. Visualization in Python**:** Matplotlib package, Plotting Graphs, Adding Text, More Graph Types. Advanced data visualization using seaborn.

Total Hours-45

Text Books:

1.	Wes McKinny, “Python for Data Science”, O'Reilly Media, Inc.,3rd Edition, August 2022.
2.	David Amos, Dan Bader, Joanna Jablonski, Fletcher Heisler, “Python Basics : A practical introduction to Python3”, Real python Publication, Fourth Edition, 2021.
3.	Cole Nussbaumer Knaflic, “Story Telling with Data : A data visualization guide for business professionals”, Wiley Publications, 2015.

Reference Books:	
1.	Eric Matthes, “Python Crash Course: A Hands-On, Project-Based Introduction to Programming”, No Starch Press, 2nd Edition, 2019.
2.	Al Sweigart “Automate the Boring Stuff With Python: Practical Programming for Total Beginners ”, No Starch Press, 2015.
Web References:	
1.	https://realpython.com/python-web-applications/
2.	https://www.python.org/about/gettingstarted/
3.	https://www.programiz.com/python-programming
4.	https://www.datacamp.com/community/tutorials/python-statistics-data-science
Online Resources:	
1.	https://www.udemy.com/course/python-complete-course-for-beginners/
2.	https://www.simplilearn.com/learn-python-basics-free-course-skillup
3.	https://www.learnpython.org/

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										1	1		2
C902.2	3	3	1		2							1	1		2
C902.3	3	3	1	3	2							1	2		2
C902.4	2	3	1	2	2							2	2	2	2
C902.5	3	1	3		3				2			2	2	2	2
C902	**3**	**3**	**3**	**3**	**2**				**2**			**2**	**2**	**2**	**2**

22IT922	DATA MINING	3/0/0/3
Nature of Course	D (Theory Application)	
Pre requisites	Nil	

Course Objectives:

1.	To learn the fundamentals of data warehousing and mining.
2.	To acquire knowledge in data pre-processing and association rule mining.
3.	To perform data classification and clustering.
4.	To gain knowledge about the emerging trends in data mining.
5.	To perform classification and prediction of data.

Course Outcomes

Upon completion of the course, students shall have ability to

C922.1	Understand basics of data warehousing and mining.	[U]
C922.2	Perform data pre-processing.	[AP]
C922.3	Apply association, classification and clustering methods.	[AP]
C922.4	Compare between classification and clustering solutions.	[AP]
C922.5	Analyze data mining techniques for real world problems.	[A]
C922.6	Apply association rule mining techniques for data analysis.	[AP]

Course Contents:

Data Warehousing and Online Analytical Processing: 15 Hours

Basic Concepts, Warehouse Modeling, Schemas, Data cube, Multidimensional data model, Concept hierarchy, Dimension, Measures, OLAP operations, Starnet query model, Data warehouse design process, Data cube computation, OLAP Indexing, OLAP server architectures, OLAP and OLTP.

Introduction to Data Mining: 15 Hours

Describe data mining, Related technologies - Machine Learning, Statistics, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, and Applications. **Data preprocessing**: Experiments with H2O and Orange tools. **Data mining knowledge representation**: Task relevant data, Background knowledge, Representing input data and output knowledge, Visualization techniques. **Attribute-oriented analysis**: Attribute generalization, Attribute relevance, Class comparison, Statistical measures.

Data Mining Algorithms: 15 Hours

Association rule mining: Apriori, FP Growth algorithms. Classification: Inferring rudimentary rules: 1R algorithm, Decision trees, covering rules. Prediction: The prediction task, Bayesian classification, Bayesian networks, Instance-based methods (nearest neighbor), Linear models. Descriptive analytics: Data Modeling, Trend Analysis, Simple Linear Regression Analysis. Clustering: Partitioning methods and Hierarchical methods.

Total Hours	**45**

Text Books:

1.	Jiawei Han, Jian Pei and Hanghang Tong, “Data Mining Concepts and Techniques”, 4th Edition, Elsevier, 2022
2.	Pang-Ning Tan, Michael Steinbach, Anuj Karpatne, Vipin Kumar, “Introduction to Data Mining”, 2nd Edition, Pearson Education, 2021.

Reference Books:	
1.	M. Kantardzic, “Data Mining: Concepts, Models, Methods, and Algorithms”, 3rd Edition, Wiley-IEEE Press, 2019.
2.	Alex Berson, Stephen J Smith, “Data Warehousing, Data Mining, & OLAP”, Tata McGraw-Hill Education, 2017.
3.	K.P. Soman, Shyam Diwakar and V. Ajay, “Insight into Data mining Theory and Practice”, Eastern Economy Edition, Prentice Hall of India, 2014.
4.	Colleen McCue, “Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis”, Butterworth-Heinemann, 2007.
Web References:	
1.	https://www.kdnuggets.com/
2.	https://www.datasciencecentral.com/
3.	https://ocw.mit.edu/courses/sloan-school-of-management/15-062-data-mining-spring-2003/lecture-notes/
Online Resources:	
1.	https://onlinecourses.nptel.ac.in/noc21_cs06/preview
2.	https://www.edx.org/course/data-science-wrangling-2
3.	https://www.coursera.org/specializations/data-mining

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
C922.1	2	3	1		1								1	2	2
C922.2	1	2	2		2	2							2	1	1
C922.3	3	3	3	3	3	1							3	3	1
C922.4	1	1	2		1								1	1	1
C922.5	2	1	2	2	1	3							2	1	2
C922.6	1	2	2	3	3	3							2	2	3

Vertical 5-
Internet of Things and Smart Cities

22CS941	IOT Architecture and Framework	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Everything**

Course Objectives:

1	Study the fundamental concepts of Internet of Things, including Benefits, Enabling technologies.
2	Discuss layered Architecture and modules for IoT Applications.
3	Impart the knowledge of Embedded prototyping to develop a system.
4	Understand IoT Frameworks to apply in industrial IoT.
5	Introduce the concepts of data Analytics for IoT Applications.

Course Outcomes:

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

C941.1	Explain the architecture and core modules of IoT.	[AP]
C941.2	Develop IoT applications using embedded systems.	[AP]
C941.3	Illustrate the necessary IoT framework required for IoT application.	[AP]
C941.4	Apply data analytics for IoT applications.	[AP]
C941.5	Analyze Industrial IoT challenges in Industry 4.0	[AN]

Course Contents:

MODULE I IOT CONCEPTS, ENABLING TECHNOLOGIES AND ARCHITECTURE 15 Hours

Introduction – Definition and Characteristics of IoT – Benefits of IoT – Physical and Logical design of IoT – Enabling Technologies–Resource Management – Resource Partitioning – Computation Offloading - Identification and Resource/Service Discovery – IoT Levels. **ARCHITECTURE AND ITS CORE MODULES**: Reference architecture for IoT – SOA based & API oriented architecture – Four-layer architecture – Seven Layer architecture – fog computing – Open stack cloud architecture – Gateways, Edge Devices, Data acquisition systems, Cloud services.

MODULE II EMBEDDED PROTOTYPING OF IOT AND IOT FRAMEWORK 15 Hours

Overview of Raspberry Pi – General-Purpose Input/Outputs – Sensors with Raspberry Pi – Actuators with Raspberry Pi –Web Server with Raspberry Pi – Raspberry Pi as a Database Server – ESP8266 WiFi Module – Block Diagram, Features, applications. **IOT FRAMEWORK:** IoT Value Chain – IoT Platforms – Cisco, Salesforce, Azure IoT, Eclipse IoT, Thingworx, GE Predix, AWS IoT, Watson IoT, Kaa.

MODULE III INDUSTRIAL IOT AND DATA ANALYTICS 15 Hours

Introduction to Industrial Internet of Things & Industry 4.0 – IIoT Architecture – Applications and Challenges. **DATA ANALYTICS:** IoT Data Management – Analytics –Apache Hadoop–Programming Model, Job Execution, Hadoop Cluster. Case Studies – Smart Parking, Smart Irrigation Control, Air Pollution Monitoring.

Total Hours:	**45**

Text Books:

1	Arshdeep Bahga, Vijay Madisetti, “Internet of Things, A Hands-on-Approach”, 1st Edition, Universities press Pvt. Ltd., India, 2015.
2	Mayur Ramgir, “Internet of Things- Architecture, Implementation, and Security”, 1st Edition, Pearson Education,India, 2019.

Reference Books:

1	Rajkumar Buyya, Amir VahidDastjerdi, “Internet of Things: Principles and Paradigms”, 1st Edition, Elsevier, USA, 2016.

2	Dimitrios Serpanos, Marilyn Wolf, “Internet-of-things (IoT) systems: architectures, algorithms, methodologies”, 1st Edition, Springer, UK, 2017.
3	Charles Bell, “Beginning Sensor Networks with Arduino and Raspberry Pi” , 1st Edition, Apress Publishers, USA, 2013.
Web References:	
1	https://swayam.gov.in/nd1_noc20_cs24.
2	https://swayam.gov.in/nd2_arp19_ap52.
Online Resources:	
1	https://www.raspberrypi.org/
2	https://nurdspace.nl/images/e/e0/ESP8266_Specifications_English

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**
C941.1	3	2	2	-	-	2	-	-	-	-	-	2	3	2	2
C941.2	3	2	2	2	-	2	-	-	2	2	-	2	3	2	2
C941.3	3	2	2	2	-	-	-	-	2	2	-	2	3	1	2
C941.4	3	3	3	2	-	2	-	-	2	2	-	3	3	2	2
C941.5	3	3	3	2	2	2	-	-	2	2	-	3	3	2	2
C941	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**2**	**2**	**-**	**3**	**3**	**2**	**2**

22CS942	COMMUNICATION PROTOCOLS FOR IOT	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**NIL**

Course Objectives:

1	To explore the fundamental concepts of IoT protocols and standards.
2	To examine the IoT protocol standards in data link and networking layers
3	To assess the performance of different IoT protocols through open-source tools.
4	To describe the security issues of protocols in IoT.
5	

Course Outcomes:

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

C942.1	Describe the evolving communication standards for IoT	[U]
C942.2	Demonstrate and visualize the data link protocols for IoT.	[AP]
C942.3	Elucidate the network protocols and standards for IoT.	[AP]
C942.4	Analyze the importance of IoT Edge devices.	[A]
C942.5	Apply security mechanisms for IoT protocol security.	[AP]

Course Contents:

MODULE I EVOLVING IOT STANDARDS **15 Hours**

Overview and Approaches – IoT Ecosystem – Protocols for IoT- Structural Aspects- Key Technologies-Sensor Technology-RFID technology – CoAP – REST – ETSI M2M - LTE-A, – WirelessHART

MODULE II IOT PROTOCOLS **15 Hours**

Z-Wave - Bluetooth Low Energy - Zigbee Smart Energy - DASH7 – HomePlug - G.9959 -– LoRaWAN – Routing Protocols – RPL – CORPL – CARP - Encapsulation Protocols - 6LoWPAN- Session Layer Protocols – MQTT – SMQTT – XMPP – DDS.

MODULE IV IOT EDGE COMPUTING **15 Hours**

Edge Computing – Purpose and Definition– Edge Hardware Architectures – Operating System – Edge Platforms – Virtualisation – Containers – Use Cases – Ambient Computing – Synthetic Sensing.

Total Hours:	**45**

Text Books:

1	Geng, Hwaiyu. "Internet of Things and Data Analytics in the Cloud with Innovation and Sustainability." The Internet of Things & Data Analytics Handbook, 2017
2	Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri - "Internet of Things_ Architectures, Protocols and Standards", Wiley ,2018.

Reference Books:

1	Perry Lea, "IoT and Edge Computing for Architects_ Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security", 2nd Edition, Packt Publishing, 2020.
2	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014
3	Vijay Madisetti, Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2015
4	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Wiley Publications, 2013.

Web References:	
1	https://www.postscapes.com/internet-of-things-protocols/
2	https://www.edx.org/course/iot-networks-and-protocols
Online Resources:	
1	https://www.experfy.com/training/courses/iot-messaging-with-mqtt-coap
2	https://swayam.gov.in/nd2_arp19_ap52

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
C942.2	3	3	3	1	2	2						2	3	2	2
C942.3	3	3	3	1	2	2						2	3	2	2
C942.4	3	3	3	1	2	2						3	3	2	2
C942.5	3	3	3	1	2	2						3	3	2	3
C942	**3**	**3**	**3**	**1**	**2**	**2**						**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS943	Cloud Services for IOT	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Things**

Course Objectives:

1	To Understand the fundamental concepts of the cloud architecture and its services.
2	To illustrate the various sensors and their cloud interfaces.
3	To learn the cloud platforms of IoT services.
4	To gain awareness on various cloud service management functionalities for IoT.
5	To familiarize the security issues in IoT applications.

Course Outcomes:

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

C943.1	Build an appropriate cloud architecture and identify the cloud services.	[AP]
C943.2	Depict various IoT sensors and actuators and facilitate cloud interfaces.	[AP]
C943.3	Formulate IoT applications using open source cloud platforms.	[AP]
C943.4	Discover the Integration of IoT applications into the cloud services.	[AP]
C943.5	Produce robust solutions for the security issues in IoT applications and networks	[AP]

Course Contents:

MODULE I CLOUD PLATFORM ARCHITECTURE AND SERVICES 15 Hours

Cloud computing and service models: Public, Private and Hybrid clouds-Infrastructure as a service (IaaS)-Platfrom as a service (PaaS)-Software as a service (SaaS) - Architectural design of compute and storage clouds: Layered cloud architectural development - Architectural design challenges. Case Study: Setup a cloud platform to log the data

MODULE II CLOUD INTERFACE AND PLATFORMS FOR IOT 15 Hours

CLOUD INTERFACE : AWS IoT, Azure IoT, Google Cloud IoT, and Apache Kafka Cloud - Setting up IoT devices on cloud platforms - IoTcloud interactions: MQTT, CoAP, HTTP - Utilizing cloud storage for IoT-generated data. **CLOUD PLATFORMS**: Thinkspeak IoT Cloud Platform, Kaa Open Source Iot Cloud Platform, AWS IoT Cloud Platform –AWS IoT Device SDK. Arduino AWS IoT development. Raspberry Pi 3-AWS IoT development.

MODULE III CLOUD SERVICE MANAGEMENT, SECURITY AND APPLICATIONS 15 Hours

Service management in cloud computing - Service Level Agreements (SLAs), Managing IoT data – Looking at Data, Scalability & cloud services, Database & data stores in cloud, Large scale data processing. Safety and vulnerability in cloud network- IoT Security and Privacy Preservation - Security and challenges in mobile cloud computing- Fog computing characteristics in IoT security.

Total Hours:	**45**

Text Books:

1	Kai Hwang, Geoffrey C Fox, Jack G Dongarra, “Distributed and Cloud Computing, From parallel processing to the Internet of Things”, Morgan Kaufmann Publishers, 2012.
2	Raj Kamal, “Internet of Things: Architecture and Design Principles”, McGraw-Hill Education Pvt. Ltd., 2018.
3	Charalampos Doukas, “Building Internet of Things with the Arduino”, Create Space, April 2002.
4	Agus Kurniawan “Learning AWS IoT”, Packt Publishing (January 29, 2018)

Reference Books:

1	Dac-Nhuong Le , Chintan Bhatt , Mani Madhukar “Security Designs for the Cloud, IoT, and Social Networking” John Wiley & Sons (11 October 2019)

2	Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2013.
3	Marco Schwatrz, “Internet of Things with Arduino Cookbook”, Packt Publications, 2016.
4	Rajkumar Buyya, Christian Vecchiola. S.Thamarai Selvi, “Mastering Cloud Computing”, McGraw Hill Education, 2013.
5	Nick Antonopoulos and Lee Gillam, “Cloud Computing: Principles, Systems and Applications”, Second Edition, Springer, 2017.
Web References:	
1	https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/
2	https://aws.amazon.com/iot/
3	http://postscapes.com/projects
4	http://www.theinternetofthings.eu/what-is-the-internet-of-things
5	https://www.theinternetofthings.eu/digital-world-iot
6	https://cloud.google.com/solutions/iot PAGE 307
7	https://swayam.gov.in/nd1_noc20_cs20

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	2	3	1	2	2	-	-	2	-	-	2	3	2	2
C943.2	3	3	3	1	2	2	-	-	1	-	-	2	3	2	2
C943.3	3	3	3	2	1	3	2	-	2	-	-	2	3	2	2
C943.4	3	3	3	1	2	2	-	-	2	-	-	3	3	2	2
C943.5	3	3	3	2	2	3	2	-	2	-	-	3	3	2	3
C943	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**-**	**2**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS944	IoT for Healthcare	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Things**

Course Objectives:

1	Estimate the different levels of IoT and templates for deployment.
2	Explore the connectivity of sensors and actuators in IoT for WBAN.
3	Interpret routing protocols used in medical IoT devices.
4	Design and develop location based IoT healthcare solutions.
5	Employ real world applications of IoT in healthcare.

Course Outcomes:

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

C944.1	Illustrate the various designs of IoT.	[AP]
C944.2	Determine the enabling technologies of IoT.	[AP]
C944.3	Articulate big data analytics in Medical IoT devices.	[AP]
C944.4	Interpret mobility in location based IoT systems.	[AP]
C944.5	Evaluate the performance of IoT applications in healthcare.	[A]

Course Contents:

MODULE I INTRODUCTION TO IOT **15 Hours**

Introduction to IoT – Physical design of IoT – Logical design of IoT – IoT enabling technologies – IoT levels and deployment templates – Cloud computing – Deployment models – Service models – Service management – Cloud security – Communication protocols – CoAP – MQTT.

MODULE II BIG DATA AND WBAN IN IOT **15 Hours**

IoT in Healthcare – Challenges in current healthcare systems – IoT healthcare services – Big data in IoT – Architecture of apache flume and spark – Wireless Body Area Networks (WBAN) Routing Protocols – Medium access control – Issues of WBAN.

MODULE III DOMAIN SPECIFIC IOTs **15 Hours**

Wearable sensor network for remote health monitoring – IoT based location aware smart healthcare framework – Analysis of recovery of mobility through inertial navigation techniques and virtual reality – Case Studies - Control and remote monitoring of muscle activity and simulation in the rehabilitation process.

Total Hours:	**45**

Text Books:

1	Valentina Emilia Balas and Souvik Pal, Healthcare Paradigms in the Internet of Things Ecosystem, Academic Press, 2021.
2	Arsheep Bahga and Vijay Madisetti, Internet of Things: A Hands-on Approach, Universities Press, 2015.
3	Rajkumar Buyya and Amir Vahid Dastjerdi, Internet of Things Principles and Paradigms, Elsevier Inc, 2016.

Reference Books:

1	Piyush Kumar Shukla, Aditya Patel, Prashant Kumar Shukla, Prashant Parashar, Basant Tiwari, - IoT in Healthcare Systems Applications, Benefits, Challenges, and Case Studies, CRC Press, 2024.
2	Rahul K. Kher, Chirag Paunwala, Falgun Thakkar, Heena Kher, Mita Paunwala, Prasan Kumar Sahoo, Larif Ladid, - IoT Applications for Healthcare Systems, Springer, 2022.

3	Shashank Awasthi, Mahaveer Singh Naruka, Satya Prakash Yadav, Victor Hugo C. de Albuquerque, - AI and IoT-based Intelligent Health Care & Sanitation, Bentham books, 2023.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc22_cs53/preview
2	https://iotdunia.com/iot-tutorial-videos/

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	3	3	3	1	-	-	-	-	-	2	3	2	2
C944.2	3	3	3	3	3	1	-	-	-	-	-	2	3	2	2
C944.3	3	3	3	-	3	-	-	-	-	-	-	2	3	1	2
C944.4	3	3	3	3	3	1	-	-	-	-	-	3	3	2	2
C944.5	3	3	3	3	3	1	-	-	-	-	-	3	3	2	3
C944	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS945	Intelligent Transport Systems	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	-

Course Objectives:

1	To introduce the fundamentals and architecture of Intelligent Transportation Systems (ITS).
2	To explore the challenges and opportunities of implementing ITS
3	To study the application of ITS technologies in public transport and safety for vulnerable road users.
4	To familiarize students with ITS standards, specifications, and their global practices.
5	To examine the role of ITS in smart city development and its impact on urban transportation systems.

Course Outcomes:

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

C945.1	Explain the core principles and structural design of Intelligent Transportation Systems (ITS)	[U]
C945.2	Examine the role and architecture of ITS in addressing transportation challenges.	[AP]
C945.3	Illustrate the application of ITS technologies for enhancing public transport operations.	[AP]
C945.4	Employ the safety requirements for vulnerable road users and the role of ITS in enforcing traffic rules.	[AP]
C945.5	Analyze the Smart city scenario and Apply ITS standards and technologies to develop solutions for smart city transportation systems in developing countries	[A]

Course Contents:

MODULE I ITS FUNDAMENTALS AND ARCHITECTURE

ITS Fundamentals: Introduction to Intelligent Transportation Systems (ITS) – Historical Background – Transport System Characteristics – Transport Problems and Issues – Functions of ITS Components – Importance of ITS Architecture – Challenges and Opportunities in ITS – Role and Importance of ITS in Context of Indian Transport System. **ITS Architecture:** Functionalities Required for User Service - Logical Architecture – Physical Architecture – Organisational Architecture -Equipment Packages – Market Package.

MODULE II ITS for Public Transport and Vulnerable Road Users

ITS for Public Transport: Introduction – ITS operations for Public Transport – Transport Integrated Management Solutions – Best Practices in Public Transport – Advanced Vehicle Control and Safety Systems – Emergency Management – Transport Demand Management – Application of ITS forTransport Demand Management. **Vulnerable Road Users (VRU):** Introduction - Need for VRU's Safety – ITS Technologies for VRU's – ITS Technologies to enforce Traffic Rules – Detection of Violations.

MODULE III ITS Standards and ITS for Smart Cities

ITS Standards and specifications: ISO – ETSI – ITS Standardisation Committee, Japan, ITS Joint Programme Office, US, ATCS – RLVD – Speed Violation Detection System - ANPR – AVLS – PIS **ITS for Smart Cities**: Introduction – Strategies and Approaches to Smart City – Smart Cities Mission Statement and Guidelines - ITS Solutions for Smart Cities – ITS technologies for Smart City. **Case Studies:** Dubin, Ireland– ITS in Japan - London, UK - Delhi Transport Corporation, India - Mysore, India.

Total Hours:	**45**

Text Books:

1	Pradip Kumar Sarkar, Amit Kumar Jain, “Intelligent Transport Systems”, Paperback, PHI Learning, 2018.
Reference Books:	
1	Paolo Baggano,“Intelligent transport Systems Good practices to standards”, CRC press,2016.
2	Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva,Ignacio Julio García Zuazola, “Intelligent Transport Systems: Technologies and Applications”, John Wiley & Sons, Ltd., 2015.
3	Amit Kumar Tyagi, Niladhuri Sreenath, “Intelligent Transportation Systems: Theory and Practice”, Springer Singapore, 2023.
Web References:	
1	https://www.its.dot.gov/research_archives/arch/index.htm
2	https://www.its.leeds.ac.uk/projects/konsult/private/level2/instruments/instrument024/l2_024f.htm
Online Resources:	
1	https://www.udemy.com/course/cooperative-intelligent-transportation-systems-cits-its/
2	https://coeut.iitm.ac.in/ITS_synthesis.pdf

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	2	2	3	2	2					2		2	2		2
C945.2	1	2	2	2	2					3		2	3		3
C945.3	2	2	3	2	2					2		2	2		2
C945.4	2	2	2	2	2					2		3	3		2
C945.5	2	3	3	2	2					2		3	2		2
C945	**2**	**2**	**3**	**2**	**2**					**2**		**3**	**2**		**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS946	IOT for Smart Cities and Buildings	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Things**

Course Objectives:

1	To Understand the fundamental Concepts of Internet of Things.
2	To learn IoT Architecture and Terminologies.
3	To acquire knowledge on IoT working platform for different system.
4	To gain awareness on various IoT standards for smart city planning.
5	To familiarize IoT applications on different sectors.

Course Outcomes:

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

C946.1	Explain the different concepts and theories of Internet of Things.	[U]
C946.2	Assess the various components of IoT architecture.	[U]
C946.3	Perform the IoT applications in programming platform.	[AP]
C946.4	Adopt the IoT standards for smart city planning.	[AP]
C946.5	Apply the understandings of IoT in different sectors of smart city planning.	[AP]

Course Contents:

MODULE I INTRODUCTION TO IOT AND ARCHITECTURE 15 Hours

Overview and Introduction - Internet of Things (IoT) - Web of Things (WoT) - Cloud of Things - Need for IoT on Cloud - Services in the Cloud for the Internet of Things - Applications of IoT – Detailed Domain Model. **IOT ARCHITECTURE**: IoT Architecture - Sensor Layer - Gateway and Network Layer - Management Service Layer - Application Layer - IoT Enabling Technologies - Addressing Schemes - Data Storage and Analytics – Visualization - Connected Domains – Connected Home -Connected Worker - Connected Automobile - Connected Industry.

MODULE II IOT PLATFORMS DESIGN METHODOLOGY 15 Hours

IoT Systems – Intel IoT Framework - Qualcomm IoT Framework - Microsoft IoT Framework - ARM IoT Framework - Logical Design - Programming IoT platform (eg: Python, Mono C# , Objective-C, Ruby), Raspberry Pi - Program for Firmware – Case Studies.

MODULE III IOT STANDARDS AND APPLICATIONS 15 Hours

IOT STANDARDS: Need for the IOT standards - IOT and Smart City Standards and Policies: Global perspective – Policy Research and Standardization in Europe – Indian Standards formulation – Sectional committee and composition – Challenges in standardization - Digital infrastructure. **IOT APPLICATIONS:** Lighting as service – Smart Parking -Smart metering – Smart water management- Smart energy– Smart solid waste management - Smart mobility – Smart governance- Challenges in IoT Management.

Total Hours:	**45**

Text Books:

1	Olivier Hersent, David Boswarthick and Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, Second Edition, Wiley Publisher, 2012.
2	Uckelmann, Dieter, Mark Harrison, and Florian Michahelles, “Architecting the Internet of Things”. Springer Science & Business Media, 2011.
3	Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-on Approach”, 2014.

Reference Books:

1	Doukas, Charalampos, Building internet of things with the Arduino, CreateSpace Independent Publishing Platform, 2012.

2	Lu, Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning. “The Internet of Things: From RFID to the NextGeneration Pervasive Networked Systems”, CRC Press.
3	Massimo Banzi, “Getting Started with Arduino (Make: Projects)”, O'Reilly Media. 2008.
4	Samuel Greengard, “The Internet of Things (The MIT Press Essential Knowledge series)”, MIT Press, 2015.
Web References:	
1	https://iot.electronicsforu.com/content/tech-trends/smartindia-iot-future.
2	https://meity.gov.in/sites/upload_files/dit/files/Draft-IoT-Policy%20%281%29.pdf.
3	https://www.scnsoft.com/blog/iot-for-smart-city-use-cases-approaches-outcomes

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	1	1	2	-	-	2	-	-	2	3	2	2
C946.2	3	3	3	1	2	2	-	-	1	-	-	2	3	2	2
C946.3	3	3	3	2	2	3	2	-	2	-	-	2	3	2	2
C946.4	3	3	3	3	3	3	2	-	2	-	-	3	3	3	2
C946.5	3	3	3	2	3	3	2	-	2	-	-	3	3	3	3
C946	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**3**	**3**	**3**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS947	Industrial IoT	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Everything**

Course Objectives:

1	Understand the fundamental concepts of IIOT, technical aspects.
2	Study and understand IIOT Architecture with its topology.
3	Explore the difference between networks and architectures of IIoT
4	Investigate the predictive analysis used in Industrial IoT.
5	Identify automation tools applied for manufacturing process

Course Outcomes:

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

C947.1	Illustrate technical aspects and architecture of Industrial Internet of Things.	[AP]
C947.2	Discover product representation for developing smart design.	[AP]
C947.3	Analyse various network technologies with respect to IIOT.	[AN]
C947.4	Evaluate the predictive analytics involved in intelligent manufacturing.	[AP]
C947.5	Apply the automation tools required in manufacturing process	[AP]

Course Contents:

MODULE I INDUSTRY 4.0 AND IIOT TECHNICAL ASPECTS 15 Hours

Introduction to Industry revolution- Evolution of Industry 1.0 to Industry 5.0-IIOT-Power of 1%- Key IoT technologies- Cobots, Human Factors involved- Innovation in IIoT intelligent devices- Challenges and benefits of Industry 5.0-IIoT applications – health care, Oil and Gas Industry, Smart Office, Logistics. **IIOT TECHNICAL ASPECTS:** Miniaturization-Cyber Physical Systems (CPS)-Wireless technology-IP technology-Network Functional Virtualization (NFV)- Network Virtualization (NV)- Software-defined network (SDN)- NFV vs SDN- smart phones- cloud and fog- big data analytics- M2M learning and AI- Augmented Reality and Virtual Reality- 3D Printing- People vs Automation.

MODULE II IIOT ARCHITECTURE AND SMART DESIGN 15 Hours

IIC reference architecture- Industrial Internet Architecture Framework (IIAF)- Implementation-architecture topology- Three–tier topology: edge tier, platform tier, enterprise tier, gateway mediated edge, connectivity, key system characteristics, data management. **SMART DESIGN:** Introduction - Smart Design - Digital Tools, Product representation and exchange technologies and standards, Agile (Additive) Manufacturing Systems and standards.

MODULE III INTELLIGENT MANUFACTURING AND SMART MACHINES 15 Hours

Introduction- Cloud manufacturing- IIoT enabled manufacturing- intelligent manufacturing- intelligent manufacturing platforms – GE predix, PTC thingworx, SIEMENS: smart factory- predictive analytics – Google Cloud ML platform, Microsoft Azure. **SMART MACHINES**: Mass customization, Smart Machine Tools, Robotics and Automation (perception, manipulation, mobility, autonomy) - Smart manufacturing systems - design & Analysis, planning & control.

Total Hours:	**45**

Text Books:

1	Uthayan Elangovan, “Industry 5.0: The Future of Industrial Economy”, 1st Edition, CRC Press, 2022.
2	Alasdar Gilchrist, “Industry 4.0: The Industrial Internet of Things”, 1st Edition, Apress, 2016

Reference Books:

1	Jeschke S., Brecher C., Song H., and Rawat D. B., “Industrial Internet of Things Cyber manufacturing Systems”, Springer, 1st Edition, 2017.
2	Tao F., Zhang M., and Nee A. Y. C., “Digital Twin Driven Smart Manufacturing”, Academic

	Press, 1st Edition, 2019
3	M. Kuniavsky, “Smart Things: Ubiquitous Computing User Experience Design”, Morgan Kaufmann, 1st Edition, 2010.
4	A. McEwen and H. Cassimally, “Designing the Internet of Things”, Wiley, 1st Edition, 2013
Web References:	
1	https://www.coursera.org/learn/industrial-internet-of-things
2	https://onlinecourses.nptel.ac.in/noc20_cs69/preview

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	2	2	-	-	3	2	2	-	-	-	3	2	2	2
C947.2	3	2	2	-	2	3	2	2	-	-	-	3	3	2	2
C947.3	3	2	2	-	-	3	2	2	-	-	-	3	2	2	2
C947.4	3	2	2	2	2	3	2	2	-	-	-	3	3	2	2
C947.5	3	2	2	2	2	3	2	2	-	-	-	3	3	2	2
C947	**3**	**2**	**2**	2	2	**3**	**2**	**2**	**-**	**-**	**-**	**3**	**3**	**2**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS948	IOT for Smart Grids	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Internet of Things**

Course Objectives:

1	Interpret the priority areas of smart grid.
2	Employ advanced metering infrastructure for an IoT smart grid device.
3	Illustrate the smart grid designs and renewable integration.
4	Design and develop static and dynamic optimization techniques.
5	Employ real world applications of IoT in smart grid.

Course Outcomes:

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

C948.1	Determine smart-grid activities in India.	[AP]
C948.2	Illustrate IP based systems for smart grid.	[AP]
C948.3	Discover supervisory control and data acquisition system.	[AP]
C948.4	Evaluate energy management in smart grid.	[AP]
C948.5	Examine the tools and techniques for smart grid.	[A]

Course Contents:

MODULE I INTRODUCTION TO SMART GRID **15 Hours**

Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India.

MODULE II SMART GRID ARCHITECTURE **15 Hours**

Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration.

MODULE III TOOLS AND TECHNIQUES FOR SMART GRID **15 Hours**

Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in power system – Artificial Intelligence techniques and applications in power system.

Total Hours:	**45**

Text Books:

1	S. Borlase, - Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013, 1st Edition.
2	P. Sanjeevikumar, Rajesh Kumar Dhanaraj, Malathy Sathyamoorthy, Jens Bo Holm-Nielsen, Balamurugan Balusamy, - Smart Grids and Internet of Things: An Energy Perspective, Wiley 2023.
3	S.K.Salman, - Introduction to the Smart Grid: Concepts, Technologies and Evolution, IET Energy Engineering Series, 2017, 1st Edition.

Reference Books:

1	O.V. Gnana Swathika, K. Karthikeyan, Sanjeevikumar Padmanaban, - IoT and Analytics in Renewable Energy Systems, CRC Press, 2023.
2	Ersan Kabalci, Yasin Kabalci, - From Smart Grid to Internet of Energy, Academic Press, 2020.
3	J. Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley-IEEE Press, 2015, 1st Edition.

Web References:	
1	https://onlinecourses.nptel.ac.in/noc23_ee60/preview
2	https://iotdunia.com/iot-tutorial-videos/
3	https://www.coursera.org/learn/energy-management-for-iot-devices

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	3	3	3	3	3	1	-	-	-	-	-	2	3	2	2
C948.2	3	3	3	3	3	1	-	-	-	-	-	2	3	2	2
C948.3	3	3	3	-	3	-	-	-	-	-	-	2	3	1	2
C948.4	3	3	3	3	3	1	-	-	-	-	-	3	3	2	2
C948.5	3	3	3	3	3	1	-	-	-	-	-	3	3	2	3
C948	**3**	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

22CS949	BIG DATA ANALYTICS FOR IOT	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**NIL**

Course Objectives:

1	To gain exposure to the significance of Big data analytics for IoT
2	To get familiarity on IoT semantics and big data streaming analytics.
3	To be aware with the strategies for processing IoT data through data analytics
4	To identify suitable applications that makes use of multimedia Big Data and IoT
5	To implement smart systems using Big Data and IoT

Course Outcomes:

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

C949.1	Integrate big data and IoT for IoT analytics	[U]
C949.2	Extract semantics by processing IoT real-time and linked stream data	[AP]
C949.3	Process and handle IoT Big data using Apache Hadoop	[AP]
C949.4	Perform analytics with multimedia Big Data and IoT	[AP]
C949.5	Design and implement smart IoT systems with big data.	[AP]

Course Contents:

MODULE I BIG DATA INTEGRATION FOR IOT ANALYTICS 15 Hours

IoT data and Big data – Challenges of IoT analytics applications – IoT analytics life cycle and techniques –Searching the Internet of Things: Search Architecture for Social and Physical Sensors - Local Event Retrieval - Using Sensor Metadata Streams to Identify Topics of Local Events in the City – Venue Recommendation

MODULE II DATA STREAMING ANALYTICS AND PROCESSING OF IOT BIG DATA 15 Hours

Linking data - Real-time & Linked Stream Processing - Semantic-based Distributed Reasoning - Cross-Domain Recommender Systems - Semantic Analytics - Semantic Modelling and Validation Tools - Data Reasoning - Ethical IoT- Stream processing for handling real-time IoT data - Big data processing frameworks: Apache Hadoop, Apache Spark, Hive, and Vertica. Data stream processing using machine learning.

MODULE III MULTIMEDIA BIGDATA COMPUTING FOR IOT AND CASE STUDY 15 Hours

Characteristics of Multimedia Bigdata – Multimedia Big Data Life Cycle - Processing and analysing images and videos from IoT devices – Processing methods for speech and audio data in IoT environments - Integration of data from multiple modalities in IoT- Precision Agriculture and optimized farming - Health monitoring and personalized medicine – Predictive maintenance in industries.

Total Hours:	**45**

Text Books:

1	John Soldatos, “Building Blocks for IoT Analytics”, River Publishers Series In Signal, Image and Speech Processing, 2017
2	Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, “Multimedia Big Data Computing for IoT Applications: Concepts, Paradigms and Solutions”, Springer, 2020

Reference Books:

1	Valentina E. Balas, Vijender Kumar Solanki, Raghvendra Kumar, ManjuKhari, “Internet of Things and Big Data Analytics for Smart Generation”, Volume 154.
2	Stackowiak, R., Licht, A., Mantha, V., Nagode, L.,” Big Data and The Internet of Things Enterprise Information Architecture for A New Age”, Apress, 2015.
3	Andrew Minteer, “Analytics for the Internet of Things (IoT): Intelligent analytics for your

	intelligent devices", Packt Publishing, first edition, July 2017.
4	Nilanjan Dey, Aboul Ella Hassanien, Chintan Bhatt, Amira S. Ashour, Suresh Chandra Satapathy, "Internet of Things and Big Data Analytics Toward Next-Generation Intelligence", Springer International Publishing, 2018.
Web References:	
1	https://data-flair.training/blogs/data-analytics-tutorial/
2	https://www.edureka.co/blog/iot-tutorial/
Online Resources:	
1	https://www.sas.com/en_us/insights/analytics/big-data-analytics.html
2	https://swayam.gov.in/nd1_noc20_cs92

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
C949.2	3	3	3	1	2	2						2	3	2	2
C949.3	3	3	3	1	2	2						2	3	2	2
C949.4	3	3	3	1	2	2						3	3	2	2
C949.5	3	3	3	1	2	2						3	3	2	3
C949	**3**	**3**	**3**	**1**	**2**	**2**						**3**	**3**	**2**	**3**

Vertical 6-

Machine Learning

22CS951	Computer Vision	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	Image Processing

Course Objectives:

1	Understand the fundamental concepts related to Image formation and processing.
2	Learn feature detection, matching and detection.
3	Familiar with feature-based alignment and motion estimation.
4	Develop skills on 3D reconstruction.
5	Understand image-based rendering and recognition.

Course Outcomes:

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

C951.1	Apply low level processing of image and transformation techniques to images.	[AP]
C951.2	Demonstrate the use of feature extraction, segmentation, and object recognition methods in various computer vision applications.	[AP]
C951.3	Apply 2D a feature-based based image alignment, segmentation and motion estimations.	[AP]
C951.4	Apply 3D image reconstruction techniques.	[AP]
C951.5	Design and develop innovative image processing and computer vision applications.	[AP]

Course Contents:

MODULE I IMAGE FORMATION, PROCESSING AND FEATURE DETECTION

IMAGE FORMATION AND PROCESSING: Computer Vision - Geometric primitives and transformations - Photometric image formation – The digital camera - Point operators - Linear filtering - More neighborhood operators – Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization. **FEATURE DETECTION, MATCHING AND SEGMENTATION:** Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.

MODULE II ALIGNMENT, MOTION ESTIMATION AND 3D RECONSTRUCTION

ALIGNEMENT AND MOTION ESTIMATION :2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration -Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment – Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion – Optical flow - Layered motion. **3D RECONSTRUCTION:** Shape from X - Active range finding - Surface representations - Point-based representations Volumetric representations - Model-based reconstruction - Recovering texture maps and albedos.

MODULE III ADVANCED 3D RECONSTRUCTION, RENDERING, AND RECOGNITION

ADVANCED 3D RECONSTRUCTION: Multi-View Stereo and Photogrammetry - SLAM (Simultaneous Localization and Mapping). **RENDERING:** View interpolation Layered depth images - Light fields and Lumigraphs - Environment mattes - Video-based rendering. **RECOGNITION:** Object detection - Face recognition - Instance recognition – Category recognition - Context and scene understanding- Recognition databases and test sets. **Case studies** - Analysis of notable 3D reconstruction projects - Hands-on project: Building a simple 3D model using photogrammetry- Discussion of challenges and future trends in 3D reconstruction.

Total Hours:	**45**

Text Books:

1	Richard Szeliski, “Computer Vision: Algorithms and Applications”, Second Edition, Springer- Texts in Computer Science, 2022.
2	Adrian Rosebrock , "Deep Learning for Computer Vision with Python" , PyImageSearch, Second Edition, 2021.
3	Mark S. Nixon and Alberto S. Aguado,” Feature Extraction and Image Processing for Computer Vision”, Third Edition, Academic Press,2020.
4	D. A. Forsyth, J. Ponce, “Computer Vision: A Modern Approach”, Second Edition, Pearson Education, 2015.

Reference Books:

1	Jan Erik Solem,“Programming Computer Vision with Python: Tools and Techniques for Solving Real-World Computer Vision Problems", Second Edition, O'Reilly Media ,2020.

2	E. R. Davies, “Computer and Machine Vision”, Fourth Edition, Academic Press, 2012.
3	Richard Hartley and Andrew Zisserman,” Multiple View Geometry in Computer Vision”, Second Edition, Cambridge University Press, March 2004.
4	Christopher M. Bishop,” Pattern Recognition and Machine Learning”, First Eition,Springer, 2006
Web References:	
1	https://onlinecourses.nptel.ac.in/noc19_cs58/preview.
2	https://www.coursera.org/learn/computer-vision-basics
Online Resources:	
1	https://www.udacity.com/course/computer-vision-nanodegree--nd891
2	https://www.coursera.org/learn/computer-vision-basics

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	3	1	1	1	1	-	-	-	2	1	3	2	2	1	1
C951.2	3	3	3	2	3	-	1	-	2	1	2	2	3	1	2
C951.3	3	3	2	2	3	-	-	-	1	1	2	2	3	2	2
C951.4	2	3	3	2	3	-	-	-	2	1	2	3	2	2	3
C951.5	2	3	3	2	2	2	-	-	3	1	2	3	3	3	3
C951	**3**	**3**	**3**	**2**	**3**	**2**	**1**	**-**	**3**	**1**	**3**	**3**	**3**	**3**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS952	Feature Engineering	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**NIL**

Course Objectives:

1	Understanding the prelims of Feature Engineering
2	Understanding the various Processes of Feature Engineering
3	Understanding the various Feature Engineering Techniques
4	Apply various Feature Engineering model for real-world problems

Course Outcomes:

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

C952.1	Articulate different strategies for dealing with data	[AP]
C952.2	Infer feature selection and evaluation frameworks	[A]
C952.3	Develop the methods for Patten-Based Feature Engineering	[AP]
C952.4	Apply feature engineering model for a given real-world problem like Social Bot detection and Twitter-based platform	[AP]
C952.5	Identify applications suitable for software analytics with justification.	[AP]

Course Contents:

MODULE I OVERVIEW OF FEATURE ENGINEERING AND ITS DATA TYPES 15 Hours

Machine Learning Pipeline – **Simple Data Types**: Scalars, Vectors, and Spaces – Dealing with counts – Log Transformation – Feature Scaling or Normalization – Interaction Features – Feature Selection – **Text Data:** Bag-of-X – Filtering for Cleaner Features – Atoms of Meaning. **Visual Data:** Classical and Visual Feature Representation – Latent Feature Extraction – Deep Image Features

MODULE II GENERAL FEATURE ENGINEERING TECHNIQUES 15 Hours

Feature Selection and Evaluation: Feature Selection Frameworks – Advanced Topics for Feature Selection. **Pattern-based Feature Engineering:** Preliminaries – Framework of Pattern-based Feature Generation – Pattern Mining Algorithms – Pattern Selection Approaches – Pattern-based Feature Generation - Pattern-based Feature Generation for Classification - Pattern-based Feature Generation for Clustering

MODULE III FEATURE ENGINEERING APPLICATIONS 15 Hours

Social Bot Detection: Introduction – Social Bot Detection – Online Bot Detection Framework. **Software Analytics:** Features for Defect Prediction – Features for Crash Release Prediction for Apps – Features from Mining Monthly Reports to Predict Developer Turnover. **Twitter-based Applications:** Data Present in a Tweet – Common Types of Features Used in Twitter-based Applications – Twitter Feature Engineering in Selected Twitter-based studies – Twitris: A real-time Social Media Analysis Platform.

Total Hours:	**45**

Text Books:

1	Alice Zheng and Amanda Casari, “Feature Engineering for Machine Learning – Principles and Techniques for Data Scientists”, O’Riley, 2018
2	Guozhu Dong and Huan Liu, “Feature Engineering for Machine Learning and Data Analytics”, CRC Press, 2018.
3	Sinan Ozdemir, “Feature Engineering Bookcamp”, Manning Publications, 2022

Reference Books:

1	Pablo Duboue, “The Art of Feature Engineering: Essentials for Machine Learning”, Cambridge University Printing House, 2020.

2	Max Kuhn, Kjell Johnson, “Feature Engineering and Selection: A Practical Approach for Predictive Models”, CRC Press, 2019
Web References:	
1	https://cgorale111.medium.com/feature-engineering-for-machine-learning-2a20acefcfd8
2	https://www.udemy.com/topic/feature-engineering/
3	https://www.datacamp.com/courses/feature-engineering-for-machine-learning-in-python
Online Resources:	
1	https://www.microsoft.com/en-us/research/uploads/prod/2019/09/NFS_ICDM_2019_camera_ready.pdf
2	https://pmworldlibrary.net/wp-content/uploads/2021/02/pmwj102-Feb2021-Budeli-Feature-engineering-and-AI-in-industrial-systems-programs2.pdf

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	3	3	3	1	2	2	-	-	-	-	-	2	3	2	2
C952.2	3	3	3	1	2	2	-	-	-	-	-	2	3	2	2
C952.3	3	3	3	-	-	-	-	-	-	-	-	2	3	-	2
C952.4	3	3	3	1	2	2	-	-	-	-	-	3	3	2	2
C952.5	3	3	3	1	2	2	-	-	-	-	-	3	3	2	3
C952	**3**	**3**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS953	Deep Neural Networks	3/0/0/3
Nature of Course	H (Theory Technology)	
Prerequisites	**Computational fundamentals of machine learning**	

Course Objectives:

1	To Understand the neural network concepts including single layer and multi-layer perceptron's, activation functions, and the representation power of MLPs.
2	To Learn about deep learning fundamentals, deep feedforward networks, and advanced optimization techniques such as Gradient Descent variants and Adam. Explore regularization techniques to enhance model performance.
3	To Acquire practical skills in designing and implementing CNNs and RNNs, understanding their architecture, and applying them to real-world datasets like MNIST for CNNs and text data for RNNs.
4	To Address common problems in training neural networks such as overfitting, vanishing and exploding gradients, and other computational challenges.
5	To learn and apply neural network models to complex problems in fields such as natural language processing and image recognition.

Course Outcomes:

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

C953.1	Illustrate the basic concepts of neural networks and its practical issues.	[AP]
C953.2	Outline the standard regularization and optimization techniques for deep neural networks	[U]
C953.3	Develop, optimize, and regularize deep learning models using advanced techniques and apply them to complex real-world problems.	[AP]
C953.4	Build CNN and RNN models for different use cases.	[AP]
C953.5	Explain the concepts of modern RNNs like LSTM, GRU	[U]

Course Contents:

MODULE I INTRODUCTION OF NEURAL NETWORKS

Introduction to neural networks -Single layer perceptrons, Multi Layer Perceptrons (MLPs), Representation Power of MLPs, Activation functions - Sigmoid, Tanh, ReLU, Softmax. Risk minimization, Loss function, Training MLPs with backpropagation, Practical issues in neural network training - The Problem of Overfitting, Vanishing and exploding gradient problems, Difficulties in convergence, Local and spurious Optima, Computational Challenges. Applications of neural networks.

MODULE II DEEP LEARNING

Introduction to deep learning, Deep feed forward network, Training deep models, Optimization techniques - Gradient Descent (GD), GD with momentum, Nesterov accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam. Regularization Techniques - L1 and L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout, Parameter initialization.

MODULE III CNN and RNN

Convolutional Neural Networks – Convolution operation, Motivation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of convolution functions, Structured outputs, Data types, Efficient convolution algorithms. Practical use cases for CNNs, Case study - Building CNN model AlexNet with handwritten digit dataset MNIST. Recurrent neural networks – Computational graphs, RNN design, encoder – decoder sequence to sequence architectures, deep recurrent networks, recursive neural networks, modern RNNs LSTM and GRU, Practical use cases for RNNs. Case study - Natural Language Processing.

Total Hours:	**45**

Text Books:

1	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2	Neural Networks and Deep Learning, Aggarwal, Charu C., c Springer International Publishing AG, part of Springer Nature 2018
3	Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms (1st. ed.). Nikhil Buduma and Nicholas Locascio. 2017. O'Reilly Media,

	Inc.
Reference Books:	
1	Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
2	Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3	Michael Nielsen, Neural Networks and Deep Learning, 2018
Web References:	
1	https://www.coursera.org/learn/neural-networks-deep-learning
2	https://cs231n.stanford.edu/
3	https://ocw.mit.edu/
Online Resources:	
1	https://neuralnetworksanddeeplearning.com/
2	https://www.udemy.com/course/the-complete-neural-networks-bootcamp-theory-applications/?couponCode=IND21PM

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	3	3	3	1	-	-	-	-	-	-	-	2	3	2	2
C953.2	3	3	3	1	-	-	-	-	-	-	-	2	3	2	2
C953.3	3	3	3	-	-	-	-	-	-	-	-	2	3	-	2
C953.4	3	3	3	1	-	-	-	-	-	-	-	3	3	2	2
C953.5	3	3	3	1	2	2	-	-	-	-	-	3	3	2	3
C953	**3**	**3**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS954	Optimization Techniques	3/0/0/3

Nature of Course	H (Theory Analytical)

Course Objectives:

1	To formulate and solve optimization problems using linear and non-linear programming techniques.
2	To understand and apply methods to optimize job sequencing and machine scheduling.
3	To explore decision-making tools for various scenarios, including certainty, uncertainty, and risk.
4	To gain insights into competitive strategies through the study of game theory.
5	To develop skills in project scheduling, including network planning and critical path analysis.

Course Outcomes:

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

C954.1	Illustrate the fundamental concepts of linear and non-linear programming, including the formulation of LPP and NLPP.	[AP]
C954.2	Interpret graphical methods to solve linear programming problems and address special cases like multiple solutions and infeasibility.	[AP]
C954.3	Construct sequencing models for job processing and make decisions using decision theory under different conditions.	[AP]
C954.4	Choose game theory models and strategies to solve competitive situations and assess their practical limitations.	[AP]
C954.5	Categorize optimized project schedules using PERT/CPM techniques for effective time-cost management in complex projects.	[A]

Course Contents:

MODULE I Linear and Non-Linear Programming **15 Hours**

Mathematical Formulation of Linear Programming Problems (LPP)-Basics of linear programming-Constructing the objective function and constraints- **Graphical Solution of LPP:**Feasible region-Optimality and special cases: Multiple optimal solutions, unbounded solutions, and infeasibility- **General Non-Linear Programming Problems (NLPP):**Differences between linear and non-linear programming-Formulating non-linear problems- **Constrained Optimization:**Optimization with equality and inequality constraints-Techniques such as Lagrange multipliers and Kuhn-Tucker conditions.

MODULE II Sequencing Models & Decision Theory **15 Hours**

Sequencing Models: Introduction to sequencing problems and assumptions-Processing nnn jobs through one, two, and multiple machines-Algorithms and methods for optimal sequencing-Practical problems related to sequencing- **Decision Theory:**Decision making in various environments (certainty, uncertainty, risk)-Decision tree analysis-Utility theory and decision making with utilities

MODULE III Game Theory & Network Scheduling **15 Hours**

Ga**me Theory:**Fundamentals of game theory and its applications-Characteristics of games and different game models-Mixed strategies and nnn-person zero-sum games-Limitations and practical applications of game theory- **Network Scheduling using PERT/CPM:**Rules for network construction-Critical path analysis and probability considerations in PERT-Differences between PERT and CPM-Resource analysis and time-cost optimization in network scheduling

Total Hours:	**45**

Text Books:	
1	Kanti Swarup, Gupta P.K and Man Mohan, “Operation Research”, 16th Edition, Sultan Chand & sons, 2014.
2	Chong, E. K. P., & Zak, S. H. (2013). *Introduction to Optimization* (4th ed.). Hoboken, NJ: John Wiley & Sons. ISBN 978-1118515150.
Reference Books:	
1	Prem Kumar Gupta and Hira D.S., "Operations Research”, 6th Edition, S.Chand & Company Ltd, 2013.
2	Taha H.A., “Operations Research”, 9th Edition, Pearson India Education, 2016. 3. Sharma J.K., “Operations Research Theory and Applications”, 5th Edition, Macmillan, 2013
Web References:	
1	https://www.analyticsvidhya.com/blog/2020/10/optimization-techniques-in-deep-learning/
2	https://www.geeksforgeeks.org/introduction-to-optimization-techniques/
3	https://www.coursera.org/learn/optimization-methods
	https://nptel.ac.in/courses/111/105/111105104/
Online Resources:	
1	https://web.stanford.edu/class/cs20si/2017/lectures/slides_02.pdf
2	https://ocw.gatech.edu/courses/optimization-techniques/
3	https://web.stanford.edu/~boyd/cvxbook/
4	https://ocw.mit.edu/courses/mathematics/18-086-mathematical-methods-for-engineers-ii-spring-2006/

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	3	3	3	3	2	1	-	-	-	-	-	2	3	2	2
C954.2	3	3	3	3	2	1	-	-	-	-	-	2	3	2	2
C954.3	3	2	2	3	1	1	-	-	-	-	-	2	2	1	1
C954.4	3	3	3	3	2	1	-	-	-	-	-	3	3	2	2
C954.5	3	3	3	3	2	1	-	-	-	-	-	3	3	2	3
C954	**3**	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS955	Advanced Learning Algorithms	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	**Introduction to Machine Learning**

Course Objectives:

1	To understand the concepts of neural network and TensorFlow framework.
2	To build and train a neural network with TensorFlow to perform multi-class classification.
3	Use the best practices of machine learning development so that your models generalize data and tasks in the real world.
4	Understand the concepts of decision trees and its variations.
5	To create decision trees using different ensemble models.

Course Outcomes:

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

C955.1	Apply the concepts of Neural Networks to make predictions.	[AP]
C955.2	Illustrate the TensorFlow framework to build neural network.	[AP]
C955.3	Apply machine learning models to develop solutions to the real world problems.	[AP]
C955.4	Analyze the machine learning cycle, training and evaluation to improve performance.	[A]
C955.5	Build decision trees using ensemble methods for random forests and boosted trees.	[AP]

Course Contents:

MODULE I INTRODUCTION TO NEURAL NETWORKS AND NEURAL NETWORK TRAINING

Neurons and the brain - Demand Prediction - Example: Recognizing Images - Neural network layer - More complex neural networks - Inference: making predictions (forward propagation) - Inference in Code - Data in TensorFlow - Building a neural network - Forward prop in a single layer - General implementation of forward propagation - Matrix multiplication rules. TensorFlow implementation - Alternatives to the sigmoid activation - Choosing activation functions - Neural Network with Softmax output - Classification with multiple outputs - Advanced Optimization.

MODULE II TRAINING AND EVALUATION

Evaluating a model - Model selection and training/cross validation/test sets - Diagnosing bias and variance - Regularization and bias/variance - Establishing a baseline level of performance - Learning curves - Deciding what to try next revisited - Bias/variance and neural networks - Iterative loop of ML development - Error analysis - Adding data - Transfer learning: using data from a different task - Full cycle of a machine learning project - Fairness, bias, and ethics - Error metrics for skewed datasets - Trading off precision and recall.

MODULE III DECISION TREES

Decision tree model - Learning Process - Measuring purity - Choosing a split: Information Gain - Using one-hot encoding of categorical features - Continuous valued features - Regression Trees - Using multiple decision trees - Sampling with replacement - Random forest algorithm – XGBoost – Case Study: Andrew Ng and Chris Manning on Natural Language Processing.

Total Hours:	**45**

Text Books:

1	Venkata Reddy, KonasaniShailendra Kadre, “Machine Learning and Deep Learning Using Python and TensorFlow”, 1st Edition, McGraw Hill, 2021.

2	Charu C. Aggarwal, “Neural Networks and Deep Learning”, Springer, 2018.
Reference Books:	
1	Dr. Raghuram Bhukya, “Exploring Machine Learning: A Beginners Perspective”, Horizon Books, 2021.
2	Tom Mitchell, “Machine Learning”, McGraw Hill, 1997.
Web References:	
1	https://www.coursera.org/learn/advanced-learning-algorithms
2	https://online.stanford.edu/courses/cs229-machine-learning
3	https://www.coursera.org/learn/machine-learning
Online Resources:	
1	https://www.kaggle.com/code/pavansanagapati/ensemble-learning-techniques-tutorial
2	https://www.simplilearn.com/tutorials/deep-learning-tutorial/deep-learning-algorithm

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	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
C955.2	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
C955.3	3	3	3	2	2	2	-	-	-	-	-	2	3	2	2
C901.4	3	3	3	2	2	2	-	-	-	-	-	3	3	2	2
C901.5	3	3	3	2	2	2	-	-	-	-	-	3	3	2	3
C901	**3**	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS956	Scalable Machine Learning	3/0/0/3
Nature of Course	H (Theory Technology)	
Prerequisites	**Random Variables and Statistics**	

Course Objectives:

1	Understand the key principles and challenges associated with scalability in machine learning
2	Explore the distributed computing frameworks, such as Apache Spark and Hadoop, to process large datasets and implement scalable machine learning algorithms.
3	Learn to design, train, and optimize machine learning models using advanced techniques, including parallel and distributed processing, to ensure they perform well on large-scale data.
4	Acquire the skills to deploy machine learning models in production environments using cloud-based platforms.
5	Develop the ability to apply scalable machine learning techniques to practical, real-world problems across various domains, ensuring that models can handle data growth and real-time processing requirements.

Course Outcomes:

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

C956.1	Apply advanced techniques such as parallel and distributed processing to design, train, and optimize machine learning models.	[AP]
C956.2	Illustrate distributed hyper parameter tuning frameworks to improve models at scale.	[AP]
C956.3	Solve practical, real-world problems by implementing scalable machine learning models capable of processing large datasets in real time.	[AP]
C956.4	Use advancements in scalable deep learning architectures and predict future trends in distributed AI.	[A]
C956.5	Analyze privacy-preserving techniques and ethical issues in scalable machine learning	[A]

Course Contents:

MODULE I INTRODUCTION TO SCALABLE MACHINE LEARNING 15 Hours

Understanding Scalability in Machine Learning-Definitions and importance of scalability - Challenges in scaling traditional machine learning models - Overview of large-scale data processing - **Distributed Computing and Parallelism**-Introduction to distributed computing concepts - Parallel vs. distributed computing - MapReduce and its application in machine learning - Case study: Using Hadoop/Spark for data processing - **Big Data Frameworks for Machine Learning** - Introduction to Apache Spark and Hadoop - Hands-on: Setting up a Spark environment -Implementing machine learning algorithms using MLlib in Spark - Distributed data storage (HDFS, NoSQL) **Case Studies and Applications** Real-world applications of scalable machine learning.

MODULE II ADVANCED TECHNIQUES IN SCALABLE MACHINE LEARNING 15 Hours

Model Training on Large Datasets - Techniques for handling large datasets (batch processing, mini-batch gradient descent) - Distributed model training -Model parallelism and data parallelism - **Model Optimization and Hyperparameter Tuning -** Scalable hyperparameter tuning methods (Grid Search, Random Search, Bayesian Optimization) - Distributed hyperparameter tuning frameworks (e.g., Hyperopt, Ray Tune) - **Case study**: Tuning models for performance at scale - **Model Deployment at Scale -** Containerization and orchestration (Docker, Kubernetes) - Serving models in production environments (TensorFlow Serving, MLflow, Seldon) - A/B testing and model monitoring at scale

MODULE III SPECIALIZED TOPICS IN SCALABLE MACHINE LEARNING 15 Hours

Scalable Deep Learning - Deep learning architectures and their scalability challenges - Distributed

training techniques for deep learning (Horovod, PyTorch Distributed) - Hands-on: Training deep neural networks at scale using Horovod - Discussion on recent advancements and future directions - **Real-Time Machine Learning and Streaming Data -** Introduction to real-time machine learning and streaming data processing - Frameworks for real-time ML (Apache Kafka, Apache Flink, Spark Streaming) - Hands-on: Building and deploying real-time ML models using Spark Streaming and Kafka - **Case study**: Real-time recommendation engines and anomaly detection - **Ethics, Privacy, and Fairness in Scalable ML -** Ethical considerations in scalable machine learning - Privacy-preserving machine learning techniques (Federated Learning, Differential Privacy) - Fairness in machine learning at scale - Discussion on the societal impact of large-scale AI systems.

	Total Hours:	**45**

Text Books:

1	Adi Polak, “Scaling Machine Learning with Spark: Distributed ML with MLlib, TensorFlow, and PyTorch”, Ist edition, O'Reilly Media, 2023
2	Tanay Agrawal, “Hyperparameter Optimization in Machine Learning”, Apress,2020.
3	Machine Learning with Spark and Python: Essential Techniques for Predictive Analytics" by Michael Bowles
4	**"Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron**

Reference Books:

1	"Spark: The Definitive Guide: Big Data Processing Made Simple" by Bill Chambers and Matei Zaharia
2	Ian Goodfellow, Yoshua Bengio, Aaron Courville, “Deep Learning (Adaptive Computation and Machine Learning)”,MIT press, 2023
3	Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems" by Martin Kleppmann

Web References:

1	https://ischoolonline.berkeley.edu/data-science/curriculum/machine-learning-at-scale/
2	https://freevideolectures.com/course/2257/machine-learning
3	https://www.coursera.org/learn/machine-learning

Online Resources:

1	https://www.analytixlabs.co.in/machine-learning-course-certification-training
2	https://in.udacity.com/course/intro-to-machine-learning--ud120-india

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	1	2	2	-	-	-	-	-	2	3	2	2
C956.2	3	3	3	1	2	2	-	-	-	-	-	2	3	2	2
C956.3	3	3	3	-	-	-	-	-	-	-	-	2	3	-	2
C956.4	3	3	3	1	2	2	-	-	-	-	-	3	3	2	2
C956.5	3	3	3	1	2	2	-	-	-	-	-	3	3	2	3
C956	**3**	**3**	**3**	**1**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS957	Mathematics for Machine Learning	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	-

Course Objectives:

1	To equip students with the mathematical foundations essential for understanding and developing machine learning algorithms.
2	To enable students to apply linear algebra, calculus, probability, and optimization techniques to machine learning models and data-driven decision-making.
3	To cultivate analytical and problem-solving skills through the use of mathematical tools in designing, training, and evaluating machine learning models.

Course Outcomes:

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

C957.1	Analyze and apply linear algebra concepts such as vector spaces, eigenvalues, and singular value decomposition (SVD) to machine learning models.	[AN]
C957.2	Demonstrate the ability to use multivariate calculus to optimize machine learning algorithms, including gradient-based methods.	[AP]
C957.3	Apply probability theory and statistical methods for understanding uncertainty and constructing probabilistic models in machine learning.	[AP]
C957.4	Design and implement optimization techniques, such as convex optimization, for improving the efficiency and performance of machine learning algorithms.	[AP]
C957.5	Evaluate and integrate various mathematical techniques to solve real-world machine learning problems and perform model evaluation.	[EV]

Course Contents:

MODULE I Linear Algebra for Machine Learning **15 Hours**

Introduction to Machine Learning – Types of Machine Learning – Basic Concepts in Machine Learning Supervised Learning – Unsupervised Learning. **Vector Spaces and Linear Transformations**: Scalars, vectors, matrices, matrix operations, matrix inversion, properties of vector spaces. **Eigenvalues and Eigenvectors**: Importance of eigenvalues in data representation, Principal Component Analysis (PCA), Singular Value Decomposition (SVD). **Applications in Machine Learning**: Data transformations, dimensionality reduction, and feature extraction using SVD and PCA.

MODULE II Multivariate Calculus and Optimization **15 Hours**

Multivariate Functions: Partial derivatives, gradient, Hessian, and Jacobian matrix. **Optimization Techniques**: Gradient Descent, Newton's method, stochastic gradient descent, convergence rates, and regularization techniques. **Applications in Machine Learning**: Cost function optimization for linear regression, logistic regression, neural networks, and support vector machines (SVM).

MODULE III Probability and Statistics for Machine Learning **15 Hours**

Probability Theory: Basics of probability, conditional probability, Bayes' theorem, random variables, expectation, variance, covariance. **Statistical Inference**: Probability distributions (Gaussian, Binomial, Poisson), maximum likelihood estimation, and hypothesis testing. **Applications in Machine Learning**: Probabilistic reasoning, Naive Bayes classifier, Gaussian Mixture Models (GMM), Hidden Markov Models (HMM), and Bayesian networks.

Total Hours:	**45**

Text Books:

1	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. *Mathematics for machine learning*. Cambridge University Press, 2020.
2	Strang, G. "Linear Algebra and its Applications. San Diego, Harcourt Brace Jovanovich."

	(1988).
3	Bishop, Christopher M. *Pattern recognition and machine learning by Christopher M. Bishop*. Springer Science+ Business Media, LLC, 2006.
4	Mitchell, Tom M. Machine Learning. India: McGraw Hill, 2017.
5	Alpaydin, Ethem. Introduction to Machine Learning. United States: MIT Press, 2009.
Reference Books:	
1	Bishop, Christopher M. Pattern Recognition and Machine Learning. Switzerland: Springer New York, 2006.
2	Golub, Gene Howard., Van Loan, Charles F. Matrix Computations. United States: Johns Hopkins University Press, 2013.
3	Stewart, James., Clegg, Daniel K., Watson, Saleem. Multivariable Calculus. United States: Cengage Learning, 2020.
4	Boyd, Stephen P., Vandenberghe, Lieven. Convex Optimization. India: Cambridge University Press, 2004.
5	Murphy, Kevin P. Machine Learning: A Probabilistic Perspective. United Kingdom: MIT Press, 2012.
6	Marsland, Stephen. Machine Learning: An Algorithmic Perspective, Second Edition. United States: CRC Press, 2014.
7	Nelli, Fabio. Python Data Analytics: With Pandas, NumPy, and Matplotlib. Germany: Apress, 2018.
8	Bell, Jason. Machine Learning: Hands-On for Developers and Technical Professionals. United States: Wiley, 2020.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc16_cs18/preview 2.
2	https://web.stanford.edu/class/cs109/
2	https://www.khanacademy.org/math/linear-algebra
3	https://www.coursera.org/learn/optimization-methods
4	https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/
Online Resources:	
1	https://www.coursera.org/learn/multivariate-calculus-machine-learning
2	https://ocw.mit.edu/courses/mathematics/18-02sc-multivariable-calculus-fall-2010/
3	http://web.stanford.edu/class/ee364a
4	https://www.coursera.org/specializations/deep-learning
5	https://www.fast.ai/

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	2	3	2	-	-	-	1	2	1	-	3	3	2
C957.2	3	3	3	3	3	-	-	-	2	1	-	-	3	2	2
C957.3	3	3	2	3	2	-	-	-	2	1	-	1	3	2	3
C957.4	3	3	3	3	3	-	-	-	2	2	-	1	3	3	2
C957.5	3	3	3	3	2	-	-	-	2	1	-	2	3	3	2
C957	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**2**	**1**	**1**	**1**	**3**	**3**	**2**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS958	GENERATIVE ADVERSARIAL NETWORKS	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	

Course Objectives:

1	Understand the fundamental concepts and principles of Generative Adversarial Networks (GANs), including the architecture, training process, and applications.
2	Design and implement GAN models using popular deep learning frameworks such as TensorFlow or PyTorch.
3	Apply GANs to real-world problems, such as generating realistic images, videos, and music, as well as enhancing image quality and resolving data scarcity issues.
4	Analyze and evaluate the performance of GANs in various tasks, including image generation, data augmentation, and style transfer.
5	6. Stay up-to-date with recent advancements and breakthroughs in GAN research, including conditional GANs, progressive GANs, and StyleGANs and demonstrate critical thinking and problem-solving skills in applying GANs to novel applications and domains.

Course Outcomes:

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

C958.1	Summarize the fundamental concept of Generative Adversarial Networks (GANs), including autoencoders.	[U]
C958.2	Implement Variational Autoencoders (VAEs), including the encoder, loss function, and training procedures.	[AP]
C958.3	Illustrate the concept of deep neural networks and multilayer perceptrons (MLPs).	[AP]
C958.4	Apply GANs to real-world problems, including generating shapes and face aging.	[AP]
C958.5	Identity image style transfer across various domains using deep learning techniques.	[AN]

Course Contents:

MODULE I INTRODUCTION **15 Hours**

Introduction to GANs– Auto encoders as a Path to GANs – Basic Concepts in Deep Convolutional GAN (DCGAN) – Training and Common Challenges: GANing for Success. Working functionalities of GAN – MNIST digit generation using GAN in Tensorflow – DCGAN for MNIST digits – GAN Architectures: SRGAN, CycleGAN – Applications of GAN.

MODULE II GENERATIVE DEEP LEARNING **15 Hours**

Generative Modeling – Our First Generative Model – Core Probability Theory – Generative Model Taxonomy – The Generative Deep Learning Codebase – Deep Neural Networks – Multilayer Perceptron (MLP) – Variational Autoencoders: The Encoder- The Loss Function- Training the Variational Autoencoder- Analysis of the Variational Autoencoder. **Case study on The CarRacing Environment using world model**.

MODULE III LEARNING GENERATIVE ADVERSARIAL NETWORKS **15 Hours**

Introduction to Deep Learning - Unsupervised Learning with GAN- Transfer Image Style Across Various Domains - Building Realistic Images from Your Text - Using Various Generative Models to Generate Images - Taking Machine Learning to Production.

Total Hours:	**45**

Text Books:

1	Jakub Langr and Vladimir Bok, “GANs in Action: Deep learning with Generative Adversarial Networks”, Manning, 2019.
2	David Foster, “Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play”, 2nd edition O'Reilly Media, Inc., 2023.
3	Kailash Ahirwar, “Generative Adversarial Networks Projects: Build next-generation generative models using TensorFlow and Keras**”,** Packt Publishing , 2019**.**
4	Kuntal Ganguly, “Learning Generative Adversarial Networks: Next-generation deep learning simplified”, Packt Publishing , 2017.
Reference Books:	
1	Josh Kalin, — “Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras”, Packt Publishing , 2018.
2	Rafael Valle, — Hands-On Generative Adversarial Networks with Keras: Your guide to implementing next-generation generative adversarial network, Packt Publishing, 2019.
3	Francois Chollet — “Deep Learning with Python”, Second Edition, Manning, 2019.
Web References:	
1	https://onlinecourses.nptel.ac.in/noc22_cs22/preview.
2	https://www.udacity.com/course/building-generative-adversarial-networks--cd1823.
3	Build Basic Generative Adversarial Networks (GANs) | Coursera
Online Resources:	
1	https://www.deeplearning.ai/courses/generative-adversarial-networks-gans-specialization/.
2	https://arxiv.org/abs/1406.2661.

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	3	1	2	2						2	2	2	2
C958.2	3	3	3		2	2						2	2	2	2
C958.3	3	3	3	2	2	3						2	2	3	2
C958.4	3	3	3	1	2	2						3	2	2	2
C958.5	3	3	3	1	2	1						3	2	2	3
C958	**3**	**3**	**3**	**1**	**2**	**2**						**3**	**2**	**2**	**3**

3	Strongly agreed	2	Moderately agreed	1	Reasonably agreed

22CS959	Deep Learning Frameworks	3/0/0/3

Nature of Course	H (Theory Technology)
Prerequisites	

Course Objectives:

1	Develop and Implement Complex Deep Learning Models
2	Leverage Model Serialization and Deployment:
3	Apply Advanced Hyperparameter Tuning Techniques
4	Master Advanced Architectures for NLP and Computer Vision
5	Evaluate Frameworks for Complex Tasks and Big Data

Course Outcomes:

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

C959.1	Apply Core Deep Learning Concepts Using Leading Frameworks TensorFlow and Pytorch.	[AP]
C959.2	Develop complex models and applying model serialization techniques for real-world applications.	[AP]
C959.3	Analyze different hyperparameter tuning techniques in TensorFlow and PyTorch and evaluate how different methods affect the model's speed and accuracy.	[AN]
C959.4	Implement advanced architectures for Natural Language Processing tasks and Computer Vision tasks.	[AP]
C959.5	Analyze the performance of various deep learning frameworks in specialized applications for handling complex tasks and big data.	[AN]

Course Contents:

MODULE I Introduction to Deep Learning Frameworks 15 Hours

Overview of Deep Learning – Introduction to Neural Networks - Key Concepts in Deep Learning (Activation Functions, Loss Functions, Optimizers) - Model Training, Validation, and Testing- **Deep Learning Frameworks**: Importance of frameworks in Deep Learning - Popular frameworks(Tensorflow, Pytorch, Keras, MXNet) - **TensorFlow:** Introduction-, Tensor Operations and Graphs- Tensorflow Keras API - **PyTorch**: Autograd, and Neural Network Module.

MODULE II Advanced Concepts and Model Development 15 Hours

Model Development using Tensorflow keras API and Pytorch -Working with Custom Layers in Tensorflow - Model Serialization and Loading Pre-trained Models - TFX for Prodcution, Building complex models using pytorch - Custom Layers and Model Subclassing in Pytorch - Pytorch Lightning for structured model development, **Hyperparameter Tuning and Optimization**: Techniques for Structured model development- using tensorflow and Pytorch for Hyperparameter Optimization.

MODULE III Specialized Applications 15 Hours

Natural Language Processing with Deep Learning Frameworks: Text Preprocessing and Embedding Techniques- Building RNNs, LSTMs, and Transformers - BERT-GPT- **Computer Vision with Deep Learning Frameworks**: Image Preprocessing and Data Augumentation - Building CNNs, ResNets and GANs- VGG,Inception and EfficientNet-**Case Study**: Image Classification or Object Detection- Future Trends in Deep Learning Frameworks - Sentiment Analysis or Text Generation

Total Hours:	**45**

Text Books:

1	Francois Chollet, "Deep Learning with Python", Manning Publications, 2017.
2	Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" , O'Reilly Media, 2022.
3	Ian Pointer, "Programming PyTorch for Deep Learning",O'Reilly Media 2019.

Reference Books:

1	Ian Goodfellow, Yoshua Bengio, and Aaron Courville, " Deep Learning", MIT Press,2016.

2	Eli Stevens, Luca Antiga, and Thomas Viehmann, “Deep Learning with Python and PyTorch", Manning Publications ,2020.
Web References:	
1	https://www.tensorflow.org/.
2	https://keras.io/
Online Resources:	
1	https://lightning.ai/docs/pytorch/stable/
2	https://developer.nvidia.com/deep-learning-frameworks

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	3	3	3	2	-	-	-	-	-	2	3	3	2
C959.2	3	3	3	3	3	2	-	-	-	-	-	2	3	3	2
C959.3	3	3	3	3	3	2	-	-	-	-	-	2	3	3	2
C959.4	3	3	3	3	3	2	-	-	-	-	-	2	3	3	2
C959.5	3	3	3	3	3	2	-	-	-	-	-	2	3	3	2
C959	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**

EMERGING ELECTIVES
STREAM-1

22CS007	Design of Dependable System	3/0/0/3

Nature of Course	C (Theory Concept)

Course Objectives:

1	To discover the fundamentals of dependable computing.
2	To explore various modeling techniques for dependable computing.
3	To determine various fault-tolerant design concepts.
4	To examine dependability evaluation tools and techniques.
5	To interpret the features of real-time Fault-tolerant systems.

Course Outcomes:

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

C007.1	Design and develop dependable computing models by leveraging techniques and measures to ensure system reliability and robustness.	[AP]
C007.2	Analyze the reliability of systems using modeling techniques like series-parallel systems, k-out-of-n systems, fault-tree methods, and reliability graphs.	[AN]
C007.3	Classify various types of faults, errors, and failures, and evaluate their impact on system reliability	[AN]
C007.4	Apply redundancy techniques (hardware, software, time, and information) and tools like HIMAP for dependability evaluation in practical scenarios, including healthcare industries.	[AP]
C007.5	Evaluate fault-tolerant architectures, protocols, and algorithms, including checkpointing, stable storage, RAID, and fault-tolerant scheduling, to design reliable real-time distributed systems.	[E]

Course Contents:

MODULE I Fundamentals of Dependable Computing 15 Hours

Introduction - Dependable system - Techniques for achieving dependability - dependability measures - Combinational Modelling - Modeling by Case Analysis -Series and Parallel Systems - Classes of k-out-of-n Systems - Reliability Block Diagrams - Reliability Graphs - The Fault-Tree Method.

MODULE II Defects, Faults and Errors 15 Hours

Faults – errors – Defects - faults and their manifestation - classification of faults and failures - Fault detection – masking – containment – location – reconfiguration - recovery. **Dependability Evaluation Techniques :** Hardware redundancy - software redundancy - time redundancy - information redundancy - HIMAP tool. **CASE STUDY:** Dependability evaluation in healthcare industries.

MODULE III Fault Tolerance in Real-Time Distributed Systems 15 Hours

Introduction to Real-Time Distributed Systems- Byzantine General problem - consensus protocols - checkpointing and recovery - stable storage and RAID architectures - data replication and resiliency – Dependability evaluation techniques and tools – Analysis of Fault-tolerant hardware architecture – Analysis of Fault-tolerant software architecture - Fault tolerance in real-time systems: Time-space tradeoff – fault-tolerant scheduling algorithms. **CASE STUDY:** Fault-tolerant multiprocessor and distributed systems.

Total Hours:	**45**

Text Books:

1	Fault Tolerant Systems by Israel Koren, C.Krishna, Morgan Kaufmann, Science Direct, Second Edition,2020.
2	Reliable Computer Systems: Design and Evaluation (Third edition) by D. P. Siewiorek and R. S. Swarz, CRCl Press, 2019
3	Fault Tolerance in Distributed Systems, Pankaj Jalote, PTR Printice Hall, 1994.

Reference Books:

1	Distributed Real-Time Systems: Theory and Practice (Paperback - 2020) , Springer 2020.

2	Reliability Engineering: Theory and Practice (Eight Edition) by Alessandro Birolini, Springer 2017.
3	Design and Analysis of Fault Tolerant Digital Systems by B.W. Johnson, Addison Wesley, 1989.
4	Design of Dependable Computing Systems, Jean-Claude Geffroy, G. Motet, Springer 2002.

Web References:

1	https://web.ece.ucsb.edu/~parhami/text_dep_comp.htm
2	https://www.docsity.com/en/terminology-and-concepts-dependable-computing-systems-lecture-notes/333794/
3	https://depend.csl.illinois.edu/our-research/nftape-2/#sthash.MaWOOCos.dpbs

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

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**
C007.1	3	3	3	2	1							1	2	2	1
C007.2	3	3	3	2	1							1	2	2	1
C007.3	3	3	3	3	1							1	2	2	1
C007.4	3	3	3	2	2	1						1	2	3	1
C007.5	3	3	3	3	2	1						1	3	2	1
C007	**3**	**3**	**3**	**3**	**2**	**1**						**1**	**3**	**3**	**1**

22CS008	Networked Cyber Physical Systems	3/0/0/3
Nature of Course:	C (Theory Concept)	

Prerequisites: Computer Organization and Digital System design

Course Objectives:

1.	To explain the fundamental aspects of cyber physical systems.
2.	To explore modeling techniques of physical systems.
3.	To examine computational systems modeling.
4.	To discuss various communication concepts of networked cyber physical systems.
5.	To understand security and privacy issues in networked cyber physical systems.

Course Outcomes:

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

C008.1	Exemplify the fundamentals and Modelling of cyber physical systems.	[U]
C008.2	Demonstrate the human behavior modelling and data driven modelling for real-time problems.	[AP]
C008.3	Apply safety monitors on cyber physical systems.	[AP]
C008.4	Show the communication aspects of Cyber physical systems and CPS implementation issues	[AP]
C008.5	Assess the security and privacy issues in Cyber Physical Systems.	[AP]

Course Contents:

MODULE I Fundamentals of Cyber Physical Systems **15 Hours**

Introduction to Cyber Physical Systems: Key Features – Computational Vs Physical Systems – Applications – Hardware Platforms for CPS - Synchronous Models – Properties of Components - Composing Components – Synchronous designs – **Modeling Physical Systems:** Reconnecting with the Physical World - Conservation Laws - Elements in Mechanical and Electrical systems – Hybrid Systems – Hybrid Automata – Reset Maps – Zeno Behavior.

MODULE II Computational Systems Modeling **15 Hours**

Introduction - sensing and workload modeling- human behaviour modeling- data-driven modeling- Quantization – Discretization - Boundedness of Digital Memory - Abstract Modeling of Computational Effects – Modeling Quantization and Discretization - **CPS implementation issues:** CPS Performance Analysis: Effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion- Building real-time networks for CPS

MODULE III Communication and Security **15 Hours**

Communication, Certainty, Uncertainty, and Belief – Messages - Belief, Knowledge, and Truth - Carrier Signal, Medium, and Link - Link Characteristics - Cyber-physical systems and their security Risks - Protections Against Natural Events and Accidents - Security and Privacy Concerns–Preventing, Detecting and mitigating attacks. **Case Study:** Intelligent CPS for Robot motion control and Autonomous vehicle control.

Total Hours: 45 Hours

Text Books:

1.	Walid M. Taha, Abd-Elhamid M. Taha, Johan Thunberg," Cyber-Physical Systems: A Model-Based Approach", Springer, 2021.
2.	Edward Ashford Lee and Sanjit Arun kumar Seshia, "Introduction to Embedded Systems: A Cyber-Physical Systems Approach", Second edition, MIT press, 2017.
3.	Rajeev Alur, "Principles of Cyber-Physical Systems ", MIT press, 2015.

Reference Books:

1.	Cyber-Physical Systems Security Knowledge Area Issue 1.0 by Alvaro Cardenas University of California, 2019.

2.	Security and Privacy in Cyber-Physical Systems: Foundations, Principles, and Applications, Glenn A. Fink, Houbing Song, Sabina Jeschke, 2017.
Web References:	
1.	https://www.coursera.org/learn/cyber-physical-systems-1
2.	https://www.udacity.com/course/cyber-physical-systems-design-analysis--ud9876
3.	https://www.classcentral.com/course/edx-cyber-physical-systems-1910
Online Resources:	
1.	https://www.eecs.umich.edu/courses/eecs571/lectures/lecture2-intro-of-CPS.pdf
2.	http://ieeecss.org/sites/ieeecss/files/2019-07/IoCT-Part3-02CyberphysicalSystems.pdf
3.	https://fardapaper.ir/mohavaha/uploads/2019/04/Fardapaper-Cyber-physical-systems-and-their-security-issues.pdf

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

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	2	2										3	2	
C008.2	3	2	2										3	2	
C008.3	3	3	3	1	1								3	2	1
C008.4	3	3	3	2	1							1	3	2	1
C008.5	3	3	3	2	1							1	3	2	1
C008.6	3	3	3	2	1							1	3	2	1
C008	**3**	**3**	**3**	**2**	**1**							**1**	**3**	**2**	**1**

22CS009	SERVERLESS COMPUTING	3/0/0/3
Nature of Course:	D (Theory Applications)	
Prerequisites:	Web Technology, Cloud Computing	

Course Objectives:

1.	To comprehend the working of serverless computing and ways it can be used in cloud applications.
2.	To create and manage serverless functions using the Cloud Functions platform.
3.	To organize functions and create reusable building blocks using packages.
4.	To navigate the web user interface to perform the tasks.

Course Outcomes:

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

C009.1	Design and develop serverless computing solutions by leveraging its fundamental concepts for diverse applications.	[AP]
C009.2	Critically evaluate the functionality and interactions of Handlers, Callback Functions, Events, and Context objects in serverless architectures.	[E]
C009.3	Devise and execute operations on storage and database services to optimize serverless application performance.	[AP]
C009.4	Construct and deploy serverless solutions using various functions and frameworks, addressing real-world challenges.	[AP]
C009.5	Analyze and optimize web services by utilizing advanced features of different serverless computing platforms.	[A]

Course Contents:

MODULE I Serverless Essentials **15 Hours**

Serverless Computing - Benefits and use cases- Limitations - Provider offers - Explore Triggers and Events - Development Options, Toolkits, SDKs - Developing Locally vs Using the Console- The Tools - Environment Setup.

MODULE II Computing Services **15 Hours**

Serverless Security: Comparing FaaS to IaaS - Serverless Framework – Serverless Functions – Understanding lambda functions - Command line interface - Integrating Lambda Layers with the Serverless Framework – Serverless storage services and Database services. **Case Study:** Amazon DynamoDB and AWS Lambda Functions.

MODULE III Web Services **15 Hours**

Explore the UI - Security - Code - Environment Variable - HTTP Event - Storage Event using Amazon Web Services - Azure and Google Cloud - An Agnostic Approach- Reference architecture for a web App - Reference architecture for a real-time file processing. **Case Study:** Build AWS serverless web applications - Create a CRUD HTTP API with Lambda and DynamoDB.

Total Hours: 45 Hours

Text Books:

1.	Maddie Stigler , “Beginning Serverless Computing: Developing with Amazon Web Services, Microsoft Azure, and Google Cloud”, A Press, 2018.
2.	Kuldeep Chowhan," Hands-On Serverless Computing”, Packt Publishing, July 2018.
3.	Sheen Brisals & Luke Hedger, “Serverless Development on AWS – Building Enterprise - scale Serverless solutions”, O’Reilly Publications Inc., 2024.

Reference Books:

1.	Praveen Kumar Sreeram, “Azure Serverless Computing Cookbook", Third Edition, Packt Publishing, 2021.
2.	Scott Patterson, "Learn AWS Serverless Computing", Packt Publishing, December 2019.

Web References:	
1.	https://www.tutorialspoint.com/serverless/serverless_introduction.htm
2.	https://bytescout.com/blog/serverless-computing-tutorial.html
3.	https://www.naukri.com/learning/articles/a-guide-to-serverless-computing/
Online Resources:	
1.	https://cognitiveclass.ai/courses/serverless-computing-using-cloud-functions-developer-1
2.	https://www.coursera.org/learn/aws-fundamentals-building-serverless-applications
3.	https://www.udemy.com/course/serverless-computing-with-aws-lambda-faas/

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

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	3	2	2										3	2	
C009.2	3	2	2										3	2	1
C009.3	3	3	3	2	1								3	2	1
C009.4	3	3	3	2	1							1	3	2	1
C009.5	3	3	3	2	1							1	3	2	1
C009	**3**	**3**	**3**	**2**	**1**							**1**	**3**	**2**	**1**